The Pigment Code

Trace how a DNA change could affect an inherited trait.

BIO.3C "Students will construct an explanation based on evidence to describe how the structure and nucleotide base sequence of DNA determines the structure of proteins or RNA that carry out essential functions of life..."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the steps that connect DNA to a working protein. Circle evidence that helps you predict whether a mutation could change shell color.

A Beetle's Pigment Gene

1. A beetle's shell color can depend on an enzyme that helps make dark pigment. A gene gives instructions for that enzyme, and the gene is a stretch of DNA on a chromosome. A beetle inherits chromosomes from its parents, so it may inherit different versions, or alleles, of the gene. This short model shows part of one allele's DNA coding strand: ATG GAA TTT TAA. It is not an entire gene. The order of bases matters because cells read the instructions in groups of three, called codons, when making a protein.

2. First, RNA polymerase transcribes the gene into messenger RNA (mRNA). For a coding strand, the mRNA sequence matches its base order except that U replaces T. A ribosome then translates each mRNA codon into an amino acid. Use this small codon key: AUG means methionine, GAA and GAG mean glutamate, UUU means phenylalanine, GUA means valine, UUA means leucine, CGA means arginine, and AUU means isoleucine. UAA signals a stop rather than an amino acid. Amino acids join in order; their sequence helps determine the protein's shape and activity.

3. A mutation changes a DNA base sequence. Replacing one base can change one amino acid, or it can leave the amino acid unchanged because some codons share a meaning. Adding one base can shift how every later group of three is read. Either change could affect the pigment enzyme, but a changed amino acid does not prove that shell color will change. A disrupted enzyme might make less dark pigment; an enzyme that still works might make the usual amount. If a mutation is in a reproductive cell and reaches offspring, the new allele can be inherited.

2 ANSWER WITH EVIDENCE

Use the passage

1. Transcribe the model DNA coding strand into mRNA. Then use the codon key to write the amino acid sequence and identify the stop signal.

2. Suppose the second DNA codon changes from GAA to GTA. Which amino acid changes? Explain why this mutation might, but does not have to, change shell color.

3. Suppose the second DNA codon changes from GAA to GAG instead. Predict whether the protein segment changes, and support your answer with the codon key.

4. Insert C immediately after ATG in the model DNA. Write the first four complete mRNA codons. How is this protein segment different from the original?

3 YOUR TURN

Your own words

Make a new model by changing the third DNA codon from TTT to TTA. Write the full mRNA sequence and resulting protein segment, then explain a possible effect on pigment production and why that effect is not certain.

The Pigment Code

PART 1 · READ AND MARK

Underline the steps that connect DNA to a working protein. Circle evidence that helps you predict whether a mutation could change shell color. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	Transcribe the model DNA coding strand into mRNA. Then use the codon key to write the amino acid sequence and identify the stop signal.	**mRNA: AUG GAA UUU UAA. Protein segment: methionine, glutamate, phenylalanine. UAA is the stop signal.**
2	Suppose the second DNA codon changes from GAA to GTA. Which amino acid changes? Explain why this mutation might, but does not have to, change shell color.	**The mRNA codon becomes GUA, so valine replaces glutamate. This could change the enzyme's activity and pigment production, but the enzyme might still work.**
3	Suppose the second DNA codon changes from GAA to GAG instead. Predict whether the protein segment changes, and support your answer with the codon key.	**The protein segment does not change. Both GAA and GAG in mRNA code for glutamate.**
4	Insert C immediately after ATG in the model DNA. Write the first four complete mRNA codons. How is this protein segment different from the original?	**The first four complete mRNA codons are AUG CGA AUU UUA. They code for methionine, arginine, isoleucine, and leucine. Several amino acids differ from the original segment, and no stop signal appears in the shown segment.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The changed DNA model is ATG GAA TTA TAA, so its mRNA is AUG GAA UUA UAA. The protein segment is methionine, glutamate, and leucine, followed by a stop signal. Leucine replaces phenylalanine, which might change the enzyme and reduce dark pigment. The effect is uncertain because the enzyme might still work.

Accept amino acid abbreviations if they are unambiguous. For the inheritance connection, distinguish a possible effect on shell color from a guaranteed one.