**Muscle Tissue**

- **Smooth muscle** (A): walls of hollow organs, blood vessels, and respiratory passages
- **Cardiac muscle** (B): wall of heart (see Coloring Exercise 8-6)
- **Skeletal muscle** (C): makes up muscles under voluntary control; moves bones and face, compresses abdominal organs
  - Several muscle cell precursors fuse to form a single muscle cell, containing multiple nuclei
- Muscle cells are also called fibers

**Skeletal Muscle: Attachments to Bones**

- **Tendons** (D) attach skeletal muscle body (E) to bones
- **Origin** (F): attachment to less moveable bone (e.g., scapula (G))
- **Insertion** (H): attachment to more moveable bone (e.g., radius (I))

**Anatomy of a Skeletal Muscle**

- Muscle enveloped by a membrane, the **epimysium** (J)
  - The **tendon** (D) is a continuation of the epimysium
- Skeletal muscle body divided into **fascicles** (K)
  - Each fascicle surrounded by membrane; the **perimysium** (L)
  - **Blood vessels** (M) travel between fascicles
- Each fascicle made up of individual **muscle cells** (C)
  - Each muscle cell surrounded by **endomysium** (N) membrane
- Remember, you already colored a longitudinal view of skeletal muscle fibers in the top figure

**COLORING INSTRUCTIONS**

*Color each structure and its name at the same time, using the same color. On the top figure:*
1. Color the nuclei black in each figure.
2. Color the muscle cells for each muscle type (A to G).

*On the middle figure:*
1. Color the bones (D, I), tendons (D), and the muscle body (G). Use light colors for the bones (D, I) and the muscle body.
2. Using two dark colors, draw circles at the origins (F) and insertion (H) of the muscle.

*On the bottom figure:*
1. Color the bone (I), tendon (D), and epimysium (J).
2. Color the perimysium (L) around the extruded fascicle and in the cross section.
3. Color the fascicle (K) that is labeled in the cross section, and one additional fascicle.
4. Color the endomysium (N) around the extruded muscle fiber. Outline some muscle fibers in the cross-section with the same color, because the endomysium surrounds all fibers.
5. Color the ends of some muscle fibers (C) and the blood vessels (M).
A. smooth muscle cells
B. cardiac muscle cells
C. skeletal muscle cells
D. tendon
E. muscle body
F. origin
G. scapula
H. insertion
I. radius
J. epimysium
K. fascicle
L. perimysium
M. blood vessel
N. endomysium
Coloring Exercise 4-2 ➤ The Neuromuscular Junction

**The Neuromuscular Junction**
- Consists of a muscle cell A and motor neuron B
- Each muscle cell contains multiple nuclei C

**Components of a Muscle Cell**
- Muscle cell organized into sarcomeres D
- Each sarcomere contains actin (thin) E and myosin (thick) F filaments

**Events at the Neuromuscular Junction**
- Action potential G arrives at axon branches H of a motor neuron B
- Synaptic vesicles I containing stored neurotransmitters (acetylcholine, J) fuse with the neuron membrane
- Acetylcholine released into the synaptic cleft K
- Acetylcholine binds receptor L in the motor end plate M (muscle cell membrane)
- Bound receptor creates action potential in muscle cell
- Mitochondria N make some neurotransmitters and provide ATP

**COLORING INSTRUCTIONS**
Color each structure and its name at the same time, using the same color.
1. Color the cytoplasm of the muscle cell A light pink; color the nuclei C purple.
2. Color the column of sarcomeres D indicated by the bracket.
3. In the other sarcomeres, color the actin filaments E red and the myosin filaments F blue.
4. Shade the entire motor neuron B light yellow and the mitochondria M dark yellow in both views.
5. Color the arrow representing the action potential G travelling down the axon.
6. Lightly shade the synaptic vesicles H in both views; use a darker color for acetylcholine molecules, represented by small dots I.
7. Use a light color for the synaptic cleft J, a medium color for the motor end plate K, and a dark color for the acetylcholine receptor L.
A. muscle cell  G. action potential
B. motor neuron  H. synaptic vesicle
B₁. axon branches  I. acetylcholine
C. nucleus  J. synaptic cleft
D. sarcomere  K. receptor
E. actin  L. motor end plate
F. myosin  M. mitochondria
The Sliding Filament Mechanism

