Muscle Tissue & Muscles

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Functions of the muscular system

1. **Locomotion** – all body movements are the results of skeletal muscle contraction.

2. **Vasoconstriction** and **Vasodilatation** - constriction and dilation of blood vessel walls are the results of smooth muscle contraction.

3. **Peristalsis** – wavelike motion along the digestive tract is produced by the smooth muscle.

4. **Cardiac motion** – heart chambers are able to pump blood to the lungs and the body because of cardiac muscle contraction.

5. **Posture maintenance** - contraction of skeletal muscles maintains body posture and muscle tone.

6. **Heat generation** – about 75% of **ATP** energy used in muscle contraction is released as heat to help maintain a constant body temperature (since skeletal muscles are the most abundant, they release the largest amount of heat in muscle tissue).
Comparison of the three types of muscle

1. **Location**
   a) Skeletal muscles are on or near the body surface.
   b) Smooth muscles form walls of hollow visceral organs, such as blood vessels and digestive tract.
   c) Cardiac muscle forms the walls of heart chambers.

2. **Function**
   a) Skeletal muscle moves bones at the joints, maintain body posture, and generates body heat.
   b) Smooth muscle constricts and dilates hollow organs, and conducts peristalsis.
   c) Cardiac muscle contracts the heart chambers.

3. **Striation**
   a) Present in skeletal and cardiac muscles (alternating Actin & Myosin)
   b) Absent in smooth muscle.
(a) Photomicrograph of portions of two isolated muscle fibers (700×). Notice the obvious striations (alternating dark and light bands).

(b) Diagram of part of a muscle fiber showing the myofibrils. One myofibril extends from the cut end of the fiber.

(c) Small part of one myofibril enlarged to show the myofilaments responsible for the banding pattern. Each sarcomere extends from one Z disc to the next.
4. **Nucleus**
a) smooth and cardiac are uninucleated (one nucleus per cell).
b) skeletal muscle is multinucleated (several nuclei per cell).

5. **Transverse tubule (T tubule)**
a) well developed in skeletal and cardiac muscles to transport calcium.
b) absent in smooth muscle.

6. **Intercalated disk**
a) specialized intercellular junction that only occurs in cardiac muscle.
b) skeletal and smooth muscles mainly rely on desmosomes.

7. **Mode of control**
a) skeletal muscle is always under *voluntary* control, with some exceptions (the diaphragm, and pili arrector muscles in the dermis).
b) smooth and cardiac muscles are under *involuntary* control.
Part of a skeletal muscle fiber (cell)

Myofibril

Sarcolemma

I band

A band

I band

Z disc

H zone

M line

Z disc

Sarcolemma

Triad:
- T tubule
- Terminal cisterns of the SR (2)

Tubules of the SR

Myofibrils

Mitochondria

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8. **Contraction**

a) Skeletal muscle contracts and relaxes rapidly with powerful force.

b) Smooth muscle contracts and relaxes slowly but at longer duration, and is self-exciting and rhythmic.

c) Cardiac muscle contracts and relaxes as a unit (syncytium), and is also self-excit ing.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Skeletal</th>
<th>Cardiac</th>
<th>Smooth</th>
</tr>
</thead>
<tbody>
<tr>
<td>Body location</td>
<td>Attached to bones or (some facial muscles) to skin</td>
<td>Walls of the heart</td>
<td>Unitary muscle in walls of hollow visceral organs (other than the heart); multi unit muscle in intrinsic eye muscles, airways, large arteries</td>
</tr>
<tr>
<td>Cell shape and appearance</td>
<td>Single, very long, cylindrical, multinucleate cells with obvious striations</td>
<td>Branching chains of cells; uni- or binucleate; striations</td>
<td>Single, fusiform, uninucleate; no striations</td>
</tr>
</tbody>
</table>

Table 9.3: Comparison of Skeletal, Cardiac, and Smooth Muscle
Smooth Muscle

a) **Actin** and **myosin** filaments are randomly arranged in the myofibrils (resulting in the lack of striations), thus smooth muscle contracts slowly and with less force involved.

b) **Sarcoplastic reticulum** (SR) is not well developed and lacks transverse tubules (T-tubules), thus calcium ion cannot be released rapidly.
(a) Cross section of the intestine showing the smooth muscle layers running at right angles to each other.

