Pigment Code

Trace DNA changes from codons to colony color

BIO.3C.3 "Use models to predict how various changes in the nucleotide sequence (e.g., point mutations, and frameshift mutations) will affect the resulting protein product and the subsequent inherited trait."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Circle the original DNA sequence and number its codons from left to right. Underline the two conditions the enzyme must meet to make dark pigment.

Why Did the Yeast Turn Pale?

1. Imagine a yeast strain that makes dark colony pigment. A short DNA sequence models the beginning of a pigment-enzyme gene: ATG GAA TTT AAA CAA TAA. These are triplets on the coding strand, read from left to right. The matching mRNA has the same bases except U replaces T. A ribosome reads mRNA in groups of three, starting at the first group. Each group specifies an amino acid or signals a stop. This classroom model tracks only the displayed segment; real enzyme genes are much longer. Descendant yeast cells inherit a DNA change when the dividing cell carries it.

2. Use this translation guide for the mRNA groups in this model: AUG codes for methionine (Met); GAA for glutamate (Glu); GUA for valine (Val); UUU and UUC for phenylalanine (Phe); UAU for tyrosine (Tyr); AAA for lysine (Lys); CAA for glutamine (Gln); CAC for histidine (His); AUU for isoleucine (Ile); and UAA for stop. Stop is an instruction, not an amino acid. One changed DNA base can change a codon without changing its amino acid, or it can replace one amino acid with another. A stop that appears too soon cuts the protein short.

3. For this simplified pigment model, the enzyme works only if the third amino acid is Phe and translation reaches the usual stop after the fifth amino acid. Working enzyme makes colonies dark; an enzyme that fails either condition makes them pale. Treat changes outside these two conditions as having no effect on pigment in this model. An inserted base can shift the groups of three, changing several codons downstream. To test a DNA change, regroup the coding strand into triplets from its first base, make matching mRNA triplets, translate until a stop, and apply the pigment rules.

2 ANSWER WITH EVIDENCE

Use the passage

1. A DNA base change makes the third codon TTC instead of TTT. What mRNA codon and amino acid result? Predict the colony color.

2. A DNA base change makes the third codon TAT instead of TTT. What amino acid appears in that position? Predict the colony color.

3. An A is inserted immediately before the third codon in the original DNA sequence. Write the first four new mRNA codons, then predict the amino acids made and the colony color.

4. A DNA base change makes the second codon GTA instead of GAA. Which amino acid changes? Predict the colony color and explain why.

3 YOUR TURN

Your own words

Start with the original DNA sequence. Change exactly one base in the fourth or fifth codon to make a different codon listed in the translation guide. Write your new DNA and mRNA sequences, translate through the stop, and explain your predicted colony color.

ANSWER KEY

Pigment Code

HIGH SCHOOL · BIO.3C.3

PART 1 · READ AND MARK

Circle the original DNA sequence and number its codons from left to right. Underline the two conditions the enzyme must meet to make dark pigment. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	A DNA base change makes the third codon TTC instead of TTT. What mRNA codon and amino acid result? Predict the colony color.	**TTC produces mRNA codon UUC, which still codes for Phe. The colony remains dark.**
2	A DNA base change makes the third codon TAT instead of TTT. What amino acid appears in that position? Predict the colony color.	**TAT produces mRNA codon UAU, which codes for Tyr instead of Phe. The colony is pale.**
3	An A is inserted immediately before the third codon in the original DNA sequence. Write the first four new mRNA codons, then predict the amino acids made and the colony color.	**The mRNA codons are AUG GAA AUU UAA. They produce Met, Glu, and Ile, then stop. The colony is pale because the protein stops early.**
4	A DNA base change makes the second codon GTA instead of GAA. Which amino acid changes? Predict the colony color and explain why.	**Val replaces Glu at position two. The colony remains dark because position three is still Phe and translation reaches the usual stop.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

I changed the fourth DNA codon from AAA to CAA. My DNA sequence is ATG GAA TTT CAA CAA TAA, and its mRNA is AUG GAA UUU CAA CAA UAA. The amino acids are Met, Glu, Phe, Gln, and Gln, followed by a stop. The colony stays dark because the third amino acid is Phe and translation reaches the usual stop after the fifth amino acid.

For the open task, accept any one-base substitution in codon four or five that produces a codon in the guide. Check that the student regroups and translates correctly, then applies both pigment conditions.