- Remember that each muscle fiber is organized in **sarcomeres**.
- Each sarcomere contains overlapping filaments of:
  - **Myosin**: long filamentous protein with globular head
  - **Actin**: globular protein linked together in long strands; each actin has a **binding site** for myosin
- During muscle contraction, sarcomeres **shorten**
  - The length of myosin and actin filaments does not change
  - The overlap between thick and thin filaments increases; filaments “slide over” each other
  - As sarcomeres shorten, the muscle shortens
- Sliding filament mechanism includes three stages
  - **Attachment**: myosin binds specific **binding sites** on the actin, forming a cross-bridge
  - **Power Stroke**: Myosin pulls on actin, shortening the sarcomere (and thus the muscle)
  - **Release/Reattachment**: Myosin head detaches (step requires fresh ATP molecule), binds further along the actin molecule
- Cycle repeats

Calcium and Muscle Contraction

- The sliding filament mechanism only occurs if **calcium** is present
- Calcium is present in the muscle cell following an action potential in the motor end plate
- If calcium is absent:
  - **Tropomyosin** covers the **binding sites**
  - The three-part **troponin complex** keeps tropomyosin in place
- If calcium is present:
  - Calcium binds troponin
  - Troponin lets tropomyosin move away from binding sites on actin
  - Myosin heads can bind actin
  - Muscle contraction occurs

---

**COLORING INSTRUCTIONS**

**Coloring Exercise 4-3**

**Muscle Contraction**

**The Sliding Filament Mechanism**

- Remember that each muscle fiber is organized in **sarcomeres**.
- Each sarcomere contains overlapping filaments of:
  - **Myosin**: long filamentous protein with globular head
  - **Actin**: globular protein linked together in long strands; each actin has a **binding site** for myosin
- During muscle contraction, sarcomeres **shorten**
  - The length of myosin and actin filaments does not change
  - The overlap between thick and thin filaments increases; filaments “slide over” each other
  - As sarcomeres shorten, the muscle shortens
- Sliding filament mechanism includes three stages
  - **Attachment**: myosin binds specific **binding sites** on the actin, forming a cross-bridge
  - **Power Stroke**: Myosin pulls on actin, shortening the sarcomere (and thus the muscle)
  - **Release/Reattachment**: Myosin head detaches (step requires fresh ATP molecule), binds further along the actin molecule
- Cycle repeats

**Calcium and Muscle Contraction**

- The sliding filament mechanism only occurs if **calcium** is present
- Calcium is present in the muscle cell following an action potential in the motor end plate
- If calcium is absent:
  - **Tropomyosin** covers the **binding sites**
  - The three-part **troponin complex** keeps tropomyosin in place
- If calcium is present:
  - Calcium binds troponin
  - Troponin lets tropomyosin move away from binding sites on actin
  - Myosin heads can bind actin
  - Muscle contraction occurs

---

**COLORING INSTRUCTIONS**

**Coloring Exercise 4-3**

**Muscle Contraction**

**The Sliding Filament Mechanism**

- Remember that each muscle fiber is organized in **sarcomeres**.
- Each sarcomere contains overlapping filaments of:
  - **Myosin**: long filamentous protein with globular head
  - **Actin**: globular protein linked together in long strands; each actin has a **binding site** for myosin
- During muscle contraction, sarcomeres **shorten**
  - The length of myosin and actin filaments does not change
  - The overlap between thick and thin filaments increases; filaments “slide over” each other
  - As sarcomeres shorten, the muscle shortens
- Sliding filament mechanism includes three stages
  - **Attachment**: myosin binds specific **binding sites** on the actin, forming a cross-bridge
  - **Power Stroke**: Myosin pulls on actin, shortening the sarcomere (and thus the muscle)
  - **Release/Reattachment**: Myosin head detaches (step requires fresh ATP molecule), binds further along the actin molecule
- Cycle repeats

**Calcium and Muscle Contraction**

- The sliding filament mechanism only occurs if **calcium** is present
- Calcium is present in the muscle cell following an action potential in the motor end plate
- If calcium is absent:
  - **Tropomyosin** covers the **binding sites**
  - The three-part **troponin complex** keeps tropomyosin in place
- If calcium is present:
  - Calcium binds troponin
  - Troponin lets tropomyosin move away from binding sites on actin
  - Myosin heads can bind actin
  - Muscle contraction occurs
Chapter 4 The Muscular System

A. sarcomere
B. myosin
C. actin
D. binding site
E. attachment
F. power stroke
G. release/reattachment
H. calcium
I. tropomyosin
J. troponin complex
Where do Muscles Obtain ATP?

