# Three Types of Muscle Tissues

<table>
<thead>
<tr>
<th>Skeletal Muscle</th>
<th>Smooth Muscle</th>
<th>Cardiac Muscle</th>
</tr>
</thead>
<tbody>
<tr>
<td>• usually attached to bones</td>
<td>• walls of most viscera, blood vessels, skin</td>
<td>• wall of heart</td>
</tr>
<tr>
<td>• under conscious control</td>
<td>• not under conscious control</td>
<td>• not under conscious control</td>
</tr>
<tr>
<td>• striated</td>
<td>• not striated</td>
<td>• striated</td>
</tr>
</tbody>
</table>

Skeletal Muscle
- usually attached to bones
- under conscious control
- striated

Smooth Muscle
- walls of most viscera, blood vessels, skin
- not under conscious control
- not striated

Cardiac Muscle
- wall of heart
- not under conscious control
- striated
**TYPE:** Skeletal muscle  
**DESCRIPTION:** Long, striated cells with multiple nuclei  
**COMMON LOCATIONS:** In skeletal muscles  
**FUNCTION:** Contraction for voluntary movements

**TYPE:** Smooth muscle  
**DESCRIPTION:** Long, spindle-shaped cells, each with a single nucleus  
**COMMON LOCATIONS:** In hollow organs (e.g., stomach)  
**FUNCTION:** Propulsion of substances along internal passageways

**TYPE:** Cardiac muscle  
**DESCRIPTION:** Branching, striated cells fused at plasma membranes  
**COMMON LOCATIONS:** Wall of heart  
**FUNCTION:** Pumping of blood in the circulatory system
Structure of a Skeletal Muscle

Skeletal Muscle
- organ of the muscular system
- skeletal muscle tissue
- nervous tissue
- blood
- connective tissues
- fascia
- tendon
- aponeuroses
Structure of a Skeletal Muscle

- epimysium
- perimysium
- fascicle
- endomysium

- muscle
- fascicles
- muscle fibers
- myofibrils
- thick and thin filaments
- sarcolemma
- sacroplasm
- sarcoplasmic reticulum
- transverse tubule
- triad
  - cisterna of sarcoplasmic reticulum
  - transverse tubule
- myofibril
- actin filaments
- myosin filaments
- sarcomere
Structure of a Skeletal Muscle

- myofibril
- plasma membrane of muscle cell
- sarcoplasmic reticulum (calcium ion storage)
- mitochondrion
- T tubule

- section from a muscle
- muscle cell
- part of one myofibril
- Z line
Sarcomere

- I band
- A band
- H zone
- Z line
- M line
Myofilaments

Thick Filaments
• composed of myosin
• cross-bridges

Thin Filaments
• composed of actin
• associated with troponin and tropomyosin
Neuromuscular Junction

- site where axon and muscle fiber communicate
- motor neuron
- motor end plate
- synaptic cleft
- synaptic vesicles
- neurotransmitters

![Diagram of the neuromuscular junction](image)
Motor Unit

• single motor neuron
• all muscle fibers controlled by motor neuron
Stimulus for Contraction

- acetylcholine (ACh)
- nerve impulse causes release of acetylcholine from synaptic vesicles
- binds to acetylcholine receptors on motor end plate
- generates a muscle impulse
- muscle impulse eventually reaches sarcoplasmic reticulum
Excitation Contraction Coupling

- Muscle impulses cause sarcoplasmic reticulum to release calcium ions into cytosol
- Calcium binds to troponin to change its shape
- Position of tropomyosin is altered
- Binding sites on actin exposed
- Actin and myosin bind
**Muscle contraction**

Release of Ca²⁺ from sarcoplasmic reticulum exposes binding sites on thin filament:

- Ca²⁺ binds to troponin
- Tropomyosin pulled aside
- Binding sites on actin filament exposed

**Muscle relaxation**

Active transport of Ca²⁺ into sarcoplasmic reticulum, which requires ATP, makes myosin binding sites unavailable.

**Exposed binding sites on actin** allow the muscle contraction cycle to occur.

**Contraction cycle**

1. Relaxed muscle
2. Exposed binding sites on actin
3. Cross-bridge binds actin to myosin
4. Cross-bridge pulls actin filament (power stroke), ADP and Pi released from myosin
5. New ATP binds to myosin, causing linkage to release
6. ATP splits, which provides power to "cock" the myosin cross-bridge

**ATP**
Sliding Filament Theory

- When sarcromeres shorten, thick and thin filaments slide past one another
- H zones and I bands get narrower
- Z lines move closer together
Cross-bridge Cycling

- actin and myosin cross-bridge bind
- myosin cross-bridge pulls actin
- ADP and phosphate released from myosin
- new ATP binds to myosin
- linkage between actin and myosin cross-bridge break
- ATP splits
- myosin cross-bridge goes back to original position
Muscle contraction
Release of Ca²⁺ from sarcoplasmic reticulum exposes binding sites on thin filament:
- Ca²⁺ binds to troponin
- Tropomyosin pulled aside
- Binding sites on actin filament exposed

Muscle relaxation
Active transport of Ca²⁺ into sarcoplasmic reticulum, which requires ATP, makes myosin binding sites unavailable.