Longitudinal layer of smooth muscle (shows smooth muscle fibers in cross section)

Circular layer of smooth muscle (shows longitudinal views of smooth muscle fibers)
Cardiac Muscle

a) unique arrangement of acting and myosin filaments produces the cross-striations (an optical illusion under the microscope), and rapid contraction with powerful forces involved.

b) muscle cells are joined by intercalated disks, and allow muscle groups to form branching networks - both features are necessary for cardiac muscle to function as a unit.

c) SR and T-tubules are well developed, so a large amount of calcium can be released rapidly through the T tubules.

d) contains more mitochondria in each muscle cell than skeletal and smooth muscles, providing more ATP energy for continuous contraction.
Skeletal Muscle

1. Gross anatomy

a) actin and **myosin** filaments → sarcomeres → myofibrils → muscle fibers (muscle cells) → fascicles → skeletal muscle.

b) coverings:

- **Sarcolemma** surrounds the cell (plasmalemma).
- **Endomysium** surrounds muscle fibers (between).
- **Perimysium** surrounds fascicles.
- **Epimysium** surrounds skeletal muscle.
(a) Photomicrograph of portions of two isolated muscle fibers (700×). Notice the obvious striations (alternating dark and light bands).

(b) Diagram of part of a muscle fiber showing the myofibrils. One myofibril extends from the cut end of the fiber.

(c) Small part of one myofibril enlarged to show the myofilaments responsible for the banding pattern. Each sarcomere extends from one Z disc to the next.
Microscopic Anatomy

a) a motor nerve and a myofibril from a neuromuscular junction where a gap (called synapse) occurs between the two structures.

b) at the end of motor nerve, neurotransmitter (i.e. acetylcholine) is stored in synaptic vesicles which will release the neurotransmitter using exocytosis upon the stimulation of a nerve impulse.

c) across the synapse the surface of the myofibril contains receptors that can bind with the neurotransmitter.
The Neuromuscular Junction

Setting the stage
The events at the neuromuscular junction (NMJ) set the stage for E-C coupling by providing excitation. Released acetylcholine binds to receptor proteins on the sarcolemma and triggers an action potential in a muscle fiber.
Parts of Skeletal Muscle

• **a) origin** - immovable end of the muscle; connects to a bone by tendon or to another muscle by fascia.

• **b) belly** middle portion of the muscle where most contraction occurs.

• **c) insertion** – movable end of the muscle; connects to a bone by tendon or to another muscle by fascia.

• Example: during flexing motion of the arm, the origin of biceps brachii (at the coracoid process of scapula) does not move, while the insertion (at the radial tuberosity of radius) does which pulls radius toward humerus.
Interaction of skeletal muscles

a) **prime mover** – the muscle that initiates a movement and produces most of the force.

b) **synergist** – muscles that assist the prime mover.

c) **antagonist** – muscles that resist the prime mover.

- Example: during motion of the arm, biceps brachii serves as the prime mover and is assisted by brachialis (the synergist for this action), but is resisted by triceps brachii (the antagonist that tries to conduct extension to resist the prime mover).
Naming of skeletal muscles

a) **action** – some skeletal muscles are named according to their actions (e.g. adductor femoris brings the thigh toward the midline).

b) **size** – some skeletal muscles are named by their size (e.g. gluteus maximus is the largest muscle in the buttock).

c) **shape** - some skeletal muscles are named according to their shapes (e.g. trapezius is trapezoid shaped, deltoid is triangular shaped).

d) **location** – some skeletal muscles are named by their locations (e.g. external oblique is a slanted muscle at the outermost surface of the abdomen).

e) **attachment**- some other skeletal muscles are named according to their attachments to bones (e.g. sternocleido-mastoid attaches from the sternum through the clavicle to the mastoid process of temporal bone).
Principal actions of skeletal muscles

**Flexor**- muscles that decrease the anterior angle at a joint (e.g. flexor carpi radialis).

**Extensor**- muscles that increase the anterior angle at a joint (e.g. extensor carpi ulnaris).

**Abductor**- muscles that move body parts away from the midline (e.g. abductor pollicis brevis).

**Adductor**- muscles that move body parts closer to the midline (e.g. adductor longus).

** Levator** – muscles that produce an upward movement (e.g. levator scapulae ventralis).
**Depressor**- muscles that produce a downward movement (e.g. depressor labii inferioris).

