When Genes Change

Trace a mutation from DNA to protein function.

GEN.2B.2 "Explain how these mutations may result in changes in protein structure and function."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline each DNA change in the passage, circle the protein change it may cause, and number the effects on protein function. Use your marks to trace how a mutation could change a trait.

Why Might Petals Turn Pale?

1. A gene's DNA sequence provides instructions for building a protein. Cells read the sequence in three-base groups called codons, and each codon usually specifies an amino acid. The order of amino acids affects how a protein folds. Folding shapes places where a protein can bind another molecule or interact with other proteins. A mutation changes the DNA sequence, but its effect is not always the same. Some substitutions leave the amino acid unchanged because several codons specify the same amino acid. Others change one amino acid. An insertion or deletion can shift the reading frame when its length is not a multiple of three.

2. Consider a hypothetical mutation in a plant gene for a pigment-making enzyme. The normal enzyme has a pocket that holds a starting molecule while a chemical reaction helps produce purple pigment. In one plant, a single DNA base is replaced. The new codon calls for a different amino acid near that pocket. The new amino acid carries a different electrical charge, so nearby parts of the protein may attract or repel one another differently. If the pocket changes shape, the starting molecule may bind less easily. The enzyme could then produce less pigment, leaving the petals paler than usual.

3. In another plant, one DNA base is inserted early in the same gene. The cell now groups many following bases into different codons, which can change a long stretch of amino acids. The shifted reading frame may also create an early stop signal. A shortened enzyme may lack the pocket it needs to hold the starting molecule, so pigment production could drop sharply. However, a mutation does not automatically change petal color. A substitution that still specifies the original amino acid can leave the enzyme unchanged. Even a changed protein may keep working if its new shape still supports the reaction.

2 ANSWER WITH EVIDENCE

Use the passage

1. How could the single-base replacement in the first plant lead to paler petals? Trace the change from the amino acid to the enzyme's function.

2. How could the one-base insertion in the second plant cause a sharp drop in pigment production?

3. Why might a DNA base substitution leave both the enzyme and petal color unchanged?

4. Why might a plant with a changed amino acid still make the usual amount of purple pigment?

3 YOUR TURN

Your own words

Imagine a protein that forms a channel for salt ions in a cell membrane. In one cell, a three-base deletion removes one amino acid lining the channel opening; in another cell, a one-base deletion occurs at the same spot in the gene. In 3 to 4 sentences, predict how each deletion could affect the protein's structure and function, and explain why their effects may differ.

When Genes Change

PART 1 · READ AND MARK

Underline each DNA change in the passage, circle the protein change it may cause, and number the effects on protein function. Use your marks to trace how a mutation could change a trait. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	How could the single-base replacement in the first plant lead to paler petals? Trace the change from the amino acid to the enzyme's function.	**The replacement specifies an amino acid with a different charge. It may change the enzyme pocket's shape, making the starting molecule bind less easily and reducing pigment production.**
2	How could the one-base insertion in the second plant cause a sharp drop in pigment production?	**The insertion shifts the reading frame, changing many amino acids and possibly creating an early stop. A shortened enzyme may lack the pocket needed to hold the starting molecule.**
3	Why might a DNA base substitution leave both the enzyme and petal color unchanged?	**The new codon might specify the same amino acid. The enzyme would then have the same amino acid sequence and could keep producing pigment.**
4	Why might a plant with a changed amino acid still make the usual amount of purple pigment?	**The changed protein might still fold into a shape that supports the reaction, so the enzyme could keep producing pigment.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

A three-base deletion removes one amino acid without shifting the reading frame, so the opening might change shape and let fewer ions through. A one-base deletion shifts the reading frame and changes many amino acids after that spot. This larger change could disrupt folding or create an early stop, leaving a channel that passes few or no ions. Either outcome depends on whether the altered protein can still form a working opening.

Accept other plausible effects if students connect the DNA change to protein structure and then to channel function. Predictions should remain conditional because neither deletion guarantees a loss of function.