Memmler’s
*The Human Body in Health and Disease*
11th edition

Chapter 8

The Muscular System
Types of Muscle

- Smooth
- Cardiac
- Skeletal
Smooth Muscle

- Makes up walls of hollow body organs, respiratory passageways
- Involuntary movement
- Cell structure
  - Tapered ends
  - Single, central nucleus
  - No visible bands (striations)
- Stimulated by nerve impulses, hormones, stretching
Cardiac Muscle

• Makes up wall of heart
• Involuntary movement
• Cell structure
  – Branching interconnections
  – Single, central nucleus
  – Striated
  – Membranes are intercalated disks
• Stimulated by electrical impulses, nervous stimuli, hormones
**Skeletal Muscle**

- Attached to bones, muscles, or skin
- Voluntary movement
- Cell structure
  - Long and cylindrical
  - Multiple nuclei per cell
  - Heavily striated
- Stimulated by nervous system
Skeletal muscle has three primary functions

• Skeletal movement
• Posture maintenance
• Heat generation
Structure of a Muscle

- Fascicles (muscle fibers)
- Endomysium
- Perimysium
- Epimysium (deep fascia)
- Tendons
Structure of a skeletal muscle.

(A) Structure of a muscle showing the tendon that attaches it to a bone. (B) Muscle tissue seen under a microscope. Portions of several fascicles are shown with connective tissue coverings.

ZOOMING IN • What is the innermost layer of connective tissue in a muscle? • What layer of connective tissue surrounds a fascicle of muscle fibers?
Muscle Cells in Action

- Motor unit is a single neuron and all the muscle fibers it stimulates
- Neuromuscular junction (NMJ)
  - Neurotransmitter
  - Synaptic cleft
  - Receptors
  - Motor end plate
Neuromuscular junction (NMJ).

(A) The branched end of a motor neuron makes contact with the membrane of a muscle fiber (cell). (B) Enlarged view of the NMJ showing release of neurotransmitter (acetylcholine) into the synaptic cleft. (C) Acetylcholine attaches to receptors in the motor end plate, whose folds increase surface area. (D) Electron microscope photograph of the neuromuscular junction.
Properties of Muscle Tissue

- Excitability
  - Action potential

- Contractility
  - Actin
  - Myosin
  - Sarcomere
  - ATP
Sliding filament mechanism of skeletal muscle contraction.

(A) Muscle is relaxed and there is no contact between the actin and myosin filaments.

(B) Cross-bridges form and the actin filaments are moved closer together as the muscle fiber contracts. (C) The cross-bridges return to their original position and attach to new sites to prepare for another pull on the actin filaments and further contraction.

ZOOMING IN • Do the actin or myosin filaments change in length as contraction proceeds?
The Role of Calcium

Calcium

• Is released when nerve fiber stimulates muscle cell
• Attaches to proteins blocking receptor sites
• Allows cross-bridges to form between actin and myosin
• Returns to endoplasmic reticulum (ER), which is called “sarcoplasmic reticulum” in muscle cells.
Energy Sources

Muscle contraction requires energy (ATP), oxidized in muscle cells from

- Oxygen
- Glucose or other usable nutrient

Compounds in muscle cells that store oxygen, energy, or nutrients

- Myoglobin
- Glycogen
- Creatine phosphate
Oxygen Consumption

• Aerobic glucose metabolism
• Anaerobic glucose metabolism
  – Inefficient production
  – Lactic acid accumulation
  – Oxygen debt
  – Recovery oxygen consumption
Effects of Exercise

- Improved balance, joint flexibility
- Increase in muscle size (hypertrophy)
- Improvements in muscle tissue
- Vasodilation
- Strengthened heart muscle
- Improved breathing and respiratory efficiency
- Weight control
- Stronger bones
Types of Muscle Contractions

- Partial (muscle tone or tonus)
- Isotonic
  - No change in tension
  - Muscle length shortens
  - Movement
- Isometric
  - Great increase in tension
  - Muscle length unchanged
  - No movement
The Mechanics of Muscle Movement

Tendons attach muscles to bones

- **Origin**—attached to more fixed part of skeleton
- **Insertion**—attached to more moveable part of skeleton
Muscles Work Together

- Many muscles function in pairs
- Prime movers
- Antagonists
- Synergists

In development, nervous system must learn to coordinate movement. Children learning new skills may use some muscles unnecessarily or not use the correct muscles.
Levers and Body Mechanics

Musculoskeletal system as a lever system

- Lever—bone
- Fulcrum—joint
- Force—applied by muscle

Three classes of levers

- First class
- Second class
- Third class—most body systems
Three classes of levers are shown along with tools and anatomic examples that illustrate each type.