**Pronator**- muscles that turn the palm downward (e.g. pronator teres).

**Sphincter**- muscles that decrease the size of an opening (e.g. external anal sphincter).

**Tensor**- muscles that make a body part more rigid (e.g. tensor fascia lata).

**Rotator**- muscles that move a body part around its longitudinal axis (e.g. obturator externus).
Unique characteristics of skeletal muscle

**Excitability** - the ability to respond to a stimulus.

**Contractility** - the ability to undergo shortening.

**Extensibility** - the ability to be stretched.

**Elasticity** - the ability to resume its resting length after contraction.

**Muscle tone** - the ability to be partially contracted at all times.

- **Isotonic contraction** - muscle contracts while the tension within the muscle remains the same (e.g. lifting an object).

- **Isometric contraction** - muscle is unable to contract despite the increase of tension within the muscle (e.g. pushing an immovable object).
Connective tissue Covering of muscles

- Fascia: which separate muscles is a layer of dense connective tissue, that may project beyond the muscle fiber to from a cord like *tendon*. It may also form broad fibrous sheets called *aponeuroses*.
Major Skeletal Muscles of The Body

Muscles of facial Expression:

1) The **epicranius** – covers the upper part of cranium, consists of 2 parts.
   a) **occipitalis** – covers the occipital bone and pulls scalp posteriorly, innervated by facial nerve (cranial nerve VII).
   b) **frontails** – covers the frontal bone and raises the eyebrows.

2) **orbicularis oculi** – Ring like muscle that surrounds the eye. it closes or blinks the eyelid, innervated by facial nerve.
3) orbicularis oris – a muscle that encircle the mouth and is also known as kissing muscle, closes lips (cranial nerve VII).

4) buccinators: located in the wall of cheek. Draws mouth laterally, and compresses cheek as in whistling and sucking. Holds food in contact with teeth when chewing (cranial nerve VII).

5) Zygomaticus – Extends from zygomatic arch to the corner of mouth and is for smiling or laughing (cranial nerve VII).
6) **The platysma**: thin sheet of muscle extending from the chest up to neck to face. It helps lower the mandible (cranial nerve VII).
Muscles of Mastication

- **Masseter**: Extends from zygomatic arch to mandible. It raises the jaw (cranial nerve VII).
- **Temporals**: fan shaped muscle located on the side of the skull above and in front of the ear. It raises the jaw & is innervated by trigeminal nerve (cranial nerve V).
• **Medial Pterygoid**: Extend back and downward from the sphenoid, palatine, and maxillary bones to the ramus of mandible. Moves jaw from side to side, elevates mandible, and is innervated by trigeminal nerve.

• **Lateral Pterygoid**: Extends from mandibular condyle to the sphenoid bone. Moves jaw from side to side, protracts the mandible, and is innervated by trigeminal nerve.
Muscles that move the head & vertebral column

- **Sternocleidomastoid:**
  Origin: ant. surface of sternum.
  Insertion: mastoid process of temporal bone.
  Action: head flexion, contralateral rotation & ipsilaterial lat. flexion.
  Innervation: C2+C3 cervical nerves.

- **Scalenes:** (Anterior, posterior, middle scalene).
  Origin: transverse process of cervical vertebrae.
  Insertion: Ant. first two ribs
  Action: flex and rotate neck
  Innervation: cervical spine nerves.
• **Splenius capitis:**
  Origin: spinous process of upper T – spine and lower C- spine.
  Insertion: occipital bone.
  Action: extend head, rotates head, bends head to one side.
  Innervation: cervical nerves.
• **Semispinalis capitis:**
  Origin: transverse processes of C-spine and upper T-spine.
  Insertion: occipital bone.
  Action: extend head.
  Innervation: cervical & thoracic nerves.

• **Erector spinae:** group of muscles consisting of iliocostalis, longissimus, and spinalis muscles.
  Action: extend head, extend back, and maintain erect position of vertebral column.
  Innervation: spinal nerves.
Muscles that move the pectoral girdle

- **Trapezius (upper, middle, lower):**
  Origin: occipital bone and spines of C + T vertebrae.
  Insertion: clavicle, spine and acromion process of scapula.
  Action: rotates scapula, pulls shoulder & scapula downward.
  Innervation: Accessory nerve.

- **Rhomboid major:**
  Origin: spine of upper T- vertebra
  Insertion: medial border of scapula.
  Action: raises and adducts scapula
  Innervation: dorsal scapular nerve
• **Levator scapulae:**
  Origin: transverse process of C-spine vertebrae.
  Insertion: medial margin of scapula.
  Action: raises scapula.
  Innervation: dorsal scapular and cervical nerves.
• **Serratus anterior:**
  Origin: outer surface of upper ribs.
  Insertion: venteral surface of scapula.
  Action: pulls scapula Ant. & downward.
  Innervation: long thoracic nerve.