Exposed binding sites on actin allow the muscle contraction cycle to occur

Contraction cycle

1. Relaxed muscle
2. Cross-bridge binds actin to myosin
3. Cross-bridge pulls actin filament (power stroke), ADP and P released from myosin
4. New ATP binds to myosin, causing linkage to release
5. ATP splits, which provides power to "cock" the myosin cross-bridge
6. ATP ADP P ADP + P
Relaxation

- acetylcholinesterase – breaks down acetylcholine
- muscle impulse stops
- calcium moves back into sarcoplasmic reticulum
- myosin and actin binding prevented
Energy Sources for Contraction

1) Creatine phosphate  
   - creatine phosphate – stores energy that quickly converts ADP to ATP

2) Cellular respiration
Oxygen Supply and Cellular Respiration

• Anaerobic Phase
  • glycolysis
  • produces little ATP

• Aerobic Phase
  • citric acid cycle
  • electron transport chain
  • produces most ATP
  • myoglobin stores extra oxygen
Oxygen Debt

Oxygen debt – amount of oxygen needed by liver to convert lactic acid to glucose

- oxygen not available
- glycolysis continues
- pyruvic acid converted to lactic acid
- liver converts lactic acid to glucose
Muscle Fatigue

- inability to contract
- commonly caused from
  - decreased blood flow
  - ion imbalances
  - accumulation of lactic acid
- cramp – sustained, involuntary contraction
Heat Production

- by-product of cellular respiration
- muscle cells are major source of body heat
- blood transports heat throughout body
Muscular Responses

Threshold Stimulus
- minimal strength required to cause contraction

Recording a Muscle Contraction
- twitch
- latent period
- period of contraction
- period of relaxation
- refractory period
- all-or-none response
Summation

- process by which individual twitches combine
- produces sustained contractions
- can lead to tetanic contractions
Recruitment of Motor Units

- Recruitment - increase in the number of motor units activated

- Whole muscle composed of many motor units

- As intensity of stimulation increases, recruitment of motor units continues until all motor units are activated
Sustained Contractions

• smaller motor units recruited first
• larger motor units recruited later
• produces smooth movements
• muscle tone – continuous state of partial contraction
Types of Contractions

- **isotonic** – muscle contracts and changes length
- **eccentric** – lengthening contraction
- **concentric** – shortening contraction
- **isometric** – muscle contracts but does not change length

(a) Muscle contracts with force greater than resistance and shortens (concentric contraction)
(b) Muscle contracts with force less than resistance and lengthens (eccentric contraction)
(c) Muscle contracts but does not change length (isometric contraction)
# Fast and Slow Twitch Muscle Fibers

<table>
<thead>
<tr>
<th>Slow-twitch fibers (type I)</th>
<th>Fast-twitch fatigue-resistant fibers (type IIb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>• always oxidative</td>
<td>• intermediate fibers</td>
</tr>
<tr>
<td>• resistant to fatigue</td>
<td>• oxidative</td>
</tr>
<tr>
<td>• red fibers</td>
<td>• intermediate amount of myoglobin</td>
</tr>
<tr>
<td>• most myoglobin</td>
<td>• pink to red in color</td>
</tr>
<tr>
<td>• good blood supply</td>
<td></td>
</tr>
</tbody>
</table>

Fast-twitch glycolytic fibers (type II)

• white fibers (less myoglobin)
• poorer blood supply
• susceptible to fatigue
Smooth Muscle Fibers

Compared to skeletal muscle fibers

- shorter
- single nucleus
- elongated with tapering ends
- myofilaments randomly organized
- no striations
- lack transverse tubules
- sarcoplasmic reticula not well developed
Types of Smooth Muscle

Visceral Smooth Muscle
- single-unit smooth muscle
- sheets of muscle fibers
- fibers held together by gap junctions
- exhibit rhythmicity
- exhibit peristalsis
- walls of most hollow organs

Multiunit Smooth Muscle
- fibers function separately
- irises of eye
- walls of blood vessels
Smooth Muscle Contraction

- Resembles skeletal muscle contraction
  - interaction between actin and myosin
  - both use calcium and ATP
  - both depend on impulses

- Different from skeletal muscle contraction
  - smooth muscle lacks troponin
  - smooth muscle depends on calmodulin
  - two neurotransmitters affect smooth muscle
    - acetlycholine and norepinephrine
  - hormones affect smooth muscle
  - stretching can trigger smooth muscle contraction
  - smooth muscle slower to contract and relax
  - smooth muscle more resistant to fatigue
Cardiac Muscle

• only in the heart
• muscle fibers joined together by intercalated discs
• fibers branch
• network of fibers contracts as a unit
• self-exciting and rhythmic
• longer refractory period than skeletal muscle
Skeletal Muscle Actions

- origin – immovable end
- insertion – movable end

- prime mover (agonist) – primarily responsible for movement
- synergists – assist prime mover
- antagonist – resist prime mover’s action and cause movement in the opposite direction

Diagram showing the anatomy of the arm with labeled bones and muscles.
Major Skeletal Muscles