**Creatine phosphate**

- Very rapid ATP production; no oxygen or glucose required
- Muscles contain small store of creatine phosphate
- Creatine phosphate loses phosphate group, creating creatine
- ADP accepts phosphate group, resulting in ATP
- Creatine phosphate stores increased by exercise, dietary supplementation

**Anaerobic metabolism**

- Glucose rapidly converted into small amount of ATP (2–3 molecules); no oxygen required
- Lactic acid produced as byproduct
- Glucose can come from blood or (more frequently) from glycogen breakdown

**Aerobic metabolism**

- Glucose slowly converted into large amount of ATP (over 30 molecules); oxygen required
- Oxygen is stored within muscle cells attached to myoglobin
- Other energy sources (amino acids, fatty acids) can also be used

Why do Muscles Need ATP?

- **Power stroke**: movement of the myosin head that brings actin filaments closer together
- **Myosin head detachment**: no ATP results in rigor mortis: myosin heads stay attached, muscle cannot relax
- **Calcium reuptake**
  - Calcium reuptake into endoplasmic reticulum necessary for muscle relaxation
  - Occurs by active transport
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A. ATP
B. creatine phosphate
C. creatine
D. ADP
E. anaerobic metabolism
F. glucose
G. oxygen
H. lactic acid
I. glycogen
J. aerobic metabolism
K. myoglobin
L. power stroke
M. myosin head detachment
N. calcium reuptake
Muscles Work Together to Produce a Given Action

• **Prime mover** (A): accomplishes movement
• **Antagonist** (B): produces opposite movement
  • Must relax to permit prime mover contraction
• **Synergist** (C): assists prime mover by providing additional force or by stabilizing joint
  • Synergists and prime movers are also called agonists

An Example: Movements of the Forearm

• Bend your arm at a right angle; hold a weight in your hand
• During each action, use your other hand to feel muscles contract and relax
• Flexion (figure on left)
  • Bring your hand towards your shoulder
  • Prime mover: **brachialis** (D) (front of upper arm) contracts
  • Antagonist: **triceps brachii** (E) (back of upper arm) relaxes
  • Synergist: **brachioradialis** (F) (lower arm) contracts
• Extension (figure on right)
  • Slowly lower your hand
  • Prime mover: triceps brachii contracts (the biceps brachii [not shown] is also a prime mover)
  • Antagonists: brachialis and brachioradialis relax

**COLORING INSTRUCTIONS**

Color each structure and its name at the same time, using the same color. Color both figures at the same time.

1. Lightly shade the brachialis (A), triceps brachii (B), and brachioradialis (F) on each diagram. Use light colors (light blue, light orange, and light green).
2. Use the following color scheme to color terms:
   • Prime mover: navy blue
   • Antagonist: reddish orange
   • Synergist: dark green
3. Use these colors to draw stripes on the relevant muscle for each diagram. For instance, the brachialis will be striped blue (prime mover, A) in flexion figure, but reddish orange (antagonist, @) in extension figure.
Flexion