• **Pectoralis minor:**
  Origin: sternal ends of upper ribs.
  Insertion: coracoid process of scapula.
  Action: pulls scapula forward, downward and raises ribs.
  Innervation: pectoral nerves.
Muscles That Move the arm

**Flexors**

- **Coracobrachialis:**
  - Origin: coracoid process of scapula.
  - Insertion: shaft of humerus.
  - Action: flexes and adducts the arm.
  - Innervation: musculocutaneous nerve.

- **Pectoralis major:**
  - Origin: clavicle, sternum, and costal cartilages of upper ribs.
  - Insertion: intertubercular groove of humerus.
  - Action: flexes, adducts and rotates arm medially.
  - Innervation: pectoral nerve.
**Extensors**

- **Teres major:**
  Origin: Lat. border of scapula
  Insertion: intertubercular groove of humerus
  Action: Extends, adducts, and rotates arm medially.
  Innervation: lower subscapular nerve.

- **Latissimus dorsi:**
  Origin: spines of sacral, lower T– spine, lumbar, iliac crest, and lower ribs.
  Insertion: intertubercular groove of humerus.
  Action: extends, adducts and rotates the arm medially, and pulls the shoulder downward and back.
  Innervation: thoracodorsal nerve.
Abductors


(a) Anterior view

*Rotator cuff muscles

(b) Posterior view

*Rotator cuff muscles
Rotators

- **Infraspinatus:**
  Origin: post. surface of scapula below spine.
  Insertion: Greater tubercle of humerus.
  Action: rotates arm laterally.
  Innervation: suprascapular nerve.

- **Teres minor:**
  Origin: Lat. border of scapula.
  Insertion: Greater tubercle of humerus.
  Action: rotates arm laterally.
  Innervation: Axillary nerve.
• **Subscapularis:**
  Origin: Ant. surface of scapula.
  Insertion: lesser tubercle of humerus.
  Action: rotates arm medially.
  Innervation: subscapular nerve.

• **Rotator cuff:** muscles that encircle the shoulder joint.

• made up of **4 muscles:**
  Subscapularis
  Supraspinatus
  Infraspinatus
  Teres minor
Muscle that move the forearm

Flexors

- Biceps brachii:
  - Origin: coracoid process and tubercle above glenoid cavity of scapula.
  - Insertion: radial tuberostiy of radius.
  - Action: flexes forearm at elbow & rotates hand laterally.
  - Innervation: musculocutaneous nerve.
• **Brachialis:**
  Origin: Ant. shaft of humerus.
  Insertion: coronoid process of ulna.
  Action: flexes forearm at elbow.
  Innervation: musculocutaneous, median, and radial nerve.

• **Brachioradialis:**
  Origin: distal lat. end of humerus.
  Insertion: lat. surface of radius above styloid process.
  Action: flexes forearm at elbow.
  Innervation: radial nerve.
Extensors

- **Triceps brachii:**
  - Origin: tubercle below glenoid cavity, lat. & medial humerus.
  - Insertion: olecranon process of ulna.
  - Action: Extends forearm at elbow.
  - Innervation: radial nerve.

Rotators

- **Supinator:**
  - Origin: lat. epicondyle of humerus and crest of ulna.
  - Insertion: lat. surface of radius.
  - Action: rotates arm laterally.
  - Innervation: Radial nerve.
• **Pronator teres:**
  Origin: medial epicondyle of humerus and coronoid process of ulna.
  Insertion: lat. surface of radius.
  Action: rotates forearm medially.
  Innervation: median nerve.

• **Pronator quadratus:**
  Origin: Ant. distal end of ulna.
  Insertion: ant. distal end of radius.
  Action: rotates forearm medially.
  Innervation: median nerve.
Muscles that move the hand

Flexors

• **Flexor carpi radialis:**
  Origin: medial epicondyle of humerus.
  Insertion: base of 2nd + 3rd metacarpals.
  Action: flexes and abducts hand at the wrist.
  Innervation: median nerve.