- Frontalis
- Orbicularis oculi
- Zygomaticus
- Trapezius
- Serratus anterior
- External oblique
- Rectus abdominis
- Tensor fasciae latae
- Sartorius
- Rectus femoris
- Adductor longus
- Vastus lateralis
- Fibularis longus
- Tibialis anterior
- Extensor digitorum longus
- Masseter
- Orbicularis oris
- Sternocleidomastoid
- Deltoid
- Pectoralis major
- Biceps brachii
- Brachialis
- Brachioradialis
- Gracilis
- Vastus medialis
- Gastrocnemius
- Soleus
Major Skeletal Muscles

- Temporalis
- Occipitalis
- Sternocleidomastoid
- Trapezius
- Infraspinatus
- Brachialis
- Deltoid
- Rhomboideus
- Teres minor
- Latissimus dorsi
- Teres major
- External oblique
- Triceps brachii
- Gluteus medius
- Gluteus maximus
- Biceps femoris
- Adductor magnus
- Semitendinosus
- Gracilis
- Semimembranosus
- Vastus lateralis
- Gastrocnemius
- Sartorius
- Calcaneal tendon
- Fibularis longus
- Soleus
# Muscles of Facial Expression

## Table 9.3: Muscles of Facial Expression

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epicranius</td>
<td>Occipital bone</td>
<td>Skin and muscles around eye</td>
<td>Raises eyebrow as when surprised</td>
<td>Facial n.</td>
</tr>
<tr>
<td>Orbicularis oculi</td>
<td>Maxillary and frontal bones</td>
<td>Skin around eye</td>
<td>Closes eye as in blinking</td>
<td>Facial n.</td>
</tr>
<tr>
<td>Orbicularis oris</td>
<td>Muscles near the mouth</td>
<td>Skin of central lip</td>
<td>Closes lips, protrudes lips as for kissing</td>
<td>Facial n.</td>
</tr>
<tr>
<td>Buccinator</td>
<td>Outer surfaces of maxilla and mandible</td>
<td>Orbicularis oris</td>
<td>Compresses cheeks inward as when blowing air</td>
<td>Facial n.</td>
</tr>
<tr>
<td>Zygomaticus</td>
<td>Zygomatic bone</td>
<td>Orbicularis oris</td>
<td>Raises corner of mouth as when smiling</td>
<td>Facial n.</td>
</tr>
<tr>
<td>Platysma</td>
<td>Fascia in upper chest</td>
<td>Lower border of mandible</td>
<td>Draws angle of mouth downward as when pouting</td>
<td>Facial n.</td>
</tr>
</tbody>
</table>
### Muscles of Mastication

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Masseter</td>
<td>Lower border of zygomatic arch</td>
<td>Lateral surface of mandible</td>
<td>Elevates mandible</td>
<td>Trigeminal n.</td>
</tr>
<tr>
<td>Temporalis</td>
<td>Temporal bone</td>
<td>Coronoid process and anterior ramus of mandible</td>
<td>Elevates mandible</td>
<td>Trigeminal n.</td>
</tr>
<tr>
<td>Medial pterygoid</td>
<td>Sphenoid, palatine, and maxillary bones</td>
<td>Medial surface of mandible</td>
<td>Elevates mandible and moves it from side to side</td>
<td>Trigeminal n.</td>
</tr>
<tr>
<td>Lateral pterygoid</td>
<td>Sphenoid bone</td>
<td>Anterior surface of mandibular condyle</td>
<td>Depresses and protracts mandible and moves it from side to side</td>
<td>Trigeminal n.</td>
</tr>
</tbody>
</table>
Muscles of Facial Expression and Mastication

- Epicranius
- Frontalis
- Occipitalis
- Temporalis
- Orbicularis oculi
- Zygomaticus
- Masseter
- Buccinator
- Orbicularis oris
- Platysma
- Lateral pterygoid
- Medial pterygoid
- Buccinator
- Temporalis
# Muscles That Move the Head and Vertebral Column

