The Muscular System

Topics covered

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- Gross anatomy of muscles
- Muscle architecture
- Classifying muscles by shape
- Classifying muscles by function
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- Muscle actions
- Muscle nomenclature
- Muscle groups and functions
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- Sources of ATP
- Muscle fibre types
- Muscle fatigue
- Oxygen ‘debt’
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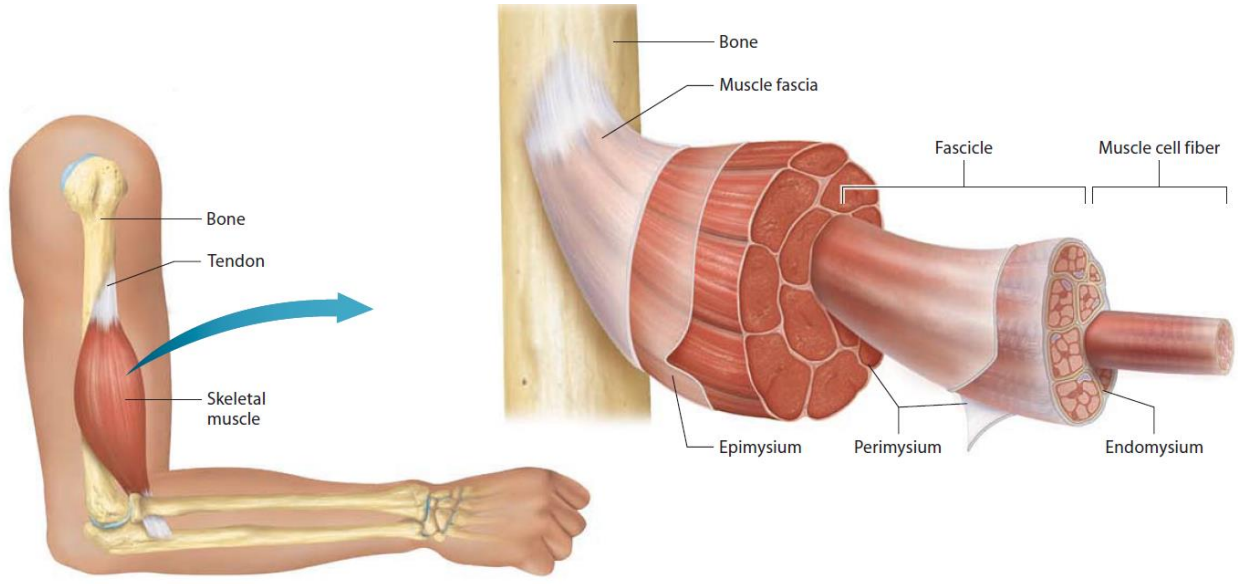
- Aging muscles

Function of muscles

- Movement:
  - Skeletal muscle contraction and relaxation causes bones to move at their joints.
  - Contraction of the diaphragm muscle produces volume and pressure changes to the thoracic cavity → assists in breathing
  - Stapedius muscle of the inner ear dampens excessive vibrations to prevent being overwhelmed by the sound of our own voice when we speak.
- Protection
- Support

Gross anatomy of muscles

- Each individual muscle cell/fibre = surrounded by endomysium (thin sheet of CT)
- Each bundle of muscle fibres = fascicle = surrounded by perimysium
- Each muscle unit = bundle of fascicles = surrounded by epimysium (fibrous CT)
- The epimysium extends to form tendons
- Muscles can attach to bones:
  - Via tendons
  - Via aponeurosis- (pearly white fibrous sheets i.e. basically a tendon but with a broader insert) *e.g. the rectus abdominus inserts into a big fan of CT that has anchoring points all over the abdominal cavity for muscles to pull in different directions where the broad insertions allow a wider ability to contract.*
  - Directly- Some muscles directly attach to the bone *e.g. temporalis* whereby the periosteum of the bone directly fuses with the epimysium



(a) Position of a representative skeletal muscle (brachialis)