• **Flexor carpi ulnaris:**
  Origin: medial epicondyle of humerus & olecranon process.
  Insertion: carpal and metacarpal bones.
  Action: flexes and adduct hand at the wrist.
  Innervation: ulnar nerve.
- **Flexor digitorum superficialis:**
  
  **Origin:** medial epicondyle of humerus, coronoid process of ulna & radius.
  
  **Insertion:** tendons of fingers.
  
  **Action:** flexes fingers and hand.
  
  **Innervation:** median nerve.
- **Palmaris longus:**
  Origin: medial epicondyle of humerus.
  Insertions: fascia of palm.
  Action: flexes hand at wrist.
  Innervation: median nerve.

- **Flexor digitorum profundus:**
  Origin: ant. surface of ulna.
  Insertion: bases of distal phalanges in fingers 2-5.
  Action: flexes distal joints of fingers.
  Innervation: median and ulnar nerve.
Extensors

Extensor carp radialis longus:
insertion: base of 2\textsuperscript{nd} metacarpal.
Action: extends and abducts hand at wrist.
innervation: radial nerve.

Extensor carpi radialis brevis:
origin: lat. epicondyle of humerus.
insertion: base of 2\textsuperscript{nd} & 3\textsuperscript{rd} metacarpals.
Action: extends and abducts hand at wrist.
innervation: radial nerve.
Extensor carpi ulnaris:
origin: lat. epicondyle of humerus.
insertion: base of 5th metacarpal.
Action: extends and adducts hand at wrist.
innervation: radial nerve.

Extensor digitorum:
origin: lat. epicondyle of humerus.
insertion: post. surface of phalanges 2-5.
Action: extend fingers.
Innervation: radial nerve.
Intrinsic muscles of the hand

Tendons of:
- Flexor digitorum profundus
- Flexor digitorum superficialis
- Third lumbral
- Fourth lumbral
- Opponens digiti minimi
- Flexor digiti minimi brevis
- Abductor digiti minimi
- Pisiform bone
- Flexor carpi ulnaris tendon
- Flexor digitorum superficialis tendons

Fibrous sheath
- Second lumbral
- Dorsal interossei
- First lumbral
- Adductor pollicis
- Flexor pollicis brevis
- Abductor pollicis brevis
- Opponens pollicis
- Flexor retinaculum
- Abductor pollicis longus
- Tendons of:
  - Palmaris longus
  - Flexor carpi radialis
  - Flexor pollicis longus

(a) First superficial layer

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Intrinsic muscles of the hand

- Flexor digitorum profundus tendon
- Flexor digitorum superficialis tendon
- Dorsal interossei
- Adductor pollicis
- Flexor pollicis brevis
- Abductor pollicis brevis
- Opponens pollicis
- Flexor pollicis longus tendon

(b) Second layer
Diaphragm

- **Diaphragm:**
  - Origin: inferior border of rib cage & sternum.
  - Insertion: central tendon.
  - Action: aid in expiration by depressing ribcage, prime mover of inspiration since it flattens and moves inferiorly on contraction.
  - Innervation: intercostal nerves 7-12.
Muscles of the abdominal wall

• **External oblique:**
  Origin: outer surface of lower ribs.
  Insertion: iliac crest & linea alba
  Action: tenses abdominal wall.
  Innervation: intercostal nerves 7-12.

• **Internal oblique:**
  Origin: crest of ilium & inguinal ligament.
  Insertion: cartilages of lower ribs, linea alba, and crest of pubis.
  Action: tenses abdominal wall.
  Innervation: intercostal nerves 7-12.
**Transversus abdominis:**
Origin: costal cartilage of lower ribs, iliac crest, inguinal ligaments and processes of lumbar fascia.
Insertion: linea alba & crest of pubis.
Action: tenses abdominal wall.
Innervation: intercostal nerves 7-12.

**Rectus abdominis:**
Origin: crest of pubis & symphysis pubis.
Insertion: xiphoid process of sternum and costal cartilages.
Action: tenses abdominal wall, and flexes back.
Innervation: intercostal nerves 7-12.
Muscles of the pelvic outlet

- **Levator ani:**  
  Origin: pubic bone and ischial spine.  
  Insertion: coccyx.  
  Action: sphincter like action in anal canal & vagina.  
  Innervation: pudendal nerve.

- **Sphincter urethrae:**  
  Origin: margin of pubis and ischium.  
  Insertion: midline fibers.  
  Action: opens and closes urethra.  
  Innervation: pudendal nerve.
Muscles that move the thigh

Anterior group

- **Psoas major:**
  Origin: lumbar vertebrae.
  Insertion: lesser trochanter of femur.
  Action: flexes thigh.
  Innervation: branches of L1-L3 nerves.