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sternocleidomastoid</td>
<td>Anterior surface of sternum and upper surface of clavicle</td>
<td>Mastoid process of temporal bone</td>
<td>Pulls head to one side, flexes neck or elevates sternum</td>
<td>Accessory, C2 and C3 cervical nerves</td>
</tr>
<tr>
<td>Splenius capitis</td>
<td>Spinous processes of lower cervical and upper thoracic vertebrae</td>
<td>Occipital bone</td>
<td>Rotates head, bends head to one side, or extends neck</td>
<td>Cervical nerves</td>
</tr>
<tr>
<td>Semispinalis capitis</td>
<td>Processes of lower cervical and upper thoracic vertebrae</td>
<td>Occipital bone</td>
<td>Extends head, bends head to one side, or rotates head</td>
<td>Cervical and thoracic spinal nerves</td>
</tr>
<tr>
<td>Erector spinae</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iliocostalis (lateral group)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iliocostalis lumborum</td>
<td>Iliac crest</td>
<td>Lower six ribs</td>
<td>Extends lumbar region of vertebral column</td>
<td>Lumbar spinal nerves</td>
</tr>
<tr>
<td>Iliocostalis thoracis</td>
<td>Lower six ribs</td>
<td>Upper six ribs</td>
<td>Holds spine erect</td>
<td>Thoracic spinal nerves</td>
</tr>
<tr>
<td>Iliocostalis cervicis</td>
<td>Upper six ribs</td>
<td>Fourth through sixth cervical vertebrae</td>
<td>Extends cervical region of vertebral column</td>
<td>Cervical spinal nerves</td>
</tr>
<tr>
<td>Longissimus (intermediate group)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longissimus thoracis</td>
<td>Lumbar vertebrae</td>
<td>Thoracic and upper lumbar vertebrae and ribs 9 and 10</td>
<td>Extends thoracic region of vertebral column</td>
<td>Spinal nerves</td>
</tr>
<tr>
<td>Longissimus cervicis</td>
<td>Fourth and fifth thoracic vertebrae</td>
<td>Second through sixth cervical vertebrae</td>
<td>Extends cervical region of vertebral column</td>
<td>Spinal nerves</td>
</tr>
<tr>
<td>Longissimus capitis</td>
<td>Upper thoracic and lower cervical vertebrae</td>
<td>Mastoid process of temporal bone</td>
<td>Extends and rotates head</td>
<td>Cervical spinal nerves</td>
</tr>
<tr>
<td>Spinalis (medial group)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spinalis thoracis</td>
<td>Upper lumbar and lower thoracic vertebrae</td>
<td>Upper thoracic vertebrae</td>
<td>Extends vertebral column</td>
<td>Spinal nerves</td>
</tr>
<tr>
<td>Spinalis cervicis</td>
<td>Ligamentum nuchae and seventh cervical vertebra</td>
<td>Axis</td>
<td>Extends vertebral column</td>
<td>Spinal nerves</td>
</tr>
<tr>
<td>Spinalis capitis</td>
<td>Upper thoracic and lower cervical vertebrae</td>
<td>Occipital bone</td>
<td>Extends vertebral column</td>
<td>Spinal nerves</td>
</tr>
</tbody>
</table>
# Muscles That Move the Pectoral Girdle

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trapezius</td>
<td>Occipital bone and spines of cervical and thoracic vertebrae</td>
<td>Clavicle, spine, and acromion process of scapula</td>
<td>Rotates scapula; various fibers raise scapula, pull scapula medially, or pull scapula and shoulder downward</td>
<td>Accessory n.</td>
</tr>
<tr>
<td>Rhomboideus major</td>
<td>Spines of upper thoracic vertebrae</td>
<td>Medial border of scapula</td>
<td>Raises and adducts scapula</td>
<td>Dorsal scapular n.</td>
</tr>
<tr>
<td>Levator scapulae</td>
<td>Transverse processes of cervical vertebrae</td>
<td>Medial margin of scapula</td>
<td>Elevates scapula</td>
<td>Dorsal scapular and cervical nerves</td>
</tr>
<tr>
<td>Serratus anterior</td>
<td>Outer surfaces of upper ribs</td>
<td>Ventral surface of scapula</td>
<td>Pulls scapula anteriorly and downward</td>
<td>Long thoracic n.</td>
</tr>
<tr>
<td>Pectoralis minor</td>
<td>Sternal ends of upper ribs</td>
<td>Coracoid process of scapula</td>
<td>Pulls scapula forward and downward or raises ribs</td>
<td>Pectoral n.</td>
</tr>
</tbody>
</table>
### Muscles That Move the Arm

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coracobrachialis</td>
<td>Coracoid process of scapula</td>
<td>Shaft of humerus</td>
<td>Flexes and adducts the arm</td>
<td>Musculocutaneus n.</td>
</tr>
<tr>
<td>Pectoralis major</td>
<td>Clavicle, sternum, and costal cartilages of upper ribs</td>
<td>Intertubercular groove of humerus</td>
<td>Flexes, adducts, and rotates arm medially</td>
<td>Pectoral n.</td>
</tr>
<tr>
<td>Teres major</td>
<td>Lateral border of scapula</td>
<td>Intertubercular groove of humerus</td>
<td>Extends, adducts, and rotates arm medially</td>
<td>Lower subscapular n.</td>
</tr>
<tr>
<td>Latissimus dorsi</td>
<td>Spines of sacral, lumbar, and lower thoracic vertebrae, iliac crest, and lower ribs</td>
<td>Intertubercular groove of humerus</td>
<td>Extends, adducts, and rotates the arm medially, or pulls the shoulder downward and back</td>
<td>Thoracodorsal n.</td>
</tr>
<tr>
<td>Supraspinatus</td>
<td>Posterior surface of scapula above spine</td>
<td>Greater tubercle of humerus</td>
<td>Abducts the arm</td>
<td>Suprascapular n.</td>
</tr>
<tr>
<td>Deltoid</td>
<td>Acromion process, spine of the scapula, and the clavicle</td>
<td>Deltoid tuberosity of humerus</td>
<td>Abducts, extends, and flexes arm</td>
<td>Axillary n.</td>
</tr>
<tr>
<td>Subscapularis</td>
<td>Anterior surface of scapula</td>
<td>Lesser tubercle of humerus</td>
<td>Rotates arm medially</td>
<td>Subscapular n.</td>
</tr>
<tr>
<td>Infraspinatus</td>
<td>Posterior surface of scapula below spine</td>
<td>Greater tubercle of humerus</td>
<td>Rotates arm laterally</td>
<td>Suprascapular n.</td>
</tr>
<tr>
<td>Teres minor</td>
<td>Lateral border of scapula</td>
<td>Greater tubercle of humerus</td>
<td>Rotates arm laterally</td>
<td>Axillary n.</td>
</tr>
</tbody>
</table>
Deep Muscles of the
Back and Neck

