

Topic: Gene Mutations WS

Summary: Students will learn about frame shift mutations and base substitution mutations.

Goals & Objectives: Students will be able to demonstrate how mutations change the amino acid sequence. Students will be able to explain the difference between mutations.

Standards: CA Biology 4c. *Students know* that mutations in the DNA sequence of a gene may or may not affect the expression of the gene or the sequence of amino acids in an encoded protein.

Time Length: 40 minutes

Prerequisite Knowledge: Students know the rules for DNA / RNA base pairing. Students know protein synthesis, purines, pyrimidines, and how to use a codon table.

Materials:

- Handouts and pencils

Procedures:

1. Review with the class about point mutations and the differences between frame shift and base substitution.
2. Students work on the handout by themselves.

Accommodations: Students with an IEP can take the handout home if they need extra time, and/or do questions 1 - 3 and questions 11 - 24.

Evaluation:

Each line with an underline is worth one point, for a total of 25 points. Students should have circled the mutated DNA or amino acid to help speed up grading.

Write each codon per line and circle the mutated DNA base where the mutation took place.

Original DNA TAC GGA CGA TCT CAG GAG CCT ATA ATC

Deletion DNA _____

Mutated mRNA _____

Mutated Amino Acids _____

Original Amino Acid Met Pro Ala Arg Val Leu Gly Tyr STOP

Usually a frame shift mutation results in the synthesis of a nonfunctional protein.
Why do you think your mutated proteins might not be functional?

BASE SUBSTITUTION MUTATIONS

For simplicity, change only one base for all of the following base substitution mutations.

Base substitution is a different type of gene mutation. It is the simplest type of mutation where a nucleotide pair is replaced with a different nucleotide pair.

Base Substitution GAC → GGC

One type of base substitution is called *transversion mutation*. Transversion mutation happens when one purine (A, G) is swapped with a pyrimidine (C, T).

Purine → Pyrimidine GAC → TAC
Pyrimidine → Purine GAC → GAG

Use the DNA code below to demonstrate a purine → pyrimidine transversion mutation.
All you have to do is change one DNA base.

Write each codon per line and circle the mutated amino acid.

Original DNA TAC CAT GCA GAT CTG GCC CAG TTC ATC

Transversion DNA _____

Mutated mRNA _____

Mutated Amino Acid _____

Original Amino Acid Met Val Arg Leu Asp Arg Val Lys STOP

The opposite of transversion mutations are *transition mutations*. A transition mutation happens when one purine is swapped with the other purine or a pyrimidine with pyrimidine.

Purine → Purine	GAC → AAC
Pyrimidine → Pyrimidine	GAC → GAT

Use the DNA code below to demonstrate a purine → purine transition mutation. All you have to do is change one DNA base.

Write each codon per line and circle the mutated amino acid.

Original DNA	TAC	GTC	GCT	CAA	CGG	GAC	CTG	ACC	ACT
Transition DNA	_____	_____	_____	_____	_____	_____	_____	_____	_____
Mutated mRNA	_____	_____	_____	_____	_____	_____	_____	_____	_____
Mutated Amino Acid	_____	_____	_____	_____	_____	_____	_____	_____	_____
Original Amino Acid	Met	Gln	Arg	Val	Ala	Leu	Asp	Trp	STOP

A third type of base substitution is called *silent mutation*. Silent mutation happens when one base in a codon is changed, but both code for the same amino acid.

DNA	CTT → CTG
Amino Acid	Leu → Leu

Use the DNA code below to demonstrate a silent mutation. All you have to do is change one DNA base but the amino acid stays the same.

Write each codon per line and circle the mutated DNA base.

Original DNA	TAC	CAT	TCT	CGG	TGT	AAA	AGG	GCG	ATT
Silent DNA	_____	_____	_____	_____	_____	_____	_____	_____	_____
Mutated mRNA	_____	_____	_____	_____	_____	_____	_____	_____	_____
Mutated Amino Acid	_____	_____	_____	_____	_____	_____	_____	_____	_____
Original Amino Acid	Met	Val	Arg	Ala	Thr	Phe	Ser	Arg	STOP

Write each codon per line and circle the mutated DNA base where the mutation took place.

Original DNA TAC GGA CGA TCT CAG GAG CCT ATA ATC

Deletion DNA _____

Mutated mRNA _____

Mutated Amino Acids _____

Original Amino Acid Met Pro Ala Arg Val Leu Gly Try STOP

Usually a frame shift mutation results in the synthesis of a nonfunctional protein. Why do you think your mutated proteins might not be functional?

BASE SUBSTITUTION MUTATIONS

A different type of gene mutation is called base substitution. It is the simplest type of mutation where a nucleotide pair is replaced with a different nucleotide pair.

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Purine → Pyrimidine GAC → TAC
 Pyrimidine → Purine GAC → GAG

Use the DNA code below to demonstrate a purine → pyrimidine transversion mutation. All you have to do is change one DNA base.

Write each codon per line and circle the mutated amino acid.

Original DNA TAC CAT GCA GAT CTG GCC CAG TTC ATC

Transversion DNA _____

Mutated mRNA _____

Mutated Amino Acid _____

Original Amino Acid Met Val Arg Leu Asp Arg Val Lys STOP

The opposite of transversion mutations is *transition mutations*. A transition mutation happens when one purine is swapped with the other purine or a pyrimidine with pyrimidine.

Purine → Purine	GAC → AAC
Pyrimidine → Pyrimidine	GAC → GAT

Use the DNA code below to demonstrate a purine → purine transition mutation. All you have to do is change one DNA base.

Write each codon per line and circle the mutated amino acid.

Original DNA	TAC	GTC	GCT	CAA	CGG	GAC	CTG	ACC	ACT
Transition DNA	_____	_____	_____	_____	_____	_____	_____	_____	_____
Mutated mRNA	_____	_____	_____	_____	_____	_____	_____	_____	_____
Mutated Amino Acid	_____	_____	_____	_____	_____	_____	_____	_____	_____
Original Amino Acid	Met	Gln	Arg	Val	Ala	Leu	Asp	Trp	STOP

A third type of base substitution is called *silent mutation*. Silent mutation happens when one base in a codon is changed but both code for the same amino acid.

DNA	CTT → CTG
Amino Acid	Leu → Leu

Use the DNA code below to demonstrate a silent mutation. All you have to do is change one DNA base but the amino acid stays the same.

Write each codon per line and circle the mutated DNA base.

Original DNA	TAC	CAT	TCT	CGG	TGT	AAA	AGG	GCG	ATT
Silent DNA	_____	_____	_____	_____	_____	_____	_____	_____	_____
Mutated mRNA	_____	_____	_____	_____	_____	_____	_____	_____	_____
Mutated Amino Acid	_____	_____	_____	_____	_____	_____	_____	_____	_____
Original Amino Acid	Met	Val	Arg	Ala	Thr	Phe	Ser	Arg	STOP

A base mutation that creates a new stop codon in place of an amino acid is called a *nonsense mutation*.

DNA	TGT → TGA
Amino Acid	Cys → STOP

Use the DNA code below to demonstrate a nonsense mutation. All you have to do is change one DNA base to create a new stop codon.

Write each codon per line and circle the mutated amino acid.

Original DNA TAC GGT AAT CAA ATA GAA CCT GAG ACT

Nonsense DNA _____

Mutated mRNA _____

Mutated Amino Acid _____

Original Amino Acid Met Pro Leu Val Tyr Leu Gly Leu STOP

Please explain the difference between a frame shift mutation and a base substitution mutation.