A. prime mover
B. antagonist
C. synergist
D. brachialis
E. triceps brachii
F. brachioradialis

Extension
## Coloring Exercise 4-6 > Muscles of the Head

### Flashcards 14 and 15

<table>
<thead>
<tr>
<th>Name</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontalis A</td>
<td>Epicranial aponeurosis (tendon P)</td>
<td>Eyebrow skin</td>
<td>Raises eyebrows</td>
</tr>
<tr>
<td>Obicularis oculi B</td>
<td>Frontal bone, maxilla (eye orbit)</td>
<td>Skin, muscle encircling eye</td>
<td>Closes eye</td>
</tr>
<tr>
<td>Nasalis C</td>
<td>Maxilla</td>
<td>Bridge of nose</td>
<td>Moves nose</td>
</tr>
<tr>
<td>Levator palpebrae superioris (not shown)</td>
<td>Sphenoid bone (roof of eye orbit)</td>
<td>Upper eyelid skin</td>
<td>Opens eye</td>
</tr>
<tr>
<td>Quadratus labii superioris D</td>
<td>Maxilla</td>
<td>Oblcularis oris; skin at lip corners</td>
<td>Elevates upper lip</td>
</tr>
<tr>
<td>Zygomaticus E</td>
<td>Zygomatic bone</td>
<td>Skin, muscle at lip corners</td>
<td>Raises corner(s) of mouth</td>
</tr>
<tr>
<td>Obicularis oris F</td>
<td>Muscles encircling mouth</td>
<td>Skin at mouth corners</td>
<td>Closes lips (kissing), shapes lips (speech)</td>
</tr>
<tr>
<td>Quadratus labii inferioris G</td>
<td>Mandible</td>
<td>Lower lip skin</td>
<td>Depresses lower lip</td>
</tr>
<tr>
<td>Mentalis H</td>
<td>Mandible</td>
<td>Chin skin</td>
<td>Elevates, protrudes lower lip (pouting)</td>
</tr>
<tr>
<td>Triangularis I (Depressor anguli oris)</td>
<td>Mandible</td>
<td>Mouth (angle)</td>
<td>Opens mouth</td>
</tr>
<tr>
<td>Buccinator J</td>
<td>Maxilla, mandible</td>
<td>Oblcularis oris</td>
<td>Flattens cheek (eating, whistling, wind instruments)</td>
</tr>
<tr>
<td>Digastricus K</td>
<td>Mandible, temporal bone</td>
<td>Hyoid bone (via tendon)</td>
<td>Opens jaw</td>
</tr>
<tr>
<td>Masseter L</td>
<td>Temporal bone</td>
<td>Mandible</td>
<td>Closes jaw</td>
</tr>
<tr>
<td>Sternocleidomastoid M</td>
<td>Sternum, clavicle</td>
<td>Temporal bone (mastoid process)</td>
<td>Together: flexes head Separately: rotates head</td>
</tr>
<tr>
<td>Temporalis N</td>
<td>Temporal bone</td>
<td>Mandible</td>
<td>Closes jaw</td>
</tr>
<tr>
<td>Trapezius O: see Coloring Exercise 4-7</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Coloring Instructions

Color each muscle and its name at the same time, using the same color. Color the lateral (top) and frontal (bottom) views together.

1. Review the skull bones in Coloring Exercise 3-6 before beginning this Coloring Exercise.
2. As you read about each muscle, try to palpate the insertion and origin.
3. Use the muscle to perform the action. Use your fingers to feel the muscle contract.
4. Color the muscle on the diagram(s).
5. Use a very light color for P, because this structure is not a muscle.
Chapter 4 The Muscular System

A. frontalis
B. obicularis oculi
C. nasalis
D. quadratus labii superioris
E. zygomaticus
F. obicularis oris
G. quadratus labii inferioris
H. mentalis
I. triangularis
J. buccinator
K. digastricus
L. masseter
M. sternocleidomastoid
N. temporalis
O. trapezius
P. epicanthal aponeurosis
### Abdominal Muscles

<table>
<thead>
<tr>
<th>Name</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectus abdominis <strong>A</strong></td>
<td>Pubis</td>
<td>Xiphoid process (sternum), ribs</td>
<td>Flexes spinal column, compresses abdomen</td>
</tr>
<tr>
<td>External oblique <strong>B</strong></td>
<td>Inferior eight ribs</td>
<td>Ilium, <strong>linea alba</strong> <strong>C</strong></td>
<td>Both: flex spinal column, compress abdomen One: rotate, laterally flex spinal column</td>
</tr>
<tr>
<td>Internal oblique <strong>D</strong></td>
<td>Iliac crest</td>
<td>Inferior ribs, <strong>linea alba</strong></td>
<td>Same as external obliques</td>
</tr>
<tr>
<td>Transverse abdominis <strong>E</strong></td>
<td>Iliac crest, inferior ribs</td>
<td>Xyxoid process, <strong>linea alba</strong>, pubis</td>
<td>Compresses abdomen</td>
</tr>
<tr>
<td>Abdominal aponeurosis <strong>F</strong></td>
<td>(tendon)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Muscles of the Perineum

