There are several types of mutations:

- **DELETION** (a base is lost/deleted)
  --- Deletion & insertion may cause what's called a **FRAMESHIFT** mutation, meaning the reading "frame" changes, thus changing the amino acid sequence from this point forward

- **INSERTION** (an extra base is added/inserted)
  --- If a substitution changes the amino acid, it's called a **MISSENSE** mutation
  --- If a substitution does not change the amino acid, it's called a **SILENT** mutation
  --- If a substitution changes the amino acid to a "stop," it's called a **NONSENSE** mutation

Complete the boxes below. Classify each as Deletion, Insertion or Substitution AND as either frameshift, missense, silent or nonsense (Hint: Deletion & Insertion will always be frameshift).

**Original DNA Sequence:**

| T | A | C | A | C | C | T | T | G | G | C | G | A | C | G | A | C | T |

**mRNA Sequence:**

| A | U | G | / | U | G | G | / | A | A | C | / | C | G | C | / | U | G | C | / | U | G | A |

**Amino Acid Sequence:** Methionine-Tryptophan-Asparagine-Arganine-Cysteine-Stop

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**Mutated DNA Sequence #1**

| T | A | C | A | T | C | T | T | G | G | C | G | A | C | G | A | C | T |

What’s the **mRNA** sequence? **A U G / U** [X] **G / A A C / C G C / U G C / U G A** *(Circle the change)*

What will be the **amino acid** sequence? Methionine-Stop

Will there likely be effects? **Yes!** What type of mutation is this? **Nonsense**

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**Mutated DNA Sequence #2**

| T | A | C | G | A | C | C | T | T | G | G | C | G | A | C | G | A | C | T |

What’s the **mRNA** sequence? **A U G / U** [C] **G / A A C / C G C / U G C / U G A** *(Circle the change)*

What will be the **amino acid** sequence? Methionine-Leucine-Glutamic Acid-Proline-Leucine-Leucine-

Will there likely be effects? **Yes!** What type of mutation is this? **Insertion**

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**Mutated DNA Sequence #3**

| T | A | C | A | C | C | T | T | A | G | C | G | A | C | G | A | C | T |

What’s the **mRNA** sequence? **A U G / U** [X] **G / A A C / C G C / U G C / U G A** *(Circle the change)*

What will be the **amino acid** sequence? Methionine-Tryptophan-Asparagine-Arganine-Cysteine-Stop

Will there likely be effects? **No!** What type of mutation is this? **Silent**

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**Mutated DNA Sequence #4**

| T | A | C | A | C | C | T | T | G | G | C | G | A | C | T | A | C | T |

What’s the **mRNA** sequence? **A U G / U** [A] **G / A A C / C G C / U G A** *(Circle the change)*

What will be the **amino acid sequence**? Methionine-Tryptophan-Asparagine-Arganine-Stop

Will there likely be effects? **Yes!** What type of mutation is this? **Nonsense**
Original DNA Sequence: T A C A C C T T G G C G A C G A C T ...

mRNA Sequence: A U G / U G G / A A C / C G C / U G C / U G A

Amino Acid Sequence: Methionine-Tryptophan-Asparagine-Arginine-Cysteine-Stop

Mutated DNA Sequence #5  T A C A C C T T G G G A C G A C T ...

What’s the mRNA sequence? A U G / U G G / A A C / C C U / G C A / G A (Circle the change)

What will be the amino acid sequence? Methionine-Tryptophan-Asparagine-Proline-Alanine-

Will there likely be effects? Yes!  What type of mutation is this? Deletion

1. Which type of mutation is responsible for new variations of a trait? Missense Mutations
2. Which type of mutation does not result in an abnormal amino acid sequence? Silent Mutation
3. Which type of mutation stops the translation of an mRNA molecule? Nonsense Mutation

Sickle Cell Anemia

Sickle cell anemia is the result of a type of mutation in the gene that codes for part of the hemoglobin molecule. Recall that hemoglobin carries oxygen in your red blood cells. The mutation causes these red blood cells to become stiff & sickle-shaped when they release their oxygen. The sickled cells tend to get stuck in blood vessels, causing pain and increased risk of stroke, blindness, damage to the heart & lungs, and other conditions.

--- Analyze the DNA strands below to determine what amino acid is changed AND what type of mutation occurred

Normal hemoglobin DNA  C A C G T A G A C T G A G G A C T C ...

Normal hemoglobin mRNA  G U G / C A U / C U G / A C U / C C U / G A G

Normal hemoglobin AA sequence  Valine-Histidine-Leucine-Threonine-Proline-Glutamic Acid

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Sickle cell hemoglobin DNA  C A C G T A G A C T G A G G A C A C ...

Sickle cell hemoglobin mRNA  G U G / C A U / C U G / A C U / C C U / G U G

Sickle cell hemoglobin AA sequence  Valine-Histidine-Leucine-Threonine-Proline-Valine

4. What type of mutation is this? Please explain why.

This is a substitution-missense mutation because one base changes and it changes the amino acid sequence.