

CHAPTER 9: THE MUSCULAR SYSTEM

OBJECTIVES:

1. Compare and contrast the types of muscle tissues in terms of structure, control, location, and type of contraction, and function.
2. Describe three similarities among the three muscle tissues.
3. Identify the terms used for a muscle fiber's cell membrane and cytoplasm.
4. Describe the functions of muscle tissue.
5. Compare and contrast the functional characteristics of muscle tissue (i.e. excitability, contractility, extensibility, and elasticity).
6. Illustrate how a skeletal muscle is wrapped in four layers of connective tissue.
7. Define the terms *tendon*, *aponeurosis*, *raphe*, and *syncytium*.
8. Explain why numerous glycogen-filled vacuoles and many mitochondria are present in the sarcoplasm of skeletal muscle fibers.
9. Explain the significance of the special membranous organelles found in skeletal muscle tissue.
10. Illustrate how the myofibrils that compose skeletal muscle fibers are composed of sarcomeres. Label the thick filaments, thin filaments, A-Band, I-Band and Z-line.
11. Compare and contrast the ultrastructure of thick and thin filaments.
12. Explain what happens to sarcomere structure when a muscle contracts.
13. List the sequence of events involved in the power stroke of muscle contraction.
14. Describe how calcium is involved in the contraction mechanism.

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15. Define the terms *neuromuscular junction (NMJ)*, *motor unit*, *motor end-plate* and *neurotransmitter*.
16. Identify the most common chemical neurotransmitter substance.
17. List the sequence of events involved in muscle contraction beginning with the necessary initial motor impulse.
18. Explain how and why a contracted muscle relaxes.
19. Describe what is meant by an "all or nothing" response.
20. Compare and contrast isometric and isotonic muscle contractions.
21. Outline a general overview of cellular respiration, denoting its two major parts and where each occurs in the cell. Be sure to include starting products, end-products, and any additional requirements. Then discuss the significance of this pathway in skeletal muscle contraction (don't forget that the midpoint product can take one of two pathways!!!).
22. Explain how lactic acid is produced and what its accumulation causes.
23. Define the term *oxygen debt*.
24. Demonstrate the negative feedback mechanisms that maintain thermal homeostasis.
25. Distinguish between multi-unit and visceral smooth muscle and give examples of each type.
26. Define *peristalsis*.
27. List the characteristics of cardiac muscle tissue.
28. Define the terms *origin* and *insertion* as they relate to a skeletal muscle.
29. List the actions permitted by skeletal muscles and give an example of each.
30. Compare and contrast parallel, pennate, convergent and circular fascicle arrangements of skeletal muscle fibers, and give an example of each.

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31. Define the terms *prime mover*, *antagonist*, *synergists*, and *fixator* as they relate to muscle actions, and use the thigh muscles as an example.
32. Discuss skeletal muscle nomenclature.
33. For every skeletal muscle listed in this outline, be able to complete the following:
 - A. locate the muscle on a diagram or human muscle model.
 - B. describe the shape and/or fascicle arrangement of the muscle.
 - C. identify key origin and insertion sites.
 - D. describe the action.

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I. OVERVIEW OF MUSCLE TISSUES: Review Chapter 5, pages 153-154.

- A. Muscle Types: Skeletal
 Smooth
 Cardiac

B. **Similarities:**

1. All muscle cells are elongated = **muscle fibers**;
2. Muscle contraction depends on two kinds of myofilaments (**actin and myosin**);
3. The cell membrane of a muscle cell is called "**sarcolemma**", while the cytoplasm of a muscle cell is called "**sarcoplasm**".

C. **Skeletal Muscle Characteristics:**

1. long, thin and multi-nucleated fibers;
2. striations;
3. voluntary control;
4. arranged into packages called muscles that attach to and cover the bony skeleton;
5. contracts rapidly & vigorously, but tired easily; may exert great force.

D. **Cardiac Muscle Characteristics:**

1. network of fibers (intercalated disks);
2. only in heart;
3. striations;
4. involuntary control;
5. contracts at rhythmic, steady rate set by "pacemaker".

E. **Smooth Muscle Characteristics:**

1. lacks striations;
2. walls of hollow visceral organs & blood vessels;
3. involuntary control;
4. contractions are slow & sustained.

