Section 10.2: Review Answers

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1. (a) Muscle atrophy is caused by reduction in neural stimulation, frequently due to damage to the nervous system such as paralysis from a spinal cord injury. Prolonged loss of stimulation (as in permanent injuries) causes irreversible muscle atrophy. Physical therapy is of some use in providing stimulation to muscles following an injury or surgery.

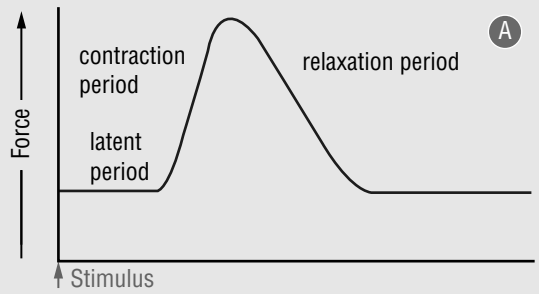
(b) As a muscle atrophies, it decreases in size and loses tone and strength because the muscle fibres become smaller. Prolonged loss of neural stimulation leads to the death of muscle fibres, creating permanent loss of muscle function.

2. Hypertrophy is an exercise-induced increase in muscle mass. It occurs due to an increase in the size of individual skeletal muscle fibres, not to an increase in their number.

Atrophy is a decrease in muscle mass due to reduced stimulation of muscles. It occurs due to a decrease in the size of individual skeletal muscle fibres, not to a decrease in their number.

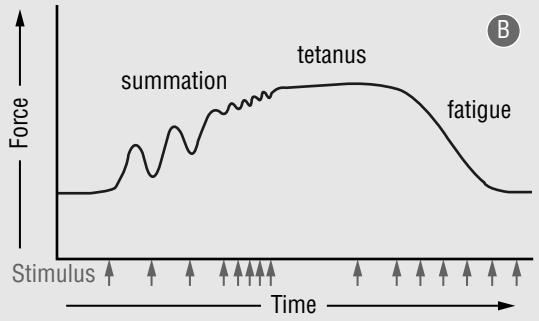
3. Any single stimulus at or above a certain threshold causes the muscle to contract and then relax a fraction of a second later. This is a muscle twitch.

4. Student diagrams should resemble the figure below.



- latent period—the time between stimulation and initiation of muscle contraction (during this time calcium ions are leaving the sarcoplasmic reticulum and are penetrating the myofibrils)
- contraction period—the time during which a muscle shortens (Z lines are pulled closer together)
- relaxation period—when the muscle returns to its normal length (actin and myosin myofilaments slide past each other to their resting position)

5. Student diagrams should resemble the figure below.



- summation—occurs when a muscle receives a rapid series of threshold stimuli and responds to each stimulus before completely relaxing from the previous one. Successive twitches blend together creating a cumulative response called summation.
- tetanus—a maximum sustained muscle contraction following summation; during tetanus, the muscle remains contracted and the graph no longer shows individual twitches. (Tetanus allows us to sustain the skeletal positions through sustained contractions, such as in the action of holding a glass of water.)
- fatigue—tetanus ends due to depletion of energy reserves; fatigue is apparent when a muscle relaxes even though stimulation continues as shown in the graph.

6. Some beneficial changes to muscle that result from regular exercise are:

- an increased blood supply, due to the growth of extra blood vessels;
- enzymes becoming more effective;

- mitochondria becoming more abundant, so muscles can withstand more exertion; and
- muscles becoming able to store more glycogen.

7. Comparison of fast-twitch and slow-twitch muscle fibres

Fast-twitch muscle fibres	Slow-twitch muscle fibres
contract rapidly, generating lots of power	contract slowly and have more endurance
anaerobic, therefore accumulation of lactate causes them to tire quickly	aerobic and resist fatigue
rich in glycogen but tire when the fuel supply is gone	have a store of glycogen and fat; the abundant mitochondria can maintain a steady, prolonged production of ATP when oxygen is available
light-coloured because they have little or no myoglobin and have fewer mitochondria and blood vessels	dark in colour due to the presence of myoglobin and contain many mitochondria surrounded by dense capillary beds to draw more blood and oxygen
used during activities like sprinting, weight lifting, swinging a hockey stick, or a racket.	used in activities such as biking, jogging, swimming, and long-distance running

8. (A) Person with a spinal injury: With a spinal cord injury, this person will likely not be participating in endurance activities, just short bursts of activity for which the intermediate and fast-twitch fibres are needed.

(B) World-class sprinter: A sprinter needs fast-twitch fibres for the generation of power but also lots of intermediate fibres that will resist fatigue. There is a low percentage of slow-twitch fibres because sprints are short events that do not require endurance.

(C) A sedentary person: This person has relatively equal numbers of each type of muscle fibre. With no training demands, there is no need to develop one type of muscle more than the others.

(D) Average active person: The average active person participates in walking, cycling, jogging, or other light activities. Because endurance is important, they have 50% slow-twitch fibres. They may occasionally participate in activities that require power, so for endurance, they have 40% intermediate fibres and only 10% fast-twitch.

(E) Middle distance runner: For middle distances, endurance is important, so these athletes have slow-twitch and intermediate twitch fibres.

(F) World-class marathon runner: This person needs good endurance and resistance to fatigue so having a majority of slow-twitch fibres is good. They may need to exert an extra short burst of speed at the end of the race, so having some intermediate fibres is necessary.

(G) Extreme endurance racer: For this athlete, endurance is most important, hence the high percentage of slow-twitch fibres with very few intermediate and no fast-twitch fibres.

9. Resistance training causes fast-twitch fibres to become thicker, so the muscle grows by hypertrophy. After a myofibril reaches a certain size, it may split into two myofibrils that are also capable of getting thicker.

10. As body temperature drops, a person experiences involuntary skeletal muscle contractions, commonly known as shivering. This action is initiated by temperature-sensitive cells in the hypothalamus of the brain. Shivering is a survival response. It tends to raise body temperature because as ATP is broken down during contraction of skeletal muscles, some of its energy is also released as heat.

11. During prolonged exposure to conditions that decrease core body temperature, death from hypothermia results. Shivering does not release enough heat to maintain body temperature indefinitely and eventually ATP sources are exhausted.

12. (a) The heart muscle pumps blood containing nutrients and oxygen to the tissues. Muscles in the blood vessels cause constriction and dilation to control body temperature and blood pressure.

(b) The diaphragm contracts and relaxes, allowing breathing to occur.

(c) Peristalsis moves food through the digestive tract.

(d) Muscle contraction moves urine in the ureters and urethra. Muscle in the bladder allows it to expand and then contract to expel urine.

13. The Rest, Ice, Compression, and Elevation method is useful because it limits the inflammatory response in injured muscles and joints.

Rest—prevents further injury and irritation of the injured tissues

Ice—causes vasoconstriction and reduces the release of histamines, thereby reducing accumulation of fluids in the injured tissue that causes swelling and pain

Compression—exerts pressure on vessels, reducing blood flow, swelling, and pain

Elevation—increases the flow of venous blood and lymph from the resting injured limb; gravity compensates for lack of skeletal muscle contractions that normally push blood and lymph through veins back to the heart.