The Moving Elbow

Trace how muscle attachments and signals produce movement

HAP.5 "Students will investigate the structures and functions of the muscular system, including the cause and effect of diseases and disorders. Develop and use models to illustrate muscle structure, muscle locations and groups, actions, origins..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each muscle's bone attachments and the elbow action it produces. Then number these events in order: the nerve signal, calcium release, myosin pulling actin, and calcium returning to storage.

What Lifts the Toolbox?

1. At the end of a long lab, Maya lifts a loaded toolbox by bending her elbow. Her biceps brachii has two origins on the scapula and an insertion on the radius, a forearm bone. Tendons connect the muscle to these bones. As the biceps shortens, it pulls the radius toward the upper arm, flexing the elbow. The triceps brachii lies on the back of the upper arm. Its origins are on the scapula and humerus, and its insertion is on the ulna. When the triceps shortens, it extends the elbow. These muscles work as an opposing pair.

2. Inside the biceps, each skeletal muscle fiber is one long cell containing bundles of myofibrils. Each myofibril contains repeating sarcomeres with thin actin and thick myosin filaments. A motor unit includes one motor neuron and all the fibers it controls. When that neuron sends a signal, its fibers receive the message at neuromuscular junctions. The signal leads to calcium release inside each fiber. Calcium allows myosin to bind actin. Using energy from ATP, myosin repeatedly pulls the actin filaments, shortening sarcomeres and producing force. Recruiting more motor units increases the force available to lift a heavier load.

3. When Maya sets the toolbox down, the story is not simply that every muscle turns off. The biceps can remain active while lengthening to control the descent against gravity. To extend an unloaded arm, the triceps can shorten while the biceps relaxes. Once nerve signals stop, calcium is pumped back into storage inside the fibers. ATP helps myosin release actin and powers the pumps that move calcium. The fibers can then relax. During repeated lifts, changes in energy supply and chemical balance can reduce muscle force, causing fatigue. Temporary muscle fatigue does not mean the tendons have detached from the bones.

2 ANSWER WITH EVIDENCE

Use the passage

1. If the biceps tendon at the radius were torn, why would bending the elbow to lift the toolbox become difficult?

2. Maya puts another tool in the box. How could her nervous system increase the force available to lift it?

3. Trace the events inside a muscle fiber from a motor neuron signal to the shortening of a sarcomere.

4. How does lowering the loaded toolbox differ from extending an unloaded arm? Describe what the biceps and triceps do.

3 YOUR TURN

Your own words

Write a numbered, six-step model for lifting a bottle toward your mouth, then extending your elbow to hand it to a friend. Include the biceps and triceps attachments, a motor unit, calcium, ATP, and what happens when nerve signals stop.

The Moving Elbow

PART 1 · READ AND MARK

Underline each muscle's bone attachments and the elbow action it produces. Then number these events in order: the nerve signal, calcium release, myosin pulling actin, and calcium returning to storage. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	If the biceps tendon at the radius were torn, why would bending the elbow to lift the toolbox become difficult?	**The biceps would no longer pull effectively on its insertion at the radius, so its contraction would produce less elbow flexion.**
2	Maya puts another tool in the box. How could her nervous system increase the force available to lift it?	**It could recruit more motor units, activating more muscle fibers to produce force.**
3	Trace the events inside a muscle fiber from a motor neuron signal to the shortening of a sarcomere.	**The signal leads to calcium release. Calcium allows myosin to bind actin, and myosin uses ATP to pull actin, shortening the sarcomere.**
4	How does lowering the loaded toolbox differ from extending an unloaded arm? Describe what the biceps and triceps do.	**While lowering the toolbox, the biceps can stay active as it lengthens to control the descent. To extend an unloaded arm, the triceps can shorten while the biceps relaxes.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

1. The biceps attaches to the scapula and radius, while the triceps attaches to the scapula and humerus and inserts on the ulna. 2. A motor neuron signals the fibers in a biceps motor unit. 3. Calcium is released inside those fibers, allowing myosin to bind actin. 4. Myosin uses ATP to pull actin, so the biceps shortens and lifts the bottle. 5. Triceps motor units activate; the triceps shortens to extend the elbow toward my friend. 6. When the signals stop, calcium returns to storage, myosin releases actin, and the fibers can relax.

Accept models that correctly connect muscle attachments, motor-unit signaling, calcium, and ATP to elbow movement. A student may also describe the biceps staying active to control the bottle's movement rather than fully relaxing during extension.