F. **Functions:**

1. **Movement** = locomotion & manipulation, vision, facial expression, blood pumping, food digesting, etc.;
2. **Posture Maintenance**
3. **Joint Stability**
4. **Heat Generation**

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I. Overview of Muscle Tissues (continued):

G. **Functional Characteristics** of Muscle:

1. **Excitability** = the ability to receive and respond to stimuli;
2. **Contractility** = the ability to shorten forcibly when stimulated;
3. **Extensibility** = the ability to be stretched or extended;
4. **Elasticity** = the ability to bounce back to original length, after being stretched or shortened.

II. **SKELETAL MUSCLE**

A. **Gross Anatomy:**

Each skeletal muscle is an organ made up of

1. thousands of muscle fibers,
2. connective tissue coverings,
3. blood vessels, and
4. nerve fibers.

B. **Connective Tissue Wrappings:** See Fig 9.2, page 283.

1. Each muscle fiber (cell) is wrapped in a thin, delicate layer of CT called **endomysium**.
 - a. Many muscle fibers are bundled together into groups called **fascicles**. See Fig 9.3, page 284.
2. Each fascicle is wrapped in a second layer of CT made of collagen called **perimysium**.
 - a. Many fascicles are bundled together to form a **skeletal muscle**.
3. Each skeletal muscle is covered by a third layer of dense, fibrous CT called **epimysium**.
4. Each skeletal muscle is then covered by a fourth, very tough fibrous layer of CT called **deep fascia**. See Fig 9.1, page 282.
 - a. The deep fascia may extend past the length of the muscle (**tendon** or **aponeuroses**), and attach that muscle to a bone, cartilage or muscle.

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II. C. Skeletal Muscle **Nerve & Blood Supply:**

1. Skeletal muscles (and each individual fiber) need a rich blood supply to provide
 - a. **oxygen** for cellular respiration to
 - b. produce **energy** for contraction, and to
 - c. **remove metabolic wastes** (CO₂).
2. Each skeletal muscle is supplied with a (motor) nerve ending that controls its activity.

See Fig 9.7, page 286 (discussed in detail later).

D. Skeletal Muscle **Attachments**

1. Review: Recall from Chapter 8 that most muscles span across joints and are attached to bones in at least two places:
 - a. The **origin** of a muscle is its immovable end,
 - b. The **insertion** of a muscle is its movable end.
 - * When a muscle contracts, its insertion is pulled toward its origin.
2. Attachments may be direct or indirect:

RARE!!!!

- a. **Direct** (fleshy) = epimysium of muscle is fused to:
 - m the periosteum of a bone or
 - m the perichondrium of a cartilage.

COMMON!!!!

- b. **Indirect** = when muscle fascia extends beyond the length of the muscle as a:
 - m rope-like tendon or
 - m sheet-like aponeurosis.
- * Indirect attachments anchor the muscle to the CT covering of a:
 - a. bone,
 - b. cartilage or
 - c. another muscle (seam of fibrous tissue = raphe).

See Figure 9.1, page 282.

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II. E. Microscopic Structure of Skeletal Muscle

1. long, cylindrical fibers with many nuclei beneath sarcolemma;
 2. very large cells that function as a **syncytium** (i.e. they function together as "fused cells");
 3. Sarcoplasm is filled with:
 - a. **glycogen** (carbohydrate/energy store) and
 - b. **numerous mitochondria**;
 4. Red color of skeletal muscle due to **myoglobin**.
 - a. oxygen-transporting pigment similar to hemoglobin,
 - b. provides only short-term oxygen supply;
 5. Specialized organelles include:
 - a. **Sarcoplasmic reticulum (SR)** = network of membranous channels.

m same as ER in other cells
 - b. **Transverse tubules (TT)** = network of membranous channels that extend from the muscle cell membrane (sarcolemma) deep into the cell.

See Fig 9.6, page 285.
- * SR and TT are involved in activating the muscle contraction mechanism (discussed in greater detail later).

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II. E. Microscopic Skeletal Muscle Structure (continued)

6. Recall that skeletal muscle fibers possess **striations**: See Fig 9.4, page 284.
 - a. A muscle fiber is a long, thin cell;
 - b. Each muscle fiber is composed of **myofibrils**;
 - c. Each myofibril is composed of two types of **protein filaments** (cytoskeletal elements):
 1. **Thick** filaments primarily composed of the protein myosin;
 2. **Thin** filaments primarily composed of the protein actin.
 - d. Striations are caused by the arrangement thick and thin filaments within the myofibrils:
 1. **A-Band** = dark area = thick plus thin;
 2. **I-Band** = light area = thin alone.
 - e. The length of each myofibril is divided into **sarcomeres**: See Fig 9.5, page 285.
 1. Sarcomeres meet one another at an area called the **Z-line**.