- Splenius capitis (cut)
- Longissimus capitis
- Semispinalis capitis
- Spinalis capitis
- Splenius capitis
cut
- Spinalis cervicis
- Iliocostalis cervicis
- Longissimus thoracis
- Iliocostalis
thoracis
- Spinalis
thoracis
- Iliocostalis
lumborum
Muscles of the Shoulder and Back

- Trapezius
- Deltoid
- Latissimus dorsi
- Levator scapulae
- Supraspinatus
- Infraspinatus
- Teres minor
- Teres major
- Rhomboideus major
- Trapezius
- Deltoid
- Rhomboideus major
- Latissimus dorsi
Muscles of the Anterior Chest and Abdominal Wall

- Sternocleidomastoid
- Pectoralis minor
- Internal intercostal
- Serratus anterior
- Rectus abdominis
- Internal oblique
- Transversus abdominis
- Trapezius
- Deltoid
- Pectoralis major
- Linea alba (band of connective tissue)
- External oblique
- Aponeurosis of external oblique
<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biceps brachii</td>
<td>Coracoid process and tubercle above glenoid cavity of scapula</td>
<td>Radial tuberosity of radius</td>
<td>Flexes forearm at elbow and rotates hand laterally</td>
<td>Musculocutaneous n.</td>
</tr>
<tr>
<td>Brachialis</td>
<td>Anterior shaft of humerus</td>
<td>Coronoid process of ulna</td>
<td>Flexes forearm at elbow</td>
<td>Musculocutaneous, median, and radial nerves</td>
</tr>
<tr>
<td>Brachioradialis</td>
<td>Distal lateral end of humerus</td>
<td>Lateral surface of radius</td>
<td>Flexes forearm at elbow</td>
<td>Radial n.</td>
</tr>
<tr>
<td>Triceps brachii</td>
<td>Tubercle below glenoid cavity and lateral and medial surfaces of humerus</td>
<td>Olecranon process of ulna</td>
<td>Extends forearm at elbow</td>
<td>Radial n.</td>
</tr>
<tr>
<td>Supinator</td>
<td>Lateral epicondyle of humerus and crest of ulna</td>
<td>Lateral surface of radius</td>
<td>Rotates forearm laterally</td>
<td>Radial n.</td>
</tr>
<tr>
<td>Pronator teres</td>
<td>Medial epicondyle of humerus and coronoid process of ulna</td>
<td>Lateral surface of radius</td>
<td>Rotates forearm medially</td>
<td>Median n.</td>
</tr>
<tr>
<td>Pronator quadratus</td>
<td>Anterior distal end of ulna</td>
<td>Anterior distal end of radius</td>
<td>Rotates forearm medially</td>
<td>Median n.</td>
</tr>
</tbody>
</table>
# Muscles That Move the Hand

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flexor carpi radialis</td>
<td>Medial epicondyle of humerus</td>
<td>Base of second and third metacarpals</td>
<td>Flexes wrist and abducts hand</td>
<td>Median n.</td>
</tr>
<tr>
<td>Flexor carpi ulnaris</td>
<td>Medial epicondyle of humerus and olecranon process</td>
<td>Carpal and metacarpal bones</td>
<td>Flexes wrist and adducts hand</td>
<td>Ulnar n.</td>
</tr>
<tr>
<td>Palmaris longus</td>
<td>Medial epicondyle of humerus</td>
<td>Fascia of palm</td>
<td>Flexes the wrist</td>
<td>Median n.</td>
</tr>
<tr>
<td>Flexor digitorum profundus</td>
<td>Anterior surface of ulna</td>
<td>Bases of distal phalanges in fingers 2-5</td>
<td>Flexes distal joints of fingers</td>
<td>Median and ulnar nerves</td>
</tr>
<tr>
<td>Flexor digitorum superficialis</td>
<td>Medial epicondyle of humerus, coronoid process of ulna, and radius</td>
<td>Tendons of fingers</td>
<td>Flexes fingers and wrist</td>
<td>Median n.</td>
</tr>
<tr>
<td>Extensor carpi radialis longus</td>
<td>Distal end of humerus</td>
<td>Base of second metacarpal</td>
<td>Extends wrist and abducts hand</td>
<td>Radial n.</td>
</tr>
<tr>
<td>Extensor carpi radialis brevis</td>
<td>Lateral epicondyle of humerus</td>
<td>Base of second and third metacarpals</td>
<td>Extends wrist and abducts hand</td>
<td>Radial n.</td>
</tr>
<tr>
<td>Extensor carpi ulnaris</td>
<td>Lateral epicondyle of humerus</td>
<td>Base of fifth metacarpal</td>
<td>Extends wrist and adducts hand</td>
<td>Radial n.</td>
</tr>
<tr>
<td>Extensor digitorum</td>
<td>Lateral epicondyle of humerus</td>
<td>Posterior surface of phalanges in fingers 2-5</td>
<td>Extends fingers</td>
<td>Radial n.</td>
</tr>
</tbody>
</table>
Muscles of the Shoulder and Arm

