

Hole's Human Anatomy and Physiology

Twelfth Edition

Shier ♦ Butler ♦ Lewis

Chapter
9
Muscular System



9.7: Skeletal Muscle Actions

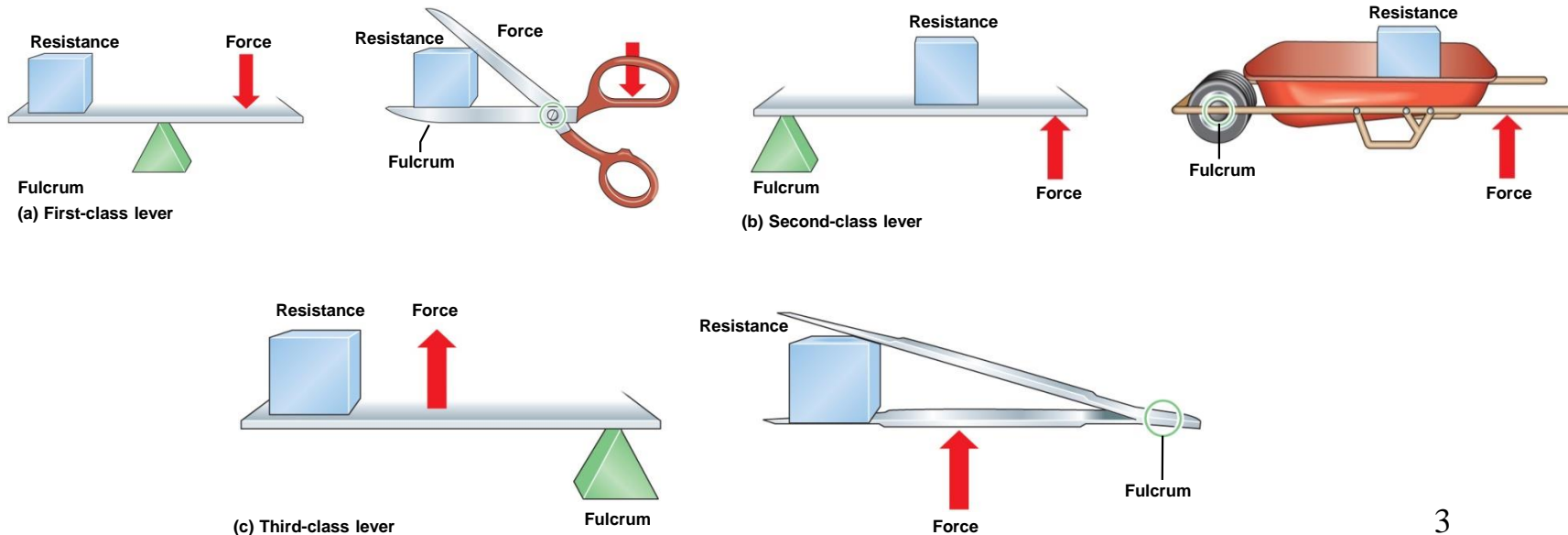
- Skeletal muscles generate a great variety of body movements.
- The action of each muscle mostly depends upon the kind of joint it is associated with and the way the muscle is attached on either side of that joint.

Body Movement

Four Basic Components of Levers:

