ANSWER KEY.

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Mutations

Biology | ANSWER KEY

Directions: Answer each question in the space provided. Show your work for every calculation. For Claim, Evidence, Reasoning (CER) questions, write all three parts.

1. Define a mutation and give two causes of mutations.

A mutation is a change in the DNA sequence. Causes include errors when DNA is copied and environmental factors such as UV light, X-rays, or some chemicals.

2. Use the genetic code chart. Classify each change as silent, missense, or nonsense.

First base	Second base: U		Second base: C		Second base: A		Second base: G		Third base
U	UUU	Phe	UCU	Ser	UAU	Tyr	UGU	Cys	U
	UUC	Phe	UCC	Ser	UAC	Tyr	UGC	Cys	C
	UUA	Leu	UCA	Ser	UAA	**Stop**	UGA	**Stop**	A
	UUG	Leu	UCG	Ser	UAG	**Stop**	UGG	Trp	G
C	CUU	Leu	CCU	Pro	CAU	His	CGU	Arg	U
	CUC	Leu	CCC	Pro	CAC	His	CGC	Arg	C
	CUA	Leu	CCA	Pro	CAA	Gln	CGA	Arg	A
	CUG	Leu	CCG	Pro	CAG	Gln	CGG	Arg	G
A	AUU	Ile	ACU	Thr	AAU	Asn	AGU	Ser	U
	AUC	Ile	ACC	Thr	AAC	Asn	AGC	Ser	C
	AUA	Ile	ACA	Thr	AAA	Lys	AGA	Arg	A
	AUG	**Met**	ACG	Thr	AAG	Lys	AGG	Arg	G
G	GUU	Val	GCU	Ala	GAU	Asp	GGU	Gly	U
	GUC	Val	GCC	Ala	GAC	Asp	GGC	Gly	C
	GUA	Val	GCA	Ala	GAA	Glu	GGA	Gly	A
	GUG	Val	GCG	Ala	GAG	Glu	GGG	Gly	G

AUG (Met) is the start codon. UAA, UAG, and UGA are stop codons.

a. UUU → UUC: _____ b. CAU → CAA: _____ c. UGG → UGA: _____

a. UUU = Phe, UUC = Phe: silent. b. CAU = His, CAA = Gln: missense. c. UGG = Trp, UGA = Stop: nonsense.

3. Translate this mRNA: AUGAAACCCUGGUAA Then translate the mutant mRNA in which one A has been inserted after the first codon: AUGAAAACCCUGGUAA

Original: _____

Mutant: _____

Original: AUG AAA CCC UGG UAA = Met - Lys - Pro - Trp - Stop.

Mutant: AUG AAA ACC CUG GUA A: Met - Lys - Thr - Leu - Val, then the stop codon is no longer read in this frame, because the extra base shifted the frame.

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4. Name the type of mutation in problem 3 and explain why it changes more amino acids than a substitution does.

It is a frameshift (an insertion). Adding one base shifts the reading frame, so every codon after the insertion is grouped differently. A substitution changes only one codon.

5. A mutation deletes 3 bases from the middle of a gene. Does it cause a frameshift? Explain.

No. Removing 3 bases (a multiple of 3) keeps the reading frame. It removes one whole codon, so the protein loses one amino acid, but the codons after it are unchanged.

6. In sickle cell disease, one codon changes from GAG to GUG. Use the chart to name the amino acid before and after, and name the type of mutation.

GAG = Glu and GUG = Val. One amino acid is replaced by a different one, so it is a missense (substitution) mutation.

7. The table shows sample data for four variants of an enzyme gene. Write a Claim, Evidence, Reasoning response: which variants lose enzyme activity?

Variant	Type of change	Amino acids	Activity (% of normal)
Normal	none	7	100
Variant 1	silent	7	100
Variant 2	nonsense	3	0
Variant 3	missense	7	35

Claim: The nonsense variant (Variant 2) loses all activity, and the missense variant (Variant 3) loses part of it.

Evidence: Variant 2 makes a protein of 3 amino acids instead of 7 and has 0% activity. Variant 3 has 7 amino acids but only 35% activity. Variant 1 is the same as normal (100%).

Reasoning: A nonsense mutation creates an early stop codon, so the protein is too short to work. A missense mutation changes one amino acid, which can change the shape of the enzyme a little. A silent mutation leaves the amino acids unchanged.

8. A mutation happens in a skin cell of an adult. Can it be passed to the person's children? Explain.

No. Only mutations in cells that form gametes (egg or sperm) can be passed to offspring. A mutation in a skin cell stays in that cell and the cells that come from it.

9. Explain why a mutation can be helpful in one environment and harmful in another. Give an example of your own.

The effect of a mutation depends on how the changed protein affects the organism in its environment. Sample example: a mutation that makes a bacterium resistant to an antibiotic helps it when the antibiotic is present, but may give no benefit when the antibiotic is absent.

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