(a) Levator scapulae
Supraspinatus
Spine of scapula
Deltoid
Infraspinatus
Teres minor
Teres major
Long head of triceps brachii
Lateral head of triceps brachii

(b) Levator scapulae
Infraspinatus
Teres minor
Teres major

(c) Supraspinatus
Teres major

(d) Triceps brachii
Cross Section of the Arm

- Pectoralis major
- Serratus anterior
- Coracobrachialis
- Short head of biceps brachii
- Long head of biceps brachii
- Deltoid
- Humerus
- Teres major
- Latissimus dorsi
- Biceps brachii
- Coracobrachialis
- Triceps brachii
Muscles of the Shoulder and Arm

- Trapezius
- Deltoid
- Short head of biceps brachii
- Long head of biceps brachii
- Clavicle
- Subscapularis
- Coracobrachialis
- Medial border of scapula
- Brachialis

(b) Biceps brachii (short and long heads)

(c) Subscapularis

(d) Coracobrachialis

Brachialis
Muscles of the Arm and Forearm

- Triceps brachii
- Extensor carpi radialis longus
- Flexor carpi ulnaris
- Extensor carpi ulnaris

- Brachioradialis
- Extensor carpi radialis brevis
- Extensor digitorum

- Extensor carpi radialis longus and brevis

- Extensor retinaculum

(a)

(b)

(c)
Cross Section of the Forearm

- Abductor pollicis longus m.
- Flexor pollicis longus m.
- Radius
- Extensor carpi radialis brevis m.
- Extensor carpi radialis longus m.
- Pronator teres m.
- Brachioradialis m.
- Radial n.
- Radial a.
- Flexor carpi radialis m.
- Extensor digitorum m.
- Extensor carpi ulnaris m.
- Extensor pollicis longus m.
- Ulna
- Flexor digitorum profundus m.
- Ulnar n.
- Ulnar a.
- Flexor carpi ulnaris m.
- Median n.
- Flexor digitorum superficialis m.
- Palmaris longus m.
### Muscles of the Abdominal Wall

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>External oblique</td>
<td>Outer surfaces of lower ribs</td>
<td>Outer lip of iliac crest and linea alba</td>
<td>Tenses abdominal wall and compresses abdominal contents</td>
<td>Intercostal nerves 7–12</td>
</tr>
<tr>
<td>Internal oblique</td>
<td>Crest of ilium and inguinal ligament</td>
<td>Cartilages of lower ribs, linea alba, and crest of pubis</td>
<td>Same as above</td>
<td>Intercostal nerves 7–12</td>
</tr>
<tr>
<td>Transversus abdominis</td>
<td>Costal cartilages of lower ribs, processes of lumbar vertebrae, lip of iliac crest, and inguinal ligament</td>
<td>Linea alba and crest of pubis</td>
<td>Same as above</td>
<td>Intercostal nerves 7–12</td>
</tr>
<tr>
<td>Rectus abdominis</td>
<td>Crest of pubis and symphysis pubis</td>
<td>Xiphoid process of sternum and costal cartilages</td>
<td>Same as above; also flexes vertebral column</td>
<td>Intercostal nerves 7–12</td>
</tr>
</tbody>
</table>
### Muscles of the Pelvic Outlet

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levator ani</td>
<td>Pubic bone and ischial spine</td>
<td>Coccyx</td>
<td>Supports pelvic viscera and provides sphincterlike action in anal canal and vagina</td>
<td>Pudendal n.</td>
</tr>
<tr>
<td>Coccygeus</td>
<td>Ischial spine</td>
<td>Sacrum and coccyx</td>
<td>Same as above</td>
<td>S4 and S5 nerves</td>
</tr>
<tr>
<td>Superficial transversus</td>
<td>Ischial tuberosity</td>
<td>Central tendon</td>
<td>Supports pelvic viscera</td>
<td>Pudendal n.</td>
</tr>
<tr>
<td>perinei</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bulbospongiosus</td>
<td>Central tendon</td>
<td>Males: Urogenital diaphragm and fascia of penis; Females: Pubic arch and root of clitoris</td>
<td>Males: Assists emptying of urethra; Females: Constricts vagina</td>
<td>Pudendal n.</td>
</tr>
<tr>
<td>Ischiocavernosus</td>
<td>Ischial tuberosity</td>
<td>Pubic arch</td>
<td>Assists function of bulbospongiosus</td>
<td>Pudendal n.</td>
</tr>
<tr>
<td>Sphincter urethrae</td>
<td>Margins of pubis and ischium</td>
<td>Fibers of each unite with those from other side</td>
<td>Opens and closes urethra</td>
<td>Pudendal n.</td>
</tr>
</tbody>
</table>
Muscles of Pelvic Outlets and Urogenital Diaphragm