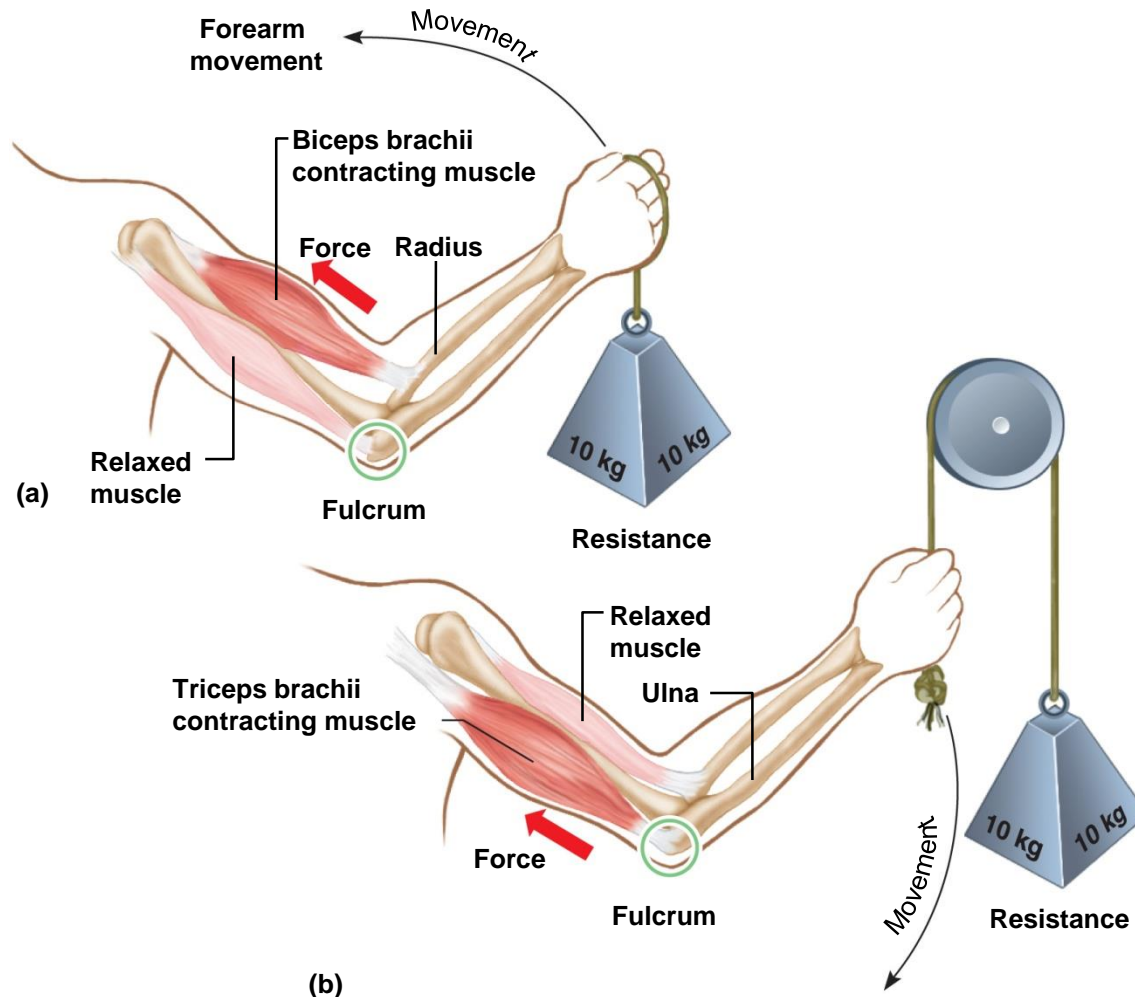
1. Rigid bar – bones
2. Fulcrum – point on which bar moves; joint
3. Object - moved against resistance; weight
4. Force – supplies energy for movement; muscles

