

Name: \_\_\_\_\_ Date: \_\_\_\_\_ Period: \_\_\_\_\_

**Mutations Worksheet**  
25 points

CA Biology Standards: Students know the general pathway by which ribosomes synthesize proteins, using tRNAs to translate genetic information in mRNA. Students know how 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.

There are three ways that DNA can be altered when a **gene mutation** (change in DNA sequence) occurs.

1. **Substitution** – one base-pair is replaced by another
2. **Insertion** – one or more base pairs is added to a sequence
3. **Deletion** – one or more base pairs is lost from a sequence

There are four possible results of a mutation.

1. **Silent mutation:** When a base pair is substituted but the change still codes for the same amino acid in the sequence. *Example: TCT and TCC both code for the amino acid Serine*
2. **Substitution:** When a base pair is substituted and the new codon codes for a different amino acid. *Example: TCT codes for Serine and CCT codes for Proline*
3. **Codon Deletion or Insertion:** A whole new amino acid is added, or one is missing.  
*Example: GTGGTCCGAAACACC — GTGGTCTGCCGAAACACC*  
*Val-Val-Pro-Asn-Thr Val-Val-Cys-Pro-Asn-Thr*
4. **Frameshift Deletion or Insertion:** When a deletion or insertion results in a different base pair being the beginning of the next codon, changing the whole sequence of amino acids.  
*Example: GTGGTCCGAAACACCT — GTGGTCGAAACACCT*  
*Val-Val-Pro-Asn-Thr Val-Val-Glu-Thr-Pro*

1. Look at the following sequence: THE FAT CAT ATE THE RAT. Delete the first H and regroup the letters in groups of three, then write out the new groups of three. Does the sentence still make sense? What type of mutation is this an example of? (2 points)

*Sickle Cell Anemia is a genetic disorder caused by a mutation in the DNA. People with Sickle Cell have red blood cells with sickle shaped hemoglobin that cannot hold as much oxygen. They get out of breath easily and have a lot of pain.*

2. Below is the base sequence for the normal protein for normal hemoglobin and the base sequence for the sickle cell hemoglobin. Transcribe and translate the normal and sickle cell DNA. (4 points)

Normal: G G G C T T C T T T T T

Sickle: G G G C A T C T T T T T

mRNA:

mRNA:

Amino Acid:

Amino Acid:

- a. Identify this as a substitution or a frameshift mutation. Explain. (2 points)
- b. If the DNA base sequence read G G G C T T C T T A A A instead, would this result in sickle cell hemoglobin? Explain and show how you know. (2 points)