R = resistance (weight);
E = effort (force);
F = fulcrum (pivot point).
Skeletal Muscle Groups

Characteristics for naming muscles (often combined)

• Location
• Size
• Shape
• Direction of fibers
• Number of heads (attachment points)
• Action
Superficial muscles, anterior view.

Associated structure is labeled in parentheses.
Superficial muscles, posterior view.

Associated structures are labeled in parentheses.
Muscles of the Head

• Facial expression (orbicularis) muscles
  – Orbicularis oculi
  – Orbicularis oris
  – Levator palpebrae superioris
  – Buccinator

• Mastication (chewing) muscles
  – Temporalis
  – Masseter
  – Intrinsic
  – Extrinsic
Muscles of the head.

Associated structure is labeled in parentheses.

ZOOMING IN

- Which of the muscles in this illustration is named for a bone it is near?
Muscles of the Neck

• Are ribbonlike
• Extend up, down, or obliquely
• Extend in several layers in a complex manner

• Most common is sternocleidomastoid
Muscles of the Upper Extremities

- Position the shoulder
- Move the arm
- Move the forearm and hand
Muscles That Move the Shoulder and Arm

- Trapezius
- Latissimus dorsi
- Pectoralis major
- Serratus anterior
- Deltoid
- Rotator cuff
  - Supraspinatus
  - Infraspinatus
  - Teres minor
  - Subscapularis
Muscles That Move the Forearm and Hand

- Brachialis
- Biceps brachii
- Brachioradialis
- Triceps brachii
- Flexor carpi
- Extensor carpi
- Flexor digitorum
- Extensor digitorum
Muscles that move the forearm and hand.
Muscles of the Trunk

- Breathing muscles
- Abdominal muscles
- Pelvic floor muscles
- Deep back muscles
Muscles of Respiration

- Diaphragm
- Intercostal muscles
Muscles of respiration.

Associated structures are also shown.
Muscles of the Abdomen and Pelvis

- External oblique
- Internal oblique
- Transversus abdominis
- Rectus abdominis
- Levator ani
Muscles of the abdominal wall. Surface tissue is removed on the right side to show deeper muscles.

Associated structures are labeled in parentheses.
Muscles of the female perineum (pelvic floor).
Associated structures are labeled in parentheses.
Deep Muscles of the Back

• Erector spinae
• Deeper muscles in the lumbar area
Muscles of the Lower Extremities

- Among the longest and strongest in the body
- Specialized for locomotion and balance
Muscles That Move the Thigh and Leg

- Gluteus maximus
- Gluteus medius
- Iliopsoas
- Adductors
- Sartorius
- Iliotibial (IT) tract
- Hamstrings
Muscles of the thigh.
Associated structures are labeled in parentheses.
Muscles That Move the Foot

- Gastrocnemius
- Achilles tendon
- Soleus
- Tibialis anterior
- Peroneus longus
- Flexor and extensor muscles
Muscles that move the foot.

Associated structures are labeled in parentheses.
Effects of Aging on Muscles

Beginning at about age 40

- Gradual loss of muscle cells
- Loss of power
- Tendency to flex hips and knees
- Decrease in height
Muscular Disorders

• Spasms
  - Colic
  - Seizure or convulsion

• Cramps
• Strains
• Sprains
• Atrophy
Diseases of Muscles

- Muscular dystrophy
- Myasthenia gravis
- Myalgia
- Myositis
- Fibrositis
- Fibromyositis
- Fibromyalgia syndrome (FMS)
Disorders of Associated Structures

• Bursitis
• Bunions
• Tendinitis
• Tenosynovitis
• Shinsplints
• Carpal tunnel syndrome