- **Iliacus:**
  Origin: iliac fossa of ilium.
  Insertion: lesser trochanter of femur.
  Action: flexes thigh.
  Innervation: femoral nerve.
Posterior group

- **Hamstrings**: (Biceps femoris, Semitendinosus, and Semimembranosus).

- **Gluteus maximus**:  
  Origin: sacrum, coccyx, and post. surface of ilium.  
  Insertion: post. surface of femur and fascia.  
  Action: extends thigh.  
  Innervation: gluteal nerve (inferior).

- **Gluteus medius**:  
  Origin: lat. surface of ilium  
  Insertion: greater trochanter of femur.  
  Action: abducts and rotates thigh medially.  
  Innervation: superior gluteal nerve.
• **Gluteus minimus:**
  Origin: lat. surface of ilium.
  Insertion: greater trochanter of femur.
  Action: abducts and rotates thigh medially.
  Innervation: superior gluteal nerve.

• **Tensor fascia lata:**
  Origin: Ant. iliac crest.
  Insertion: fascia of thigh.
  Action: Abducts, rotates thigh medially, flexes thigh.
  Innervation: sup. gluteal nerve.
Thigh Adductors

- **Pectineus:**
  Origin: spine of pubis.
  Insertion: femur distal to lesser trochanter.
  Action: adducts and flexes thigh.
  Innervation: obturator and femoral nerves.

- **Adductor longus:**
  Origin: pubic bone near symphysis pubis.
  Insertion: posterior surface of femur.
  Action: adducts, flexes, and rotate thigh laterally.
  Innervation: obturator nerve.
• Adductor magnus:
  Origin: Ischial tuberosity.
  Insertion: post. surface of femur.
  Action: adducts, extends, and rotate thigh laterally.
  Innervation: obturator nerve.

• Gracillis:
  Origin: symphysis pubis.
  Insertion: medial surface of tibia.
  Action: adduct thigh, and flexes leg at the knee.
  Innervation: obturator nerve.
Muscles that move the leg

**Flexors**: Biceps femoris, semitendinosus, semimembranosus (hamstring group), and sartorius.

- **Biceps femoris**:  
  **Origin**: Ischial tuberosity and femur.  
  **Insertion**: Head of fibula and lat. condyle of tibia.  
  **Action**: Flexes and rotates leg laterally and extends thigh.  
  **Innervation**: Tibial nerve.
• **Semitendinosus:**
  Origin: Ischial tuberosity.
  Insertion: Medial surface of tibia.
  Action: Flexes and rotates leg medially and extends thigh.
  Innervation: Tibial nerve.

• **Semimembranosus:**
  Origin: Ischial tuberosity.
  Insertion: medial condyle of tibia.
  Action: flexes and rotates leg medially and extends thigh.
  Innervation: Tibial nerve.
• **Sartorius:**

  **Origin:** anterior superior iliac spine.
  **Insertion:** medial surface of tibia.
  **Action:** flexes leg and thigh, abducts, and rotates thigh laterally.
  **Innervation:** femoral nerve.
**Extensors:** Rectus femoris, Vastus lateralis, vastus intermedius, and vastus medialis (Quadriceps femoris group).

- **Rectus femoris:**
  - Origin: spine of ilium and margin of acetabulum.
  - Insertion: patella and tibial tuberosity via patellar tendon.
  - Action: extends leg at knee.
  - Innervation: femoral nerve.

- **Vastus lateralis:**
  - Origin: greater trochanter and post. surface of femur.
  - Insertion: patella and tibial tuberosity via patellar tendon.
  - Action: extends leg at knee.
  - Innervation: femoral nerve.
12th rib
Quadratus lumborum
Psoas minor
Iliac crest
Iliopsoas
Psoas major
Iliacus
Anterior superior iliac spine
Tensor fascia lata
Pectineus
Sartorius
Quadriceps femoris
• Rectus femoris
• Vastus lateralis
• Vastus medialis
Adductor longus
Gracilis
Adductor magnus
Tendon of quadriceps femoris
Patella
Patellar ligament
• **Vastus medialis:**
  Origin: medial surface of femur.
  Insertion: patella & tibial tuberosity via patella ligament.
  Action: extends knee.
  Innervation: femoral nerve.