(a) Scrotum
Penis
Ischiocavernosus
Bulbospongiosus
Superficial transversus perinei
Levator ani
Gluteus maximus
External anal sphincter
Anus

(b) Clitoris
Urethral orifice
Vaginal orifice

(c) Coccygeus
Levator ani
Urogenital diaphragm
Anus
Rectum
Vagina
Urethra
Symphysis pubis
Coccyx
# Muscles That Move the Thigh

## Table 9.12 Muscles That Move the Thigh

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Psoas major</td>
<td>Lumbar intervertebral discs; bodies and transverse processes of lumbar vertebrae</td>
<td>Lesser trochanter of femur</td>
<td>Flexes thigh</td>
<td>Branches of L1-3 nerves</td>
</tr>
<tr>
<td>Iliacus</td>
<td>Iliac fossa of ilium</td>
<td>Lesser trochanter of femur</td>
<td>Flexes thigh</td>
<td>Femoral n.</td>
</tr>
<tr>
<td>Gluteus maximus</td>
<td>Sacrum, coccyx, and posterior surface of ilium</td>
<td>Posterior surface of femur and fascia of thigh</td>
<td>Extends thigh at hip</td>
<td>Inferior gluteal n.</td>
</tr>
<tr>
<td>Gluteus medius</td>
<td>Lateral surface of ilium</td>
<td>Greater trochanter of femur</td>
<td>Abducts and rotates thigh medially</td>
<td>Superior gluteal n.</td>
</tr>
<tr>
<td>Gluteus minimus</td>
<td>Lateral surface of ilium</td>
<td>Greater trochanter of femur</td>
<td>Same as gluteus medius</td>
<td>Superior gluteal n.</td>
</tr>
<tr>
<td>Tensor fasciae latae</td>
<td>Anterior iliac crest</td>
<td>Iliotibial band (fascia of thigh)</td>
<td>Abducts, flexes, and rotates thigh medially</td>
<td>Superior gluteal n.</td>
</tr>
<tr>
<td>Pectineus</td>
<td>Spine of pubis</td>
<td>Femur distal to lesser trochanter</td>
<td>Adducts and flexes thigh</td>
<td>Obturator and femoral nerves</td>
</tr>
<tr>
<td>Adductor longus</td>
<td>Pubic bone near symphysis pubis</td>
<td>Posterior surface of femur</td>
<td>Adducts, flexes, and rotates thigh laterally</td>
<td>Obturator n.</td>
</tr>
<tr>
<td>Adductor magnus</td>
<td>Ischial tuberosity</td>
<td>Posterior surface of femur</td>
<td>Adducts, extends, and rotates thigh laterally</td>
<td>Obturator and branch of sciatic n.</td>
</tr>
<tr>
<td>Gracilis</td>
<td>Lower edge of symphysis pubis</td>
<td>Medial surface of tibia</td>
<td>Adducts thigh and flexes leg at the knee</td>
<td>Obturator n.</td>
</tr>
</tbody>
</table>
# Muscles That Move the Leg

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamstring Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biceps femoris</td>
<td>Ischial tuberosity and linea aspera of femur</td>
<td>Head of fibula and lateral condyle of tibia</td>
<td>Flexes and rotates leg laterally and extends thigh</td>
<td>Tibial n.</td>
</tr>
<tr>
<td>Semitendinosus</td>
<td>Ischial tuberosity</td>
<td>Medial surface of tibia</td>
<td>Flexes and rotates leg medially and extends thigh</td>
<td>Tibial n.</td>
</tr>
<tr>
<td>Semimembranosus</td>
<td>Ischial tuberosity</td>
<td>Medial condyle of tibia</td>
<td>Flexes and rotates leg medially and extends thigh</td>
<td>Tibial n.</td>
</tr>
<tr>
<td>Sartorius</td>
<td>Anterior superior iliac spine</td>
<td>Medial surface of tibia</td>
<td>Flexes leg and thigh, abducts and rotates thigh laterally</td>
<td>Femoral n.</td>
</tr>
<tr>
<td>Quadriceps Femoris Group</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rectus femoris</td>
<td>Spine of ilium and margin of acetabulum</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vastus lateralis</td>
<td>Greater trochanter and posterior surface of femur</td>
<td>Patella by common tendon, which continues as patellar ligament to tibial tuberosity</td>
<td>Extends leg at knee</td>
<td>Femoral n.</td>
</tr>
<tr>
<td>Vastus medialis</td>
<td>Medial surface of femur</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vastus intermedius</td>
<td>Anterior and lateral surfaces of femur</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# Muscles That Move the Foot