F. Ultrastructure & Molecular Composition of Myofilaments:

See Fig 9.9, page 288.

1. **Thick filaments** = protein **myosin**.
 - a. rod-like **tail** (axis) that terminates in two globular **heads or cross bridges**;
 - b. Cross bridges interact with active sites on thin filaments;
2. **Thin filaments** = protein **actin**.
 - a. coiled helical structure (resembles twisted strands of pearls):
 - b. **Tropomyosin** = rod-shaped protein spiraling around actin backbone to stabilize it;
 - c. **Troponin** = complex of polypeptides:
 - m one binds to actin,
 - m one that binds to tropomyosin,
 - m one that binds to calcium ions;
 - d. Both tropomyosin and troponin help control actin's interaction with myosin during contraction.

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II. H. Skeletal Muscle Contraction:

1. "Sliding Filament Theory":

- a. most popular theory concerning muscle contraction;
- b. first proposed by Hugh Huxley in 1954;
- c. states that muscle contraction involves the **sliding movement of the thin filaments (actin) past the thick filaments (myosin)**;
- d. Sliding continues until the overlapping between the thin & thick filaments is complete.

*Remember that in a relaxed muscle cell, overlapping of thick and thin filaments is only slight.

2. Changes in muscle cell during contraction:

See Fig 9.11, page 290.

- a. The distance between the Z-lines of the sarcomeres decreases;
- b. The I-Bands (light bands) shorten;
- c. The A-Bands move closer together, but do not diminish in length.

3. The Role of Calcium in Contraction Mechanism:

- a. In a resting muscle cell (i.e. in the absence of calcium ions):
 - m Tropomyosin blocks or inhibits the myosin binding sites on actin.
- b. When **calcium ions (Ca^{++})** are present:
 - m Ca^{++} binds to troponin causing a conformational change in the troponin-complex which causes:
 1. Tropomyosin to move
 2. which "opens" or exposes the myosin binding sites on actin;
 3. This results in interaction between the active sites on actin and the heads (or cross bridges) of myosin.

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II. H. Skeletal Muscle Contraction (continued)

4. **Sequence of Events in Sliding of Actin filaments During Contraction:** See Fig 9.10, page 289.

When calcium ions are present, the myosin binding sites on actin are exposed:

- a. **Cross-bridges attach.**
m Myosin heads attach to exposed binding sites on actin.
- b. **Cross-bridges bend.**
m actin is pulled (using ATP).
- c. **Cross bridges break.**
m Myosin heads are released from actin (using ATP).
- a. New cross-bridges are formed

* As long as calcium ions are present, this walking continues until the muscle fiber is fully contracted.

5. **Stimulation of Skeletal Muscle Cell:**

In order for a skeletal muscle to contract, its fibers must first be **stimulated by a motor neuron.**

See Figure 9.8, page 287.

- a. Definitions:
 - m **Neuromuscular Junction (NMJ)** = the site where a motor nerve fiber and a skeletal muscle fiber meet; Fig 9.7, pg 286.
 - m **Motor Unit** = one motor neuron and many skeletal muscle fibers; Fig 9.8a, page 287.
 - m **Motor End-Plate** = the specific part of a skeletal muscle fiber's sarcolemma directly beneath the NMJ.
 - m **Neurotransmitter** = chemical substance released from a motor end fiber, causing stimulation of the sarcolemma of muscle fiber; **acetylcholine (ACh).**

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II. H. Skeletal Muscle Contraction (continued)