• **Vastus intermedius:**
  Origin: Ant. and Lat. surfaces of femur.
  Insertion: patella & tibial tuberosity via patellar ligament.
  Action: extends knee.
  Innervation: femoral nerve.
Muscles that move the foot

Dorsal Flexors

• Tibialis anterior:
  Origin: Lat. condyle and lat. surface of tibia.
  Insertion: Tarsal bone (cuneiform) & 1st metatarsal.
  Action: dorsiflexion and inversion of foot.
  Innervation: deep peroneal nerve.

• Peroneus (Fibularis) teritus:
  Origin: Ant. surface of fibula.
  Insertion: Dorsal surface of 5th metatarsal.
  Action: Dorsiflexion & eversion of foot.
  Innervation: deep peroneal nerve.
- Fibularis longus
- Gastrocnemius
- Tibia
- Tibialis anterior
- Extensor digitorum longus
- Soleus
- Extensor hallucis longus
- Fibularis tertius
- Superior and inferior extensor retinacula
- Extensor hallucis brevis
- Extensor digitorum brevis

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(b)
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Tibialis anterior
• **Extensor digitorum longus:**

  **Origin:** lat. condyle of tibia & ant. surface of fibula.

  **Insertion:** dorsal surface of 2\textsuperscript{nd} & 3\textsuperscript{rd} phalanges of 4 lat. toes.

  **Action:** dorsiflexion and eversion of foot & extension of toes.

  **Innervation:** deep peroneal nerve.
Plantar flexors

- **Gastrocnemius:**
  - Origin: Lat. & medial condyles of femur (two bellies).
  - Insertion: post. surface of calcaneus.
  - Action: plantar flexion of foot and flexion of leg at knee.
  - Innervation: Tibial nerve.

- **Soleus:**
  - Origin: Head & shaft of fibula, post. surface of tibia.
  - Insertion: post. surface of calcaneus.
  - Action: plantar flexion of foot.
  - Innervation: Tibial nerve.
(a) Superficial view of the posterior leg.

(b) The gastrocnemius has been removed to show the soleus immediately deep to it.
• **Flexor digitorum longus:**

  Origin: post. surface of tibia.

  Insertion: distal phalanges of 4 lat. toes.

  Action: plantar flexion and inversion of foot, and flexion of 4 lat. toes.

  Innervation: tibial nerve.
Invertor

• **Tibialis posterior:**
  Origin: Lat. condyle and post. surfaces of tibia and fibula.
  Insertion: tarsal and metatarsal bones.
  Action: plantar flexion and inversion of foot.
  Innervation: tibial nerve.

Evertor

• **Peroneus (Fibularis) longus:**
  Origin: Lat. condyle of tibia, head, and shaft of fibula.
  Insertion: tarsal and metatarsal bones.
  Action: plantar flexion and eversion of foot and supports arch.
  Innervation: superficial peroneal nerve.
Intrinsic muscles of the foot

(a) First layer (plantar aspect)

Tendon of flexor hallucis longus
Lumbricals
Flexor hallucis brevis
Flexor digiti minimi brevis
Abductor hallucis
Flexor digitorum brevis
Flexor accessorius
Abductor digiti minimi
Calcaneal tuberosity
Intrinsic muscles of the foot

(b) Second layer (plantar aspect)

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Intrinsic muscles of the foot

- Adductor hallucis (transverse head)
- Adductor hallucis (oblique head)
- Interosseous muscles
- Flexor hallucis brevis
- Flexor digiti minimi brevis
- Fibularis longus (tendon)
- Flexor accessorius
- Flexor digitorum longus (tendon)
- Flexor hallucis longus (tendon)

(c) Third layer (plantar aspect)

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Clinical Terms

**Fibrillation:** contraction of muscle fibers producing rapid, uncoordinated activity within a muscle.

**Torticollis:** neck muscles like SCM muscle contract involuntarily; also called wry neck causing chronic rotation and tilting of head to one side.

**Muscular dystrophy:** progressive muscle weakness and atrophy caused by a deficient protein called dystrophin.

**Myasthenia gravis:** chronic disease caused by muscles that are weak and easily fatigue. It results from immune system’s attack on neuromuscular junctions so that stimuli are not transmitted from motor neurons to muscle fibers.

**Shin splint:** soreness of the front of leg due to straining of flexor digitorum longus.

**Myositis:** inflammation of skeletal muscle tissue.