<table>
<thead>
<tr>
<th>Muscle</th>
<th>Origin</th>
<th>Insertion</th>
<th>Action</th>
<th>Nerve Supply</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibialis anterior</td>
<td>Lateral condyle and lateral surface of tibia</td>
<td>Tarsal bone (cuneiform) and first metatarsal</td>
<td>Dorsiflexion and inversion of foot</td>
<td>Deep fibular n.</td>
</tr>
<tr>
<td>Fibularis tertius</td>
<td>Anterior surface of fibula</td>
<td>Dorsal surface of fifth metatarsal</td>
<td>Dorsiflexion and eversion of foot</td>
<td>Deep fibular n.</td>
</tr>
<tr>
<td>Extensor digitorum longus</td>
<td>Lateral condyle of tibia and anterior surface of fibula</td>
<td>Dorsal surfaces of second and third phalanges of four lateral toes</td>
<td>Dorsiflexion and eversion of foot and extension of toes</td>
<td>Deep fibular n.</td>
</tr>
<tr>
<td>Gastrocnemius</td>
<td>Lateral and medial condyles of femur</td>
<td>Posterior surface of calcaneus</td>
<td>Plantar flexion of foot and flexion of leg at knee</td>
<td>Tibial n.</td>
</tr>
<tr>
<td>Soleus</td>
<td>Head and shaft of fibula and posterior surface of tibia</td>
<td>Posterior surface of calcaneus</td>
<td>Plantar flexion of foot</td>
<td>Tibial n.</td>
</tr>
<tr>
<td>Flexor digitorum longus</td>
<td>Posterior surface of tibia</td>
<td>Distal phalanges of four lateral toes</td>
<td>Plantar flexion and inversion of foot and flexion of four lateral toes</td>
<td>Tibial n.</td>
</tr>
<tr>
<td>Tibialis posterior</td>
<td>Lateral condyle and posterior surface of tibia and posterior surface of fibula</td>
<td>Tarsal and metatarsal bones</td>
<td>Plantar flexion and inversion of foot</td>
<td>Tibial n.</td>
</tr>
<tr>
<td>Fibularis longus</td>
<td>Lateral condyle of tibia and head and shaft of fibula</td>
<td>Tarsal and metatarsal bones</td>
<td>Plantar flexion and eversion of foot; also supports arch</td>
<td>Superficial fibular n.</td>
</tr>
</tbody>
</table>
Muscles of the Thigh and Leg
Muscles of the Thigh and Leg

- Gluteus medius
- Gluteus maximus
- Tensor fasciae latae
- Sartorius
- Rectus femoris
- Vastus lateralis
- Iliotibial band (fascia)

(b) Gluteus medius
(c) Gluteus maximus
(d) Gluteus minimus

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Muscles of the Thigh and Leg

- Adductor magnus
- Gracilis
- Semitendinosus
- Semimembranosus
- Sartorius
- Gastrocnemius
- Gluteus medius
- Gluteus maximus
- Vastus lateralis covered by fascia
- Biceps femoris
- Semitendinosus
- Semimembranosus
- Biceps femoris (shorthead)
- Biceps femoris (long head)
Cross Section of the Thigh

Lateral

- Long head of biceps femoris m.
- Short head of biceps femoris m.
- Sciatic n.

Medial

- Semitendinosus m.
- Semimembranosus m.
- Adductor magnus m.
- Gracilis m.
- Adductor longus m.
- Great saphenous v.
- Femoral v. and a.
- Sartorius m.
- Vastus medialis m.

Anterior

- Adipose tissue
- Skin
Muscles of the Leg

- Biceps femoris
- Vastus lateralis
- Gastrocnemius
- Head of fibula
- Tibialis anterior
- Fibularis longus
- Extensor digitorum longus
- Soleus
- Extensor retinacula
- Calcaneal tendon
- Fibularis brevis
- Fibularis tertius
- Fibular retinacula

(a) Fibularis longus
(b) Fibularis brevis
Muscles of the Leg

Semitendinosus
Semitendinosus
Gracilis
Sartorius

Biceps femoris

Gastrocnemius:
- Medial head
- Lateral head

Fibularis longus
Fibularis brevis

Soleus
Calcaneal tendon
Flexor digitorum longus
Flexor retinaculum
Calcaneus
Fibular retinaculum

(a)

(b) Gastrocnemius
(c) Soleus

(d) Tibialis posterior
(e) Flexor digitorum longus

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Cross Section of the Leg

- Gastrocnemius m.
- Soleus m.
- Fibula
- Superficial fibular n.
- Fibularis longus m.
- Deep fibular n.
- Anterior tibial a.
- Extensor digitorum longus m.

Small saphenous v.
Tibial n.
Posterior tibial a.
Flexor digitorum longus m.
Great saphenous v.
Tibialis posterior m.
Tibialis anterior m.
Tibia
Life-Span Changes

- Myoglobin, ATP, and creatine phosphate decline
- By age 80, half of muscle mass has atrophied
- Adipose cells and connective tissues replace muscle tissue
- Exercise helps to maintain muscle mass and function
Clinical Application

Myasthenia Gravis

- autoimmune disorder
- receptors for acetylcholine on muscle cells are attacked
- weak and easily fatigued muscles result
- difficulty swallowing and chewing
- ventilator needed if respiratory muscles are affected
- treatments include
  - drugs that boost acetylcholine
  - removing thymus gland
  - immunosuppressant drugs
  - antibodies
Active vs. Inactive Muscle: Muscular Atrophy
Exercise and Diet Stimulates Muscle Development

Arnold Schwarzenegger – Body Builder, Actor, and Politician

Hans and Franz