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Levers and Movement

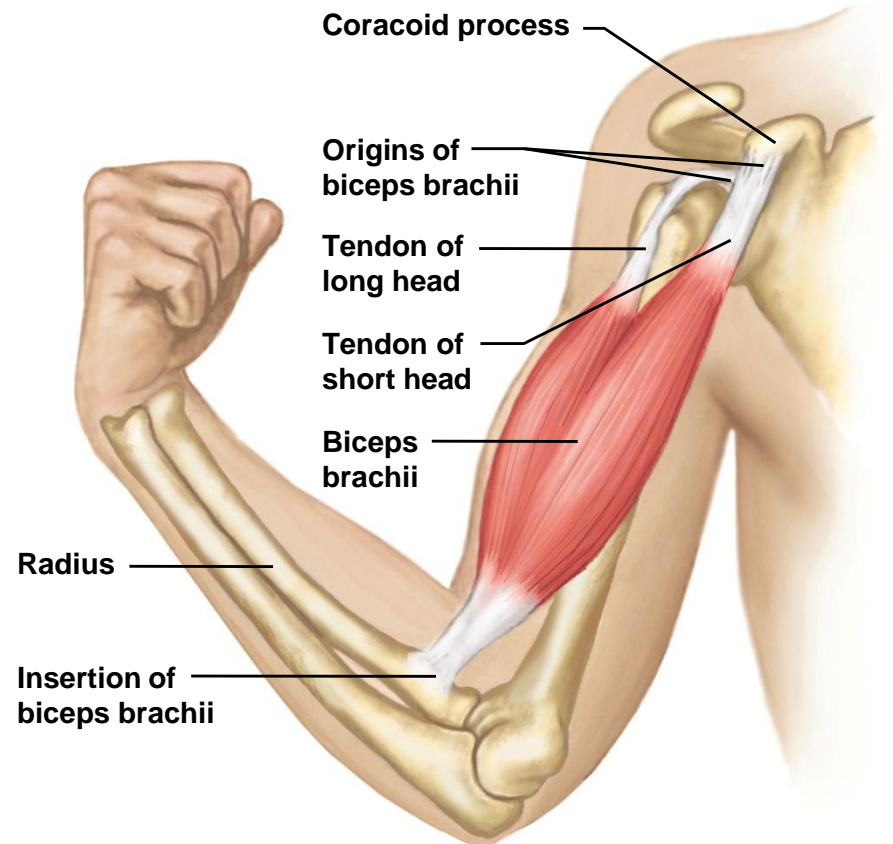
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Origin and Insertion

- **Origin** – immovable end
- **Insertion** – movable end

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Interaction of Skeletal Muscles

- **Prime mover (agonist)** – primarily responsible for movement
- **Synergists** – assist prime mover
- **Antagonist** – resist prime mover's action and cause movement in the opposite direction of the prime mover

9.9: Lifespan 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

9.5: Smooth Muscles

- Compared to skeletal muscle fibers, smooth muscle fibers are:
 - Shorter
 - Single, centrally located nucleus
 - Elongated with tapering ends
 - Myofilaments randomly organized
 - Lack striations
 - Lack transverse tubules
 - Sarcoplasmic reticula (SR) not well developed

Smooth Muscle Fibers

- **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

- **Multi-unit Smooth Muscle**

- Less organized
- Function as separate units
- Fibers function separately
- Iris of eye
- Walls of blood vessels

Smooth Muscle Contraction

- Resembles skeletal muscle contraction in that:
 - Interaction between actin and myosin
 - Both use calcium and ATP
 - Both are triggered by membrane impulses
- Different from skeletal muscle contraction in that:
 - Smooth muscle lacks troponin
 - Smooth muscle uses calmodulin
 - Two neurotransmitters affect smooth muscle
 - Acetylcholine (Ach) and norepinephrine (NE)
 - Hormones affect smooth muscle
 - Stretching can trigger smooth muscle contraction
 - Smooth muscle slower to contract and relax
 - Smooth muscle more resistant to fatigue
 - Smooth muscle can change length without changing tautness

9.6: Cardiac Muscle

- Located 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

Characteristics of Muscle Tissue

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TABLE 9.2 | Characteristics of Muscle Tissues

	Skeletal	Smooth	Cardiac
Dimensions			
Length	Up to 30 cm	30–200 μm	50–100 μm
Diameter	10–100 μm	3–6 μm	14 μm
Major location	Skeletal muscles	Walls of hollow organs	Wall of the heart
Major function	Movement of bones at joints; maintenance of posture	Movement of walls of hollow organs; peristalsis; vasoconstriction	Pumping action of the heart
Cellular characteristics			
Striations	Present	Absent	Present
Nucleus	Multiple nuclei	Single nucleus	Single nucleus
Special features	Transverse tubule system is well developed	Lacks transverse tubules	Transverse tubule system is well developed; intercalated discs separate cells
Mode of control	Voluntary	Involuntary	Involuntary
Contraction characteristics	Contracts and relaxes relatively rapidly	Contracts and relaxes relatively slowly; some types self-exciting; rhythmic	Network of fibers contracts as a unit; self-exciting; rhythmic; remains refractory until contraction ends