6. **Sequence of Events** in Skeletal Muscle Stimulation: See Table 9.1, p. 291.
 - a. A **motor impulse** travels down from the brain, through the spinal cord, into a motor neuron, which branches into many **motor nerve fibers**;
 - b. Each motor nerve fiber extends to the motor end-plate of a skeletal muscle fiber forming a **neuromuscular junction (NMJ)**;
 - c. When the motor impulse reaches the end of the motor nerve fiber, **the membrane is depolarized (-100mV to -70mV)**;
m **calcium ions rush in, and**
m **neurotransmitter (ACh) is released into the NMJ** (via exocytosis).
 - d. ACh diffuses across the NMJ & stimulates the **sarcolemma** of a skeletal muscle fiber;
 - e. The impulse then travels deep into the muscle fiber by means of the **transverse tubules**;
 - f. The muscle impulse reaches the **sarcoplasmic reticulum**, which releases **Ca⁺⁺** into the **sarcoplasm** of the muscle fiber;
 - g. Ca⁺⁺ binds to troponin, moving tropomyosin and exposing binding sites on actin filament;
 - h. linkages form between actin and myosin;
 - i. the muscle **contracts**.
7. **Relaxation Mechanism:**
 - a. **Acetylcholinesterase** is an enzyme present in the NMJ;
 - b. It immediately destroys ACh, so it cannot cause continuous muscle contraction.
8. **All-or-nothing response** = if a muscle fiber responds at all it responds completely.

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II. H. Skeletal Muscle Contraction (continued)

9. **Isotonic vs. Isometric Contractions:** See Fig 9.17, page 296.

a. During an **isotonic contraction**,

m the muscle shortens and
m its attachment(s) move(s);

b. During an **isometric contraction**,

m the muscle becomes taut, however
m the attachment(s) do not move;
m i.e. tensing a muscle;

c. Most muscular movements involve both isotonic and isometric contractions.

10. **Energy for Muscle Contraction:**

a. ATP stored in skeletal muscle lasts only about six seconds.

ATP must be regenerated continuously if contraction is to continue.

There are **three pathways in which ATP is regenerated:**

b. **Coupled Reaction with Creatine Phosphate (CP):**

See Fig 9.12, page 291.

m $CP + ADP \rightleftharpoons creatine + ATP$

m Muscle stores a lot of CP,

m This coupling reaction allows for about 10 seconds worth of ATP.

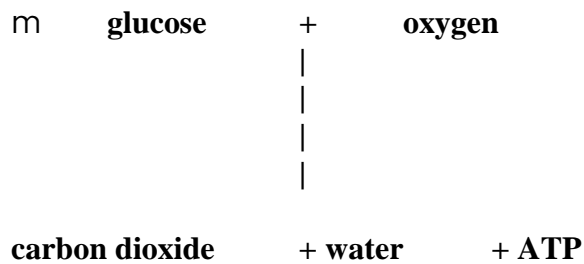
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II. H. 10. Energy for Skeletal Muscle Contraction (continued)

c. **Aerobic Respiration:** See Fig 9.13, page 292.

m **Cellular respiration** is the process by which energy (ATP) is released from glucose. (Covered in Chapter 4)

m Oxygen is required for the aerobic portion of cellular respiration which occurs in the **mitochondria** of the cell.



d. **Anaerobic Respiration**

m The first portion of CR does not require oxygen.

1. It occurs in the **cytoplasm** of the cell,
2. It is called **glycolysis**.
3. Pyruvic acid is the end-product of glycolysis.

m If no oxygen is present, pyruvic acid is converted to **lactic acid, which causes muscle fatigue and soreness**.

11. **Muscle fatigue**

- a. a state of physiological inability to contract;
- b. results from a relative deficit of ATP and/or accumulation of lactic acid (which decreases pH).

12. **Oxygen Debt:** See Fig 9.14, page 293.

- a. the amount of oxygen necessary to support the conversion of lactic acid to glycogen.
- b. needed to replenish spent glycogen stores.

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II. H. Skeletal Muscle Contraction (continued)

12. Heat Production

- a. Most of the energy released during muscle contraction is lost to heat, which helps maintain our body temperature at 98.6° F.
- b. Excessive heat is lost through many negative feedback mechanisms:
 - m sweating,
 - m dilation of superficial blood vessels,
 - m increased breathing rate, and
 - m increased heart rate.

III. Smooth Muscle Tissue: pages 297-298.

A. Two types:

1. Multi-unit smooth muscle

- a. location:
 - m irises of eyes
 - m blood vessels
- b. Contraction is rapid and vigorous (similar to skeletal muscle tissue).

2. Visceral smooth muscle

- a. Location = the walls of hollow organs
- b. Contraction is slow and sustained.
 1. Rhythmicity = pattern of repeated contractions;
 2. **Peristalsis** = wave-like motion that helps push substances through passageways.
- c. Structure:
 1. random arrangement of actin and myosin filaments.
 2. Two layers of muscle surround the passageway.
 - m circular
 - m longitudinal

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IV. CARDIAC MUSCLE TISSUE See pages 298-299.
Will be studied in greater detail in Chapter 15.