(b) Structure of a skeletal muscle

Muscle architecture

- Every muscle fibre runs parallel to each other thus each fascicle can only pull in one direction
- The fascicular arrangement is associated with:
    - The amount of power a muscle can produce
    - The ROM a muscle can produce

e.g. Longer muscles = large ROM, less strength + vice versa

Classifying muscles by shape

- The pattern in which fascicles are arranged affects the appearance and function of skeletal muscles:
- 4 main arrangements:
    1. <u>Parallel:</u>
        - Evenly spaced fascicles attaching to a tendon that is approximately the same width as the muscle
        - Strap muscles→Does not significantly change in thickness all the way along
          Fusiform→ Anatomical 'belly' at the centre i.e. thick and dense at the centre as it is usually where multiple branches of muscles come together
        - Most parallel muscles have a large ROM and less strength allowing for movements such as flexion and extension *e.g. biceps brachii, brachialis.*
        - *Strap muscles E.g. Sartorius of thigh*
    2. <u>Pennate</u>
        - Fascicles that attach to the tendon at an angle i.e. runs obliquely to the insertion
        - Unipennate→fascicles arranged in 1 oblique direction on the same side of the tendon *e.g. extensor digitorum longus*
          Bipennate→ Tendon in the middle and fibres insert obliquely on either side *e.g. rectus femoris*
          Multipennate→ Multiple tendons and multiple fibres *e.g. deltoid*
    3. <u>Convergent</u>
        - Broad sheet of fibres all fusing to attach to one focal point i.e. a single tendon
        - Generally strong however takes up lots of space and attachment points
        - Most are triangular shaped and versatile i.e. many convergent muscles have fascicles isolated according to position e.g. upper, medial, lower quadrants = same muscle however each can be contracted in different ways and intensities to produce slightly different movements
        - *E.g. pectoralis major*
    4. <u>Circular</u>
        - Form sphincter like structures that are generally enter/exit points of the body
        - Don't generally attach to bones but rather, attach to themselves
        - When it contracts, the lumen diameter decreases to limit the amount of substance that needs to leave/enter through it

