Hold, Move, Grow

How muscle action and muscle size change

HS-AP4-6 "Compare and contrast between isotonic and isometric contractions and construct an explanation for the causes of hypertrophy and atrophy of muscles."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline what stays the same and circle what changes during each type of contraction. Number the steps that explain how muscle size increases or decreases over time.

A Climb, a Hold, and a Cast

1. At a climbing gym, Mira grips a hold and pauses with her elbow bent. Her arm muscles produce force, but her elbow angle stays nearly the same. This is an isometric contraction: the muscle develops tension without a noticeable change in its overall length. Next, she pulls her body upward. Her elbow bends further as one arm muscle shortens under load. This is one kind of isotonic contraction. When she lowers herself slowly, that working muscle lengthens while still producing force, another kind of isotonic contraction. In both kinds of contraction, muscle fibers are active and generate tension.

2. Over weeks, Mira practices climbs that challenge her muscles, then allows time to recover and eats enough to support tissue repair. Repeated resistance work sends signals that increase muscle protein building. With sufficient recovery and nutrition, protein building can exceed protein breakdown, and muscle fibers can grow thicker. This increase in muscle size is hypertrophy. One hard session is not enough to explain lasting growth; the balance of building and breakdown over time matters. Both moving against resistance and holding difficult positions can contribute, so the name of a contraction alone does not predict how much a muscle will grow.

3. Now imagine Mira's arm is kept in a cast for several weeks after an injury. Without its usual work, the muscles receive less mechanical loading. Over time, muscle protein building may fall relative to protein breakdown, and fibers can shrink. This loss of muscle size is atrophy. Reduced use, not whether a muscle once performed holds or pulls, helps explain the change. Illness and inadequate nutrition can also contribute to muscle loss. After the cast comes off, the arm may feel weak; weakness can reflect changes in both muscle size and how effectively the nervous system activates it.

2 ANSWER WITH EVIDENCE

Use the passage

1. Compare Mira's pause on the hold with her upward pull. What do the contractions have in common, and what differs?

2. Compare what the working muscle does during Mira's upward pull and slow lowering. Why are both phases called isotonic?

3. Why could weeks of challenging climbs increase Mira's muscle size when one hard session would not explain lasting growth?

4. Compare the cause of muscle-size change during Mira's training with the cause while her arm is in a cast.

3 YOUR TURN

Your own words

A student holds a loaded tote still at elbow height, then lowers it slowly. In 4 to 5 sentences, compare these contractions and explain how weeks of resistance training with recovery, followed by several weeks with that arm immobilized, could change muscle size.

ANSWER KEY

Hold, Move, Grow

HIGH SCHOOL · HS-AP4-6

PART 1 · READ AND MARK

Underline what stays the same and circle what changes during each type of contraction. Number the steps that explain how muscle size increases or decreases over time. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Compare Mira's pause on the hold with her upward pull. What do the contractions have in common, and what differs?	**Both generate tension. During the isometric pause, muscle length and elbow angle stay nearly the same; during the isotonic pull, a working muscle shortens and the elbow bends further.**
2	Compare what the working muscle does during Mira's upward pull and slow lowering. Why are both phases called isotonic?	**The working muscle shortens during the pull and lengthens while resisting the load during lowering. In both phases, it changes length under load.**
3	Why could weeks of challenging climbs increase Mira's muscle size when one hard session would not explain lasting growth?	**Repeated resistance work, with sufficient recovery and nutrition, can make muscle protein building exceed breakdown over time. Fibers then grow thicker, producing hypertrophy.**
4	Compare the cause of muscle-size change during Mira's training with the cause while her arm is in a cast.	**Training provides repeated resistance that can favor protein building and growth. Immobilization reduces loading, so building may fall relative to breakdown and fibers may shrink.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

Holding the tote still is an isometric contraction because the arm muscles produce tension while the elbow angle stays nearly the same. Lowering it slowly involves an isotonic contraction because a working muscle lengthens while resisting the load. With repeated resistance training, enough recovery, and adequate nutrition, muscle protein building can exceed breakdown, causing hypertrophy. When the arm is immobilized, reduced loading can lower protein building relative to breakdown. Its muscle fibers may then shrink, causing atrophy.

Accept descriptions of the moving phase that focus on a change in muscle length under load. For muscle-size changes, look for a causal link between loading or reduced use, the balance of protein building and breakdown, and fiber growth or shrinkage.