A. Location:

1. Only in heart.

B. Anatomy:

1. Striated uni-nuclear cells joined end-to-end forming a network.
 - a. Cell junctions are called intercalated discs.
m gap junctions
2. Arrangement of actin and myosin not as organized as skeletal muscle.
3. Contains sarcoplasmic reticulum, transverse tubules, and numerous mitochondria:
 - a. Sarcoplasmic reticulum is less developed than SR in skeletal muscle and stores much less calcium.

C. Physiology

1. Self-exciting tissue (i.e. “Pacemaker”);
2. Rhythmic contractions (60-100 beats/minute);
3. Involuntary, all-or-nothing contractions
 - a. Function as a “syncytium”.
4. Pumps blood to:
 - a. Lungs for oxygenation;
 - b. Body for distribution of oxygen and nutrients.

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V. REVIEW:

A. Recall that skeletal muscles are usually attached to a fixed body part and a movable body part: See Fig 9.19, page 300.

1. **Origin** = the immovable end of a muscle;

2. **Insertion** = the movable end of a muscle.

*When a muscle contracts, its insertion is pulled toward its origin.

B. Skeletal Muscle Actions:

1. **Flexion** = decreasing the angle between 2 bones;

a. Dorsiflexion = decreasing the angle between the foot and shin;

b. Plantar flexion = pointing toes;

2. **Extension** = increasing the angle between 2 bones;

3. **Abduction** = moving a body part away from the midline;

4. **Adduction** = moving a body part toward the midline;

5. **Circumduction** = movement in a circular (cone-shaped) motion;

6. **Rotation** = turning movement of a bone about its long axis; (i.e.atlas/axis);

7. **Supination** = thumbs up;

8. **Pronation** = thumbs down;

9. **Inversion** = sole of foot in;

10. **Eversion** = sole of foot out;

11. **Elevation** = lifting a body part; (i.e. shoulder shrug);

12. **Depression** = returning a body part to pre-elevated position.

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VI. ARRANGEMENTS OF FASCICLES

The most common **four arrangements** of skeletal muscle fascicles are parallel, pennate, convergent, and circular. These different arrangements result in muscles with different shapes and functions (determines range of motion & power).

- A. **Parallel** = long axes of fascicles run with longitudinal axis of muscle.
1. Examples:
 - a. sartorius (strap-like),
 - b. biceps brachii (fusiform).
 2. Sketch:
- B. **Pennate** = short fascicles that run obliquely to a central tendon.
1. Examples:
 - a. extensor digitorum longus (uni),
 - b. rectus femoris (bi).
 2. Sketch:
- C. **Convergent** = broad origin whose fascicles converge toward a single tendon.
1. Example:
 - a. pectoralis major.
 2. Sketch:
- D. **Circular** = fascicles arranged in concentric circles; compose sphincter muscles.
1. Examples:
 - a. orbicularis oculi,
 - b. orbicularis oris.
 2. Sketch:

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VII. FUNCTIONAL GROUPS OF MUSCLES

- A. **Prime Mover (agonist)** = the primary muscle responsible for a movement.
1. The biceps brachii in flexing the arm at the elbow,
 2. The gastrocnemius in plantar flexion.
- B. **Antagonist(s)** = the muscle(s) in opposition to the action of the prime mover; They relax during the prime movement.
1. The triceps brachii is the antagonist of the biceps brachii when we flex the arm at the elbow.
 2. The hamstring group is the antagonist of the quadriceps group in extending the leg at the knee.
- C. **Synergist(s)** = muscles that help the prime mover function more efficiently.
1. The brachialis helps the biceps brachii when it flexes the arm at the elbow,
 2. The soleus helps the gastrocnemius in plantar flexion.
- D. **Fixator** = synergist muscle groups that stabilize the origin of the prime mover so that it can act more efficiently.
1. The scapula is the origin for many arm muscles, but it must be held in place by fixator muscles in order to function in this way.
 - a. serratus anterior
 - b. pectoralis minor

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VIII. NAMING SKELETAL MUSCLES