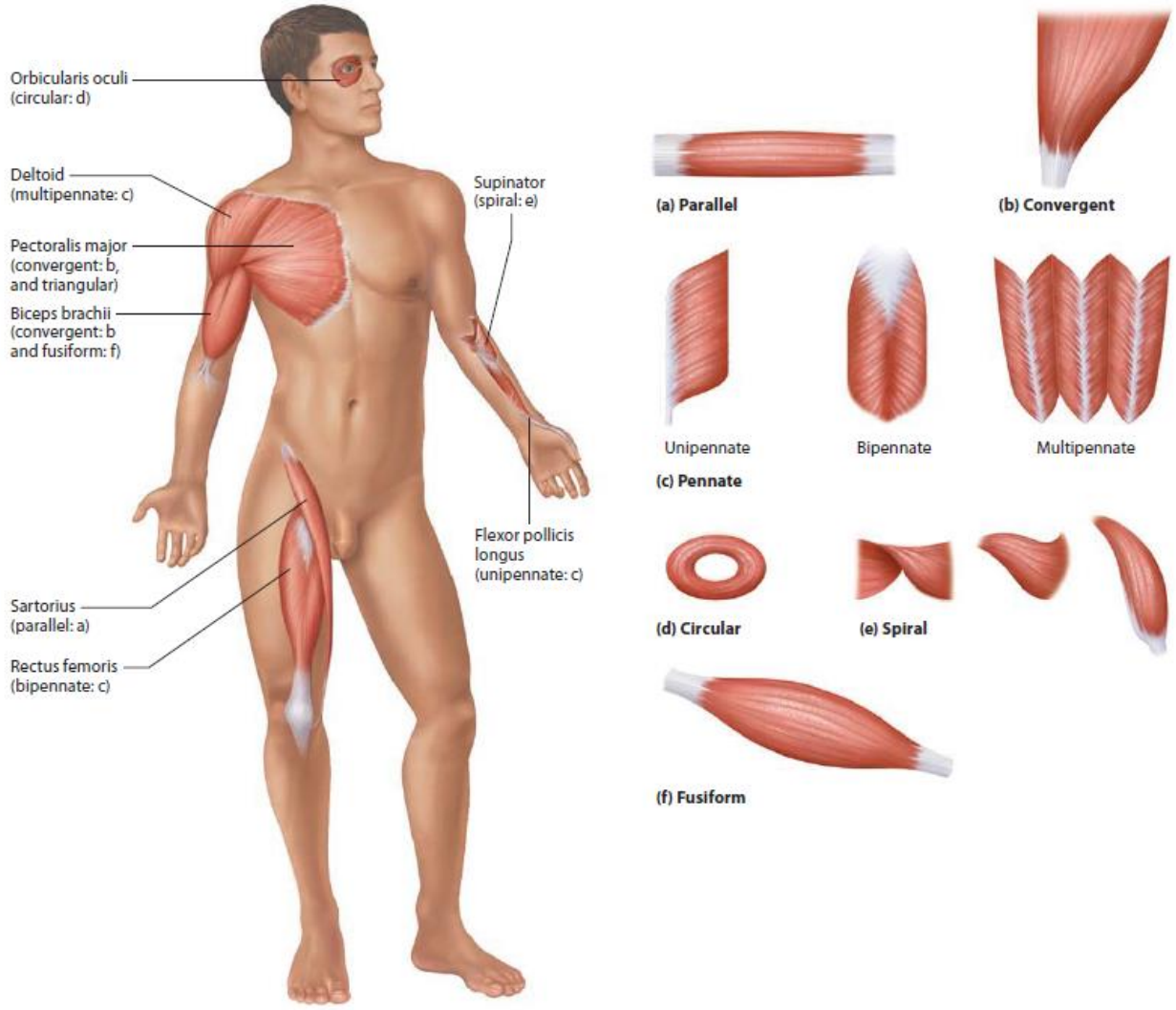


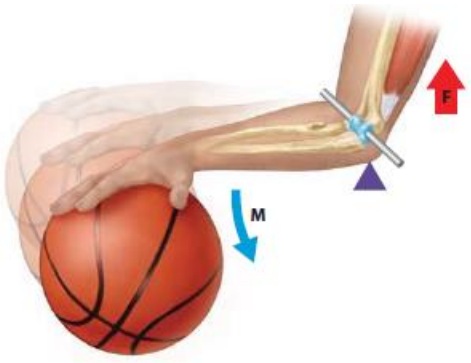
Figure 9.2 Fascicle pattern and muscle shape.

Classifying muscles by function

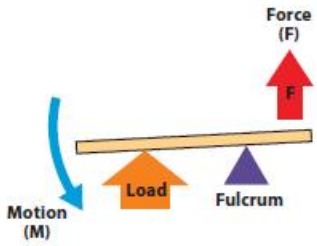
- Not all muscles act as part of a lever system
- All muscles act upon some position/joint in the body allowing it to move therefore most muscles are based on a lever system
- Muscles apply FORCE to pull bones i.e. LEVERS to move body parts via joints i.e. FULCRUM
- The type of lever depends on where the force is
- Different levers provide different contractions in terms of:
    - Direction of applied force
    - Distance of movement caused by the force
    - Speed of movement caused by the force
    - Effective strength of the applied force
- When the fulcrum is located further away from the force → lever works at a mechanical advantage
- Mechanical advantage: When a small force moves a large load over a short distance (short + strong)

Types of levers

1. First class levers
    - See-saw looking i.e. fulcrum is between the point of applied force and load to be moved
    - Rare *e.g. flexion/extension of neck at atlanto-occipital joint → load = front of head, fulcrum = joint, force = muscles at the back of the neck*
    - Not very energy efficient
    - Produces a mechanical advantage or disadvantage depending on the strength of the muscle and the location of the fulcrum
2. Second class levers
    - Wheel-barrow type
    - Fulcrum is located further from the applied force thus the force picks up the entire load to move it against the fulcrum
    - The load moves in the same direction as the applied force (rare event)
    - Small force = moves a large load but SLOW *e.g. standing up on toes i.e. PF*
    - Works at a mechanical advantage
    - "power" levers *(gastrocnemius, soleus)*
3. Third class levers
    - Most common
    - Shovel type
    - Force is much closer to the fulcrum
    - Mechanical disadvantage i.e. moves very quickly but not the strongest
    - *E.g. elbow*



(a) **First-class lever:** dribbling a basketball



- Fulcrum is located between applied force and load to be moved.
- Force applied and load moved are in opposite directions.
- Lever works at a mechanical advantage or disadvantage, depending on location of fulcrum.