<table>
<thead>
<tr>
<th>Name</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transverse perineus <strong>G</strong></td>
<td>Ischial tuberosity <strong>H</strong></td>
<td>Perineal tissues</td>
<td>Stabilizes perineum</td>
</tr>
<tr>
<td>Levator ani <strong>J</strong></td>
<td>Pubis, ischial spine</td>
<td><strong>Coccyx</strong> <strong>K</strong>, <strong>urethra</strong> <strong>L</strong>, rectum, perineum</td>
<td>Aids defecation; stabilizes perineum</td>
</tr>
<tr>
<td>External anal sphincter <strong>M</strong></td>
<td>Anococcygeal ligament, coccyx</td>
<td>Perineal tissues</td>
<td>Closes <strong>anus</strong> <strong>N</strong></td>
</tr>
<tr>
<td>Ischiocavernosus <strong>O</strong></td>
<td>Ischial tuberosity, pubis</td>
<td><strong>Clitoris</strong> <strong>P</strong>, penis</td>
<td>Maintains clitoral or penile erection</td>
</tr>
<tr>
<td>Bulbocavernosus <strong>Q</strong></td>
<td>Perineal tissues</td>
<td><strong>Clitoris</strong>, penis, other perineal tissues</td>
<td>Maintains clitoral or penile erection; aids in urination, ejaculation; constricts vagina</td>
</tr>
<tr>
<td>Coccygeus <strong>R</strong></td>
<td>Ischium</td>
<td>Coccyx, lower sacrum</td>
<td>Stabilizes perineum; pulls coccyx forward during defecation, childbirth</td>
</tr>
<tr>
<td>Obturator <strong>S</strong></td>
<td>Obturator foramen</td>
<td>Femur (greater trochanter)</td>
<td>Rotates thigh</td>
</tr>
<tr>
<td>Gluteus maximus <strong>T</strong></td>
<td>See Coloring Exercise 4-9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
A. rectus abdominis
B. external oblique
C. linea alba
D. internal oblique
E. transverse abdominis
F. abdominal aponeurosis
G. transverse perineus
H. ischial tuberosity
I. vagina
J. levator ani
K. coccyx
L. urethra
M. external anal sphincter
N. anus
O. ischiocavernosus
P. clitoris
Q. bulbocavernosus
R. coccygeus
S. obturator
T. gluteus maximus
### Coloring Exercise 4-8  ➤ Muscles that Move the Upper Limb

**Name** | **Origin** | **Insertion** | **Action** |
---|---|---|---|
Trapezius | Occipital bone, vertebral vertebrae (C7, thoracic) | Clavicle, scapula (acromion, spine) | Extends head; raises shoulder and pull it posteriorly; stabilizes and moves scapula |
Latissimus dorsi | Vertebrae, sacrum, ilium, ribs | Humerus | Extends and adducts arm (behind back) |
Pectoralis major | Clavicle, sternum, cartilage of ribs 2–6 | Humerus | Flexes and adducts arm (across chest); pulls shoulder forward and down |
Serratus anterior | Superior ribs | Scapula | Moves scapula forward; aids in punching, reaching |
Teres major | Scapula | Humerus | Extends arm |
Teres minor | Scapula | Humerus | Extends, adducts arm; part of rotator cuff |
Deltoid | Clavicle, scapula | Humerus | Abducts arm |
Biceps brachii | Scapula | Proximal radius | Flexes forearm, supinates hand |
Brachioradialis | Humerus | Radius | Flexes forearm |
Brachialis | Humerus | Ulna | Flexes forearm |
Triceps brachii | Scapula, humerus | Ulnar olecranon | Extends forearm |
Extensor carpi radialis longus | Humerus | 2nd metacarpal | Extends, abducts hand |
Flexor carpi radialis | Humerus | 2nd and 3rd metacarpals | Flexes, abducts hand |
Flexor carpi ulnaris | Humerus, ulna | 5th metacarpal | Flexes, adducts hand |
Extensor carpi ulnaris | Humerus, posterior ulna | 5th metacarpal | Extends, adducts hand |
Flexor digitorum superficialis | Humerus, ulna, radius | Middle phalanx, each finger | Flexes fingers |
Extensor digitorum | Humerus | Distal and medial phalanges, each finger | Extends fingers |

**COLORING INSTRUCTIONS**

Color each muscle and its name at the same time, using the same color. Color the anterior and posterior views together.

