

Lab-- Gene Mutations

A **gene mutation** is a change in the sequences of bases within a gene. There are three types of mutations: 1) Substitution; 2) Deletion; 3) Addition. In this lab, we will investigate these mutations and determine what effect they have on the polypeptide chain they produce.

From Normal Gene to Normal Polypeptide Chain

1. Randomly select 18 base cards and bring them to your work area.
2. Make a short gene by arranging 15 of the bases in a straight line on your desk- You must have the DNA sequence TAC, which is the "START" codon, at the beginning of your gene. Do not use a "START" or "STOP" codon anywhere else in your gene. Other than that, you may choose any order of bases you want for your gene. Set aside the three extra base cards to be used later.

Copy down the **DNA sequence** that you've just made:

Write the **RNA sequence** for this gene:

Using the RNA Codon-Amino Add Chart, write the amino acid sequence for the gene:

This is the normal polypeptide chain made from the normal gene.

RNA Codon-Amino Acid Chart

second base

	U	C	A	G	
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 gin	CGA arg	A
	CUG leu	CCG pro	CAG gin	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

Simulating the Mutations

All of the mutations that you simulate will occur at the **5th base position**

3. Simulate **Substitution** by replacing the 5th base in the normal gene with one of the bases that you set aside in step 2.

Copy down the new, mutated DNA sequence that you've just made:

Write the new mRNA sequence:

Write the new amino acid sequence:

This is the new polypeptide chain made from the mutated gene.

How many amino acids are different from the original, normal polypeptide chain? _____

What new amino acids were included in this polypeptide chain that were not present in the original polypeptide chain?

4. **"Put the gene back to its original, normal DNA sequence."**

5. Simulate **Deletion** by removing the base in the 5th position (do not add any other base). All the other bases should shift over one position to the left.

Copy down the new, mutated DNA sequence that you've just made:

Write the new mRNA sequence:

Write the new amino acid sequence:

This is the new polypeptide chain made from the mutated gene.

How many amino acids are different from the original, normal polypeptide chain?

What new amino acids were included in this polypeptide chain that were not present in the original polypeptide chain?

6. *****Put the gene back to its original, normal DNA sequence.'*****

7. Simulate **Addition** by inserting an extra base in the 5th position (do not remove any original bases this time). All the other bases should shift over one position to *the right*.

Copy down the new, mutated DNA sequence that you've just made:

Write the new mRNA sequence:

Write the new amino acid sequence:

This is the new polypeptide chain made from the mutated gene

How many amino acids are different from the original, normal polypeptide chain? _____

What new amino acids were included in this polypeptide chain that were not present in the original polypeptide chain?

Questions

1. What are the three types of gene mutations?
2. Do all three mutations produce the exact same results? Which mutation caused the most drastic change in your amino acid sequence (the polypeptide chain)?
3. What happened to the amino acid sequence of the polypeptide chain when the **substitution** mutation occurred?
4. What happened to the amino acid sequence of the polypeptide chain when the deletion mutation occurred?
5. What happened to the amino acid sequence of the polypeptide chain when the addition mutation occurred?
6. What would happen to the polypeptide chain if a mutation:
 - a) produced a STOP codon at the beginning of a gene?
 - b) omitted a START codon at the beginning of a gene?
 - c) inserted a STOP codon in the middle of a gene?
7. Why do addition and deletion mutations cause more of a drastic change in the polypeptide chain than a substitution mutation?
8. When would a substitution mutation cause no change in the resulting polypeptide chain?
9. From what you observed in this lab, why do you think addition and deletion mutations are called "frameshift" mutations?