The Tiring Grip

Use muscle cell evidence to explain tone and fatigue

HAP.4.b "Obtain, evaluate, and communicate information to explain muscle fatigue and tone in terms of muscle cell physiology."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline two statements that explain muscle tone, circle two changes inside fibers linked to fatigue, and number two details that challenge a one-cause explanation of weakness.

What Happens During a Long Hold?

1. At a climbing gym, Maya hangs from a practice hold. Before she starts, her forearm muscles are not fully relaxed. Nerve signals activate a few motor units, groups of muscle fibers controlled by one motor neuron, while other units rest. The active units change over time. Within their fibers, calcium ions allow protein filaments to interact, and ATP supplies energy for cycles of pulling and release. This low, shifting activity produces muscle tone, a slight tension that helps stabilize joints and maintain posture. Tone does not mean the muscle is making its greatest possible force.

2. As Maya keeps gripping, more motor units are recruited to maintain force. Inside their fibers, ATP is used rapidly as protein filaments slide and calcium is pumped back into storage between contractions. ATP is usually replenished, but the chemical conditions inside working fibers change. For example, inorganic phosphate can build up and interfere with force production, including calcium release and the action of the pulling proteins. The same nerve command may then produce a weaker grip. This decline in the ability to produce force is muscle fatigue; it does not mean every fiber has stopped contracting.

3. Maya lets go, and her grip strength gradually returns. With less demand for force, cells can restore chemical balance, and ATP production continues. Blood flow delivers oxygen and nutrients and helps remove some byproducts. One gym poster claims that lactate alone causes every episode of muscle weakness. But a single chemical cannot explain all cases: inorganic phosphate can disrupt force production, and calcium release can decrease. Lactate can rise during hard activity, yet its presence alone does not prove what caused a particular loss of force. Comparing a claim with cellular evidence helps explain recovery.

2 ANSWER WITH EVIDENCE

Use the passage

1. Why does Maya's forearm have tone before she grips the hold, even though it is not producing its greatest force?

2. How can a buildup of inorganic phosphate make Maya's grip weaker? Explain two effects inside the fibers.

3. A classmate says Maya's weaker grip proves that all her muscle fibers stopped contracting. What evidence from the passage challenges this claim?

4. Why can Maya's grip strength return after she lets go while her forearm still has tone?

3 YOUR TURN

Your own words

After a long rehearsal, a drummer's forearm feels weak during fast strokes but slightly firm when the hand rests. In four or five sentences, explain both observations using muscle cell physiology and evaluate a bandmate's claim that weakness proves the muscle has used up all its ATP.

The Tiring Grip

PART 1 · READ AND MARK

Underline two statements that explain muscle tone, circle two changes inside fibers linked to fatigue, and number two details that challenge a one-cause explanation of weakness. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Why does Maya's forearm have tone before she grips the hold, even though it is not producing its greatest force?	**Nerve signals activate a few motor units at a time, creating slight tension while other units rest.**
2	How can a buildup of inorganic phosphate make Maya's grip weaker? Explain two effects inside the fibers.	**Phosphate can interfere with calcium release and with the pulling proteins that produce force.**
3	A classmate says Maya's weaker grip proves that all her muscle fibers stopped contracting. What evidence from the passage challenges this claim?	**Fatigue is reduced force, not a complete stop. Working fibers can still contract, but changed conditions inside them reduce the force they produce.**
4	Why can Maya's grip strength return after she lets go while her forearm still has tone?	**The lower demand lets cells restore chemical balance, helping grip strength recover. Nerve signals still activate some motor units to maintain slight tension.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The drummer's resting forearm feels slightly firm because nerve signals keep a few motor units active, producing tone. During fast strokes, ATP is used rapidly, but the cells usually replenish it. Inorganic phosphate may build up and interfere with calcium release and the proteins that produce force, making the strokes weaker. The bandmate's claim is not supported because weakness can occur while fibers still have ATP and continue contracting. With rest, the cells can restore chemical balance and force can recover.

Accept explanations that connect tone to low-level motor unit activity and fatigue to reduced force from changes inside working fibers. Students should reject ATP depletion as the necessary cause of ordinary muscle fatigue.