1. Review the bones of the shoulder girdle and upper limb in Coloring Exercises 3-8 and 3-9.
2. Review the movements of the upper limb in Coloring Exercise 3-13. Remember that movements at the shoulder joint move the arm and movements at the elbow joint move the forearm.
3. As you read about each muscle, try to palpate the insertion and origin.
4. Use the muscle to perform the action. Use your fingers to feel the muscle contract.
5. Color the muscle on the diagram.
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Anterior view

A. trapezius
B. latissimus dorsi
C. pectoralis major
D. serratus anterior
E. teres major
F. teres minor
G. deltoïd
H. biceps brachii
I. brachioradialis
J. triceps brachii
K. brachialis
L. extensor carpi radialis longus
M. flexor carpi radialis
N. flexor carpi ulnaris
O. extensor carpi ulnaris
P. flexor digitorum superficialis
Q. extensor digitorum

Posterior view
<table>
<thead>
<tr>
<th>Name</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iliopsoas</td>
<td>Ilium, lumbar vertebrae</td>
<td>Femur (lesser trochanter)</td>
<td>Flexes hip</td>
</tr>
<tr>
<td>Sartorius</td>
<td>Iliac spine</td>
<td>Tibia body</td>
<td>Flexes thigh, leg</td>
</tr>
<tr>
<td><strong>Quadriceps</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Femoris Group:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rectus femoris</td>
<td>Iliac spine</td>
<td>Patella, then tibia</td>
<td>Extends leg; flexes hip</td>
</tr>
<tr>
<td>Vastus lateralis</td>
<td>Femur (greater trochanter, linea aspera)</td>
<td>Patella, then tibia</td>
<td>Extends leg</td>
</tr>
<tr>
<td>Vastus medialis</td>
<td>Femur (greater trochanter, linea aspera)</td>
<td>Patella, then tibia</td>
<td>Extends leg</td>
</tr>
<tr>
<td>Vastus intermedius</td>
<td>Femur</td>
<td>Patella, then tibia</td>
<td>Extends leg</td>
</tr>
<tr>
<td>Adductor longus</td>
<td>Pubic crest and symphysis</td>
<td>Femur (linea aspera)</td>
<td>Adducts thigh</td>
</tr>
<tr>
<td>Gracilis</td>
<td>Pubis</td>
<td>Tibia</td>
<td>Adducts thigh; flexes leg</td>
</tr>
<tr>
<td>Adductor magnus</td>
<td>Pubis, ischium</td>
<td>Femur (linea aspera)</td>
<td>Adducts thigh</td>
</tr>
<tr>
<td>Gluteus medius</td>
<td>Ilium</td>
<td>Femur (greater trochanter)</td>
<td>Adducts thigh</td>
</tr>
<tr>
<td>Gluteus maximus</td>
<td>Iliac crest, sacrum, coccyx</td>
<td>Iliotibial tract, femur (linea aspera)</td>
<td></td>
</tr>
<tr>
<td><strong>Hamstring Group:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biceps femoris</td>
<td>Ischial tuberosity, linea aspera of femur</td>
<td>Fibula (head) and tibia (lateral condyle)</td>
<td>Flexes leg; extends hip</td>
</tr>
<tr>
<td>Semitendinosus</td>
<td>Ischial tuberosity</td>
<td>Proximal tibia</td>
<td>Flexes leg; extends hip</td>
</tr>
<tr>
<td>Semimembranosus</td>
<td>Ischial tuberosity</td>
<td>Tibia (medial condyle)</td>
<td>Flexes leg; extends hip</td>
</tr>
<tr>
<td>Peroneus longus</td>
<td>Fibula, tibia (lateral condyle)</td>
<td>First tarsal and first metatarsal of foot</td>
<td>Everts foot</td>
</tr>
<tr>
<td>Tibialis anterior</td>
<td>Tibia: lateral condyle/body</td>
<td>1st tarsal, 1st metatarsal</td>
<td>Dorsiflexes, inverts foot</td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td>femur: lateral, medial condyles</td>
<td>Calcaneus (via Achilles tendon)</td>
<td>Plantar flexes foot</td>
</tr>
<tr>
<td>Soleus</td>
<td>Fibula (head) and proximal tibia</td>
<td>Calcaneus (via Achilles tendon)</td>
<td>Plantar flexes foot</td>
</tr>
<tr>
<td>Extensor digitorum</td>
<td>Tibia</td>
<td>Distal phalanges, 2nd to 5th toes</td>
<td>Extends toes</td>
</tr>
<tr>
<td>Flexor digitorum</td>
<td>Posterior tibia</td>
<td>Distal phalanges, 2nd to 5th toes</td>
<td>Flexes toes</td>
</tr>
<tr>
<td>Iliotibial tract</td>
<td>Gluteus maximus</td>
<td>Tibia (lateral condyle)</td>
<td>Tendon</td>
</tr>
</tbody>
</table>

**COLORING INSTRUCTIONS**

Color each muscle and its name at the same time, using the same color. Color the anterior and posterior views together.

