Mutation of DNA

Background
What is the Universal Genetic Code?
The Universal Genetic Code is the instruction manual that the cell uses to read the DNA sequence of a gene and produce a corresponding protein. Proteins are made of amino acids that are strung together in a chain. Each three-letter DNA sequence, or codon, encodes a specific amino acid.

What are the general types of nucleotide mutations?
Point mutations are single nucleotide base changes in a gene’s DNA sequence. This type of mutation can change the gene’s protein product in the following ways:

- Missense mutations are point mutations that result in a single amino acid change within the protein.
- Nonsense mutations are point mutations that create a premature “translation stop signal” (or “stop” codon), causing the protein to be shortened.
- Silent mutations are point mutations that do not cause amino acid changes within the protein.

Frame Shift mutations change the grouping of nucleotide bases into codons. This results in a shift of “reading frame” during protein translation.

- Insertion mutations and deletion mutations add or remove one or more DNA bases.

Purpose
In this activity, we use the Universal Genetic Code to predict the amino acid sequence encoded by a DNA sequence.

Background Questions
The code has several key features:
1. All genes begin with the "start" codon, AUG. What amino acid does AUG encode?
2. There are three "stop" codons that signify the end of the gene. Can you find those? Write them out!
3. Look carefully at the code: can you see that different codons can encode the same amino acid? Give four examples of amino acids that have more than one codon. List both the amino acid and the codon in your answer.
4. What types of mutations can occur in DNA sentences?

Mutate a DNA Sentence!
It's time to try your hand at mutating a DNA sequence.
Here's the sequence: TCTACCTACCAGCGGGTATCGATGTACT

Part 1: No mutation
First, try separating the sequence into three-letter codons. You can do this three ways:

- Sequence A: TCT ACC TCA CCA GCG GGT ATC GAT GTA CT
- Sequence B: T CTA CCT CAC CAG CGG GTA TCG ATG TAC T
- Sequence C: TC TAC CTC ACC AGC GGG TAT CGA TGT ACT

1. Which DNA sequence is the correct reading frame?
2. How can you tell which of the three codon reading frames is the correct one?
3. Transcribe the correct DNA sequence into mRNA.
4. Predict the amino acid sequence of the protein encoded by the DNA.
   *This will serve as your model amino acid sequence. You will compare your results from parts 2-4 with your results in part 1.

**Part 2: First Point Mutation**

The Original Sequence: TCTACCTACCAGGGGATCGATGTACT
The Mutated Sequence: TCTACCTGACCAGGGGATCGATGTACT

1. Identify the mutation. *(Be specific!)*
2. Transcribe the mutated DNA sequence into mRNA.
3. Predict the amino acid sequence of the protein encoded by the mutated DNA.
4. Compare the mutated amino acid sequence to the protein sequence from part 1. Describe the similarities and differences. Be sure to discuss the result of the mutation.

**Part 3: Second Point Mutation**

The Original Sequence: TCTACCTACCAGGGGATCGATGTACT
The Mutated Sequence: TCTACCTACCATCGGGTATCGATGTACT

1. Identify the mutation. *(Be specific!)*
2. Transcribe the mutated DNA sequence into mRNA.
3. Predict the amino acid sequence of the protein encoded by the mutated DNA.
4. Compare the mutated amino acid sequence to the protein sequence from part 1. Describe the similarities and differences. Be sure to discuss the result of the mutation.

**Part 4: Third Point Mutation**

The Original Sequence: TCTACCTACCAGGGGATCGATGTACT
The Mutated Sequence: TCTACCTACCCAGGGGATCGATGTACT

1. Identify the mutation. *(Be specific!)*
2. Transcribe the mutated DNA sequence into mRNA.
3. Predict the amino acid sequence of the protein encoded by the mutated DNA.
4. Compare the mutated amino acid sequence to the protein sequence from part 1. Describe the similarities and differences. Be sure to discuss the result of the mutation.

**Part 5: Frameshift Mutation**

The Original Sequence: TCTACCTACCAGGGGATCGATGTACT
The Mutated Sequence: TCTACCTCACCAGGGGATCGATGTACT

1. Identify the mutation. *(Be specific!)*
2. Transcribe the mutated DNA sequence into mRNA.
3. Predict the amino acid sequence of the protein encoded by the mutated DNA.
4. Compare the mutated amino acid sequence to the protein sequence from part 1. Describe the similarities and differences. Be sure to discuss the result of the mutation.

**Conclusion Questions**

1. What is the amino acid sequence encoded by the DNA sequence?
2. What does a silent mutation look like? How does it change the amino acid sequence?
3. What does a missense mutation look like? How does it change the amino acid sequence?
4. What does a nonsense mutation look like? How does it change the amino acid sequence?
5. You can make more than one frameshift mutation. What do they look like? How do they change the amino acid sequence?