

MUTATIONS

A mutation is any change in the DNA of an organism. Although 99.9% of mutations are entirely harmless, occasionally they can be harmful or even beneficial. In this activity, you will use the genetic code to “translate” an mRNA sequence into a protein (amino acid sequence). Then you will examine different types of mutations that can occur in a gene.

The mRNA does not begin translation until it reaches a “start” codon. The “start” codon is always AUG. Before you begin listing the amino acid sequence, look for AUG. Do not start translating the genetic code until you arrive at AUG. Otherwise, you will not make the correct protein. Also, translation stops when it reaches a “stop” codon. There are three of these: UAA, UAG, and UGA. Do not translate anything after the “stop” codon.

The DNA sequence for a gene is as follows:
 CGGGATCTTCTACGTTGCAATGAATATGCCTAGCCGGGCTAATGTCACTAGCGACTGG

Therefore, the mRNA sequence for the same gene is as follows:
 GCCCUAGAAGAUGCAACGUUACUUAUACGGAUCGGCCCGAUUACAGUGAUCGCUGACC

1. The mRNA sequence is already listed in the box. List the sequence of amino acids.

mRNA: GCCCUAGAAGAUGCAACGUUACUUAUACGGAUCGGCCCGAUUACAGUGAUCGCUGACCU
Protein:

2. A point mutation has now been applied to the original mRNA sequence shown in question 1. A point mutation occurs when one nucleotide is substituted for another. In this case, a “G” was turned into a “U” (shown underlined).

mRNA: GCCCUAGAAGAUGCAACGUUACUUAUAC <u>G</u> AUCGGCCCGAUUACAGUGAUCGCUGACCU
Protein:

3. A different point mutation has been applied to the original mRNA sequence shown in question 1. In this case, a “c” was turned into a “g” (shown underlined).

mRNA: GCCCUAGAAGAUGCAACGUUA <u>G</u> UUAUACGGAUCGGCCCGAUUACAGUGAUCGCUGACCU
Protein:

4. A frame-shift mutation has now been applied to the original mRNA sequence shown in question 1. A frame-shift mutation occurs when a nucleotide is added or deleted. This changes the “reading frame” of the mRNA. In this example, a nucleotide (A) was added.

mRNA: GCCCUAGAAGAUGCAACGUUACUUAUA <u>A</u> CGGAUCGGCCCGAUUACAGUGAUCGCUGACCU
Protein:

5. A frame-shift mutation has been applied to the original mRNA sequence shown in question 1. In this example, a nucleotide has been deleted between the U and the A.

mRNA: GCCCUAGAAGAUGCAACG <u>UA</u> CUUAUACGGGAUCGGCCCGAUUACAGUGAUCGCUGACCU
Protein:

6. An inversion mutation has been applied to the original mRNA sequence shown in question 1. In this example, the sequence “CUUAUACGGA” has been inverted to “AGGCAUAUUC”.

mRNA: GCCCUAGAAGAUGCAACGUUA <u>AGGCAUAUUC</u> UCGGCCCGAUUACAGUGAUCGCUGACCU
Protein:

Questions

1. What happens if a mutation converts a normal codon to a “stop” codon? In other words, what happens to the size of the protein?
2. What happens if a mutation converts a “stop” codon to a normal codon? In other words, what happens to the size of the protein?
3. Which is more harmful, a point mutation or a frame-shift mutation? Explain.
4. Explain why it is beneficial to an organism for some amino acids to be added by multiple (more than one) codons. HINT: Think in terms of protection from mutations!
5. Many amino acids can be placed by more than one possible codon. For example, GUU, GUC, GUA, and GUG all code for valine. Name the 4 other amino acids which can be placed by 4 different codons. Then name the 3 amino acids which can be placed by any of 6 possible codons.