CHARACTERISTIC	EXAMPLES	EXAMPLES IN HUMANS
Direction of fascicles relative to midline	rectus = parallel transverse = perpendicular oblique = at 45° angle	Rectus abdominis Transversus abdominis External Oblique
Location (i.e. the bone or body part that a muscle covers)	frontal bone tibia	Frontalis Tibialis Anterior
Relative Size	maximus = largest longus = longest brevis = shortest	Gluteus maximus Palmaris longus Peroneus longus
Number of Origins (Heads)	biceps = 2 origins triceps = 3 origins	Biceps brachii Triceps brachii
Shape	deltoid = triangle trapezius = trapezoid serratus = saw-toothed orbicularis = circular	Deltoid Trapezius Serratus anterior Orbicularis oris
Location of Origin and/or Insertion	origin = sternum insertion = mastoid process	Sternocleidomastoid
Action of Muscle	flexion extension adduction	Flexor carpi radialis Extensor digitorum Adductor longus

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IX. MAJOR SKELETAL MUSCLES (Keyed on pages 186-191 of this outline)

Use Fig 9.22 (page 302) through Fig 9.41 (page 330) to fill in the information in the following tables. Also refer to Plates 37 (page 338) through Plate 47 (page 342).

A. Muscles of Facial Expression

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Epicranius Frontalis Occipitalis		
Orbicularis oris		
Zygomaticus		
Buccinator		
Platysma		
Orbicularis oculi		

B. Muscles of Mastication

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Masseter(*)		
Temporalis		

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IX. Major Skeletal Muscles (continued)

C. Muscle that moves the Head

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Sternocleidomastoid		

D. Muscles that tense the Abdominal Wall

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Rectus abdominis		
External Oblique		
Internal Oblique		
Transversus abdominis		

E. Muscles used in Breathing

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Diaphragm		
Intercostals		

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IX. Major Skeletal Muscles (continued)

F. Muscles of the Perineum

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Urethral Sphincter		
External Anal Sphincter		

G. Muscles that move the Pectoral Girdle

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Trapezius		
Pectoralis minor		
Serratus anterior		

H. Muscles that move the Humerus

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Pectoralis major		
Latissimus dorsi		
Deltoid		

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IX. Major Skeletal Muscles (continued)

I. Muscles that move the Forearm (radius & ulna)

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Biceps Brachii		
Brachialis		
Brachioradialis		
Triceps brachii		

J. Muscles that move the Wrist, Hand, & Fingers

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Flexor carpi radialis		
Flexor carpi ulnaris		
Palmaris longus		
Extensor digitorum		

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IX. Major Skeletal Muscles (continued)

K. Muscles that move the Femur

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Gluteus Maximus		
Gluteus Medius		
Adductor Longus		

L. Muscles that move the Tibia & Fibula

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Rectus femoris		
Vastus lateralis		
Vastus Medialis		
Vastus intermedius		
Sartorius		
Biceps femoris		
Semitendinosus		
Semimembranosus		

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IX. Major Skeletal Muscles (continued)

M. Muscles that move the Foot & Toes

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Tibialis anterior		
Peroneus longus		
Gastrocnemius (*)		
Soleus		

***Note the location of the Calcaneal Tendon (page 329)**

X. Homeostatic Imbalances/Disorders

- A. Tendinitis (page 282)
- B. Compartment Syndrome (page 283)
- C. Muscle Strain (page 286)
- D. Poliomyelitis (page 287)
- E. Familial hypertrophic Cardiomyopathy (page 288)
- F. Myasthenia Gravis (page 289)
- G. Botulism (page 290)
- H. Rigor Mortis (page 293)
- I. Use and Disuse of Skeletal Muscles (CA 9.1, page 297)
- J. TMJ Syndrome (CA 9.2, page 304)
- K. Parkinson's Disease (page 313)
- L. Others (page 331)

XI. Innerconnections of the Muscular System:

See page 332.