1. Review the bones of the pelvis and lower limb in Coloring Exercises 3-10 and 3-11.
2. Review the movements of the lower limb in Coloring Exercise 3-13. Remember that movements at the hip joint move the thigh, and movements at the knee joint move the leg (tibia/fibula).
3. Label some of the bone features that you see in this diagram, such as the patella, tibia, and calcaneus.
4. As you read about each muscle, try to palpate the insertion and origin.
5. Use the muscle to perform the action. Use your fingers to feel the muscle contract.
6. Color the muscle on the diagram. Color the iliotibial tract a very light color, because it is not a muscle.
Chapter 4 The Muscular System

Anterior view

A. iliopsoas
B. sartorius
C. rectus femoris
D. vastus lateralis
E. vastus medialis
F. adductor longus
G. gracilis
H. adductor magnus
I. gluteus medius
J. gluteus maximus
K. biceps femoris
L. semitendinosus
M. semimembranosus
N. peroneus longus
O. tibialis anterior
P. gastrocnemius
Q. soleus
R. extensor digitorum longus
S. flexor digitorum longus
T. iliotibial tract

Posterior view

I
J
K
L
M
N
O
P
Q
S
Stabilizers

- Scapula (stabilization and movement): trapezius, serratus anterior
- Shoulder joint: rotator cuff (supraspinatus, infraspinatus, teres minor, subscapularis)
- Perineum: transverse perineus, levator ani, coccygeus
- Abdominal organs: transverse abdominus, rectus abdominus, internal and external obliques

Movements at the Shoulder Joint

- The humerus moves relative to the pectoral girdle
- Flexion: pectoralis major, anterior deltoid (both prime movers)
- Extension: latissimus dorsi (prime mover) teres major, teres minor, posterior deltoid
- Abduction: deltoid
- Adduction: latissimus dorsi (prime mover) pectoralis major, teres minor
- Rotation: pectoralis major, teres major, latissimus dorsi

Movements at the Elbow Joint

- The ulna/radius move relative to the humerus
- Flexion: brachialis (prime mover) biceps brachii, brachioradialis
- Extension: triceps brachii

Movements at the Wrist Joint

- The hand moves relative to the ulna/radius
- Flexion: flexor carpi radialis, flexor carpi ulnaris
- Extension: extensor carpi radialis longus
- Abduction: flexor carpi radialis, extensor carpi radialis longus
- Adduction: flexor carpi ulnaris

Movements of the Fingers

- Flexion: flexor digitorum superficialis
- Extension: extensor digitorum
Anterior view

A. 

B. 

C. 

D. 

E. 

F. 

G. 

H. 

I. 

J. 

K. 

L. 

M. 

N. 

O. 

P. 

Q. 

R. 

S. 

T. 

U. 

V. 

W. 

X. 

Y. 

Z.
Movements at the Thigh Joint
• The femur moves relative to the pelvis
• Flexion: iliopsoas (prime mover), sartorius (weak flexor; used for sitting cross-legged), rectus femoris
• Extension: gluteus maximus (especially when climbing or jumping), hamstring group
• Abduction: gluteus medius
• Adduction: adductor longus, adductor magnus, gracilis

Movements at the Knee Joint
• The tibia/fibula move relative to the femur
• Flexion: hamstring group (biceps femoris, semimembranosus, semitendinosus), gracilis, sartorius (weak)
• Extension: quadriceps group (rectus femoris, vastus medialis, vastus lateralis, vastus intermedius)

Movements at the Ankle Joint
• The foot moves relative to the tibia/fibula
• Dorsiflexion: tibialis anterior
• Plantar flexion: gastrocnemius (prime mover), soleus
• Inversion: tibialis anterior
• Eversion: peroneus longus

Movements of the Toes
• Flexion: flexor digitorum groups
• Extension: extensor digitorum groups

Maintenance of Body Posture
• Gluteus maximus: supports upright posture
• Gluteus medius: stabilizes pelvis during walking
• Iliopsoas: prevents upper body from falling backward when standing erect
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A. ________________
B. ________________
C. ________________
D. ________________
E. ________________
F. ________________
G. ________________
H. ________________
I. ________________
J. ________________
K. ________________
L. ________________
M. ________________
N. ________________
O. ________________
P. ________________
Q. ________________
R. ________________
S. ________________

Posterior view