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SKELETAL MUSCLE SUMMARY TABLES (outline pages 180-185)

A. Muscles of Facial Expression

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Epicranius	over head	raises eyebrow
Frontalis Occipitalis	over forehead over occipital	
Orbicularis oris	circular muscle around the mouth	closes lips ("kissing muscle")
Zygomaticus	muscle that connects zygomatic arch to corner of mouth	smiling muscle
Buccinator	hollow of cheek	"trumpeter's muscle"
Platysma	over lower jaw to neck	depresses mandible
Orbicularis oculi	circular muscle around eye	closes eye

B. Muscles of Mastication

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Masseter(*)	over lateral mandible	elevates mandible
Temporalis	convergent muscle over temporal bone	elevates mandible

**CHAPTER 9: THE MUSCULAR SYSTEM
SKELETAL MUSCLE SUMMARY TABLES**

C. Muscle that moves the Head

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Sternocleidomastoid (*)	neck muscle that originates at the manubrium of sternum and inserts at mastoid process of temporal bone	flexion of head toward chest (both contracted) head to one side (one contracted)

D. Muscles that tense the Abdominal Wall

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Rectus abdominis	strap like muscle from costal cartilages to ilium	tenses abdominal wall
External Oblique	superficial/lateral oblique abdominal muscle	tenses abdominal wall
Internal Oblique	deep oblique abdominal muscle	tenses abdominal wall
Transversus abdominis	deep abdominal muscle that runs perpendicular to rectus abdominis	tenses abdominal wall

E. Muscles used in Breathing

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Diaphragm	muscle that separates the thoracic from abdominal cavity	Inspiration
Intercostals	muscles between ribs	Inspiration

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SKELETAL MUSCLE SUMMARY TABLES**

F. Muscles of the Perineum

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Urethral Sphincter	Circular muscle surrounding urethra	urination/micturition
External Anal Sphincter	Outer circular muscle surrounding anus	defecation

G. Muscles that move the Pectoral Girdle

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Trapezius	Trapezoid shaped muscle that originates at occipital and inserts on acromion of scapula	elevate scapulae (“shoulder shrug”)
Pectoralis minor	Muscle below Pectoralis major	scapula fixator
Serratus anterior	Saw-toothed lateral thoracic muscle	scapula fixator

H. Muscles that move the Humerus

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Pectoralis major	Large, convergent chest muscle	pull arms forward (and together)
Latissimus dorsi	large back muscle	adduction of humerus
Deltoid	Triangular shaped shoulder muscle	abduction of humerus

CHAPTER 9: THE MUSCULAR SYSTEM
SKELETAL MUSCLE SUMMARY TABLES

I. Muscles that move the Forearm (radius & ulna)

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Biceps Brachii	fusiform, parallel, anterior upper arm muscle (two origins)	flexion of arm at elbow (prime mover)
Brachialis	muscle beneath biceps brachii	flexion of arm at elbow (synergist)
Brachioradialis	lateral muscle between upper and forearm	flexion of arm at elbow (synergist)
Triceps brachii	posterior upper arm muscle (three heads)	extension of arm at elbow

J. Muscles that move the Wrist, Hand, & Fingers

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Flexor carpi radialis	anterior, lateral forearm muscle	flexion of wrist
Flexor carpi ulnaris	anterior, medial forearm muscle	flexion of wrist
Palmaris longus	anterior forearm muscle located between two above	flexion of wrist
Extensor digitorum	posterior forearm muscle	extension of wrist/fingers

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K. Muscles that move the Femur

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Gluteus Maximus	buttocks, largest muscle in body	extension of hip (as in walking or climbing stairs)
Gluteus Medius	lateral hip muscle	abduction of femur
Adductor Longus	medial thigh muscle	adduction of femur

L. Muscles that move the Tibia & Fibula

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Rectus femoris	anterior thigh; quadricep	extension of leg at knee
Vastus lateralis	lateral anterior thigh; quadricep	extension of leg at knee
Vastus Medialis	medial anterior thigh; quadricep	extension of leg at knee
Vastus intermedius	deep anterior thigh; quadricep	extension of leg at knee
Sartorius (*)	parallel straplike muscle; originates on lateral ilium and inserts on medial tibia	flexion of knee forward
Biceps femoris	posterior thigh; hamstring	flexion of leg at knee
Semitendinosus	posterior thigh; hamstring	flexion of leg at knee
Semimembranosus	posterior thigh; hamstring	flexion of leg at knee

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M. Muscles that move the Foot & Toes

NAME OF MUSCLE	LOCATION/ DESCRIPTION	ACTION
Tibialis anterior	anterior to tibia	dorsiflexion
Peroneus longus	lateral to fibula	eversion
Gastrocnemius (*)	posterior lower leg (i.e. calf muscle); two origins	plantar flexion (prime mover)
Soleus	deep to gastrocnemius	plantar flexion (synergist)