**Donald Frank**

**Lab Four – DNA Replication, Transcription, and Translation Submission Form**

1. Enter the sequence of the second strand of DNA you made in step #5, using a space between each letter so that it is easier to read. Please remember to type your answers in a different color than the text of the questions (please do not use a really light color because it is too hard to read).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original Strand #1 | A | T | G | G | T | T | C | C | G | A | A | T | T | A | A |
| **Original Strand #2** | **T** | **A** | **C** | **C** | **A** | **A** | **G** | **G** | **C** | **T** | **T** | **A** | **A** | **T** | **T** |

1. **What enzyme do the scissors represent in the modeling of DNA replication (from step #11?**

**Helicase**

1. Type in the sequence of the three strands of DNA that you have made (from step #13). The original strand of DNA has already been typed in for you.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Original Strand #1 | A | T | G | G | T | T | C | C | G | A | A | T | T | A | A |
| **Newly replicated (#3)** | **T** | **A** | **C** | **C** | **A** | **A** | **G** | **G** | **C** | **T** | **T** | **A** | **A** | **T** | **T** |
|  | | | | | | | | | | | | | | | |
| **Newly replicated (#4)** | **A** | **T** | **G** | **G** | **T** | **T** | **C** | **C** | **G** | **A** | **A** | **T** | **T** | **A** | **A** |
| **Original Strand #2** | **T** | **A** | **C** | **C** | **A** | **A** | **G** | **G** | **C** | **T** | **T** | **A** | **A** | **T** | **T** |

1. What do you notice about the two new molecules of DNA?
   1. **Are they identical or not?**

**The two new DNA molecules are identical**

* 1. **Is one molecule made up of two new strands and the other made up of two old strands, or are both molecules a combination of a new and old strand?**

**Both molecules are a combination of a new and old strand**

1. Type in the sequence of the two strands of mRNA that you have made (from step #17).

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **mRNA #1 from Original Strand #1** | **U** | **A** | **C** | **C** | **A** | **A** | **G** | **G** | **C** | **U** | **U** | **A** | **A** | **U** | **U** |
|  | | | | | | | | | | | | | | | |
| **mRNA #2 from Original Strand #2** | **A** | **U** | **G** | **G** | **U** | **U** | **C** | **C** | **G** | **A** | **A** | **U** | **U** | **A** | **A** |

1. **What are two ways in which RNA differs from DNA?**

* **DNA contains thymine while RNA contains uracil**
* **In DNA the pentose sugar is deoxyribose.Whereas in RNA the pentose sugar is ribose**

1. **Are the two strands of mRNA identical?**

**No**

1. **Which strand of mRNA will you translate?**

**mRNA #2**

1. **Why did you use this strand?**

**mRNA #2 starts with the codon AUG (start codon)**

1. **What enzyme is going to be translating the mRNA and forming the covalent bonds between the amino acids (#10)?**

**RNA Polymerase**

1. **What is the name of the** **RNA molecule that will be bringing the amino acids to the enzyme mentioned in the above question?**

**tRNA**

1. Complete the chart (from step #27)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **mRNA** | **AUG** | **GUU** | **CCG** | **AAU** | **UAA** |
| **Protein** | **Met** | **Val** | **Pro** | **Asn** | **STOP** |

**Mutations**

1. **What is a mutagen?**

**A physical or chemical agent that changes genetic material**

1. Complete the tables below to show the effect of mutations on the sequence below. You do not need to find a start codon for this particular exercise. The base that will be mutated in the original sequence and the base that was mutated are in red font.

Original sequence:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | T | G | G | A | G | G | | G | G | C | | C | T | A | | G | A | C | | A | T |
| **mRNA** | **G** | **A** | **C** | **C** | **U** | **C** | **C** | | **C** | **C** | **G** | | **G** | **A** | **U** | | **C** | **U** | **G** | | **U** | **A** |
| **Amino acids** | **Asp** | | | **Leu** | | | | **Pro** | | | | **Gly** | | | | **Ser** | | | | **Val** | | |

Mutated Sequence #1:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C   |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **G** | **A** | **C** | **C** | **U** | **C** | **C** | **C** | **C** | **G** | **G** | **A** | **U** | **C** | **U** |  |  | **A** | | T | **A** | G | | A | **T** | G | | G | **C** | C | | C | **A** | A | | G | **T** | C | | A | **G** |
| **mRNA** | **G** | **A** | **U** | **C** | | **U** | **A** | **C** | | **C** | **G** | **G** | | **G** | **U** | **U** | | **C** | **A** | **G** | | **U** | **C** |
| **Amino acids** | **Asp** | | | | **Leu** | | | | **Pro** | | | | **Gly** | | | | **Ser** | | | | **Val** | | |

1. **Do the changes in the base sequence lead to a change in the protein? If so, what?**

**No**

1. Complete the tables below to show the effect of mutations on the sequence below. You do not need to find a start codon for this particular exercise.

Original sequence (different from above):

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | T | G | G | T | A | T | | C | G | A | | A | T | A | | C | G | T | | T | C |
| **mRNA** | **G** | **A** | **C** | **C** | **A** | **U** | **A** | | **G** | **C** | **U** | | **U** | **A** | **U** | | **G** | **C** | **A** | | **A** | **G** |
| **Amino acids** | **Asp** | | | **His** | | | | **Ser** | | | | **Leu** | | | | **Cys** | | | | **Lys** | | |

Mutated Sequence #2:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | T | **T** | G | | T | **T** | T | | C | **C** | A | | A | **A** | A | | C | **C** | T | | T | **G** |
| **mRNA** | **G** | **A** | **A** | **C** | | **A** | **A** | **A** | | **G** | **G** | **U** | | **U** | **U** | **U** | | **G** | **G** | **A** | | **A** | **C** |
| **Amino acids** | **Glu** | | | | **Gin** | | | | **Arg** | | | | **Phe** | | | | **Trp** | | | | **Asn** | | |

1. **Do the changes in the base sequence lead to a change in the protein? If so, what?**

**Yes, the amino acid for the first, second, third, fourth, fifth, and sixth codons changed**

1. **When you look at both Mutated sequence #1 (from question #14) and Mutated Sequence #2, what conclusions can you make about mutations of the base in the third position of the codons.**

**Substitutions of the base in the third position do not always result in a change of the amino acid. At this position Us and Cs may be read by a G in the anticodon.**

1. Complete the tables below to show the effect of mutations on the sequence below. You do not need to find a start codon for this particular exercise.

Original sequence (same as in #14):

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | T | G | G | A | G | G | | G | G | C | | C | T | A | | G | A | C | | A | T |
| **mRNA** | **G** | **A** | **C** | **C** | **U** | **C** | **C** | | **C** | **C** | **G** | | **G** | **A** | **U** | | **C** | **U** | **G** | | **U** | **A** |
| **Amino acids** | **Asp** | | | **Leu** | | | | **Pro** | | | | **Gly** | | | | **Ser** | | | | **Val** | | |

Mutated Sequence #3:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | **A** | G | G | | **T** | G | G | | **C** | G | C | | **G** | T | A | | **A** | A | C | | **T** | T |
| mRNA | **G** | **U** | **C** | **C** | | **A** | **C** | **C** | | **G** | **C** | **G** | | **C** | **A** | **U** | | **U** | **U** | **G** | | **A** | **A** |
| Amino acids | **Leu** | | | | **His** | | | | **Arg** | | | | **Ala** | | | | **Phe** | | | | **Glu** | | |

1. **Do the changes in the base sequence lead to a change in the protein?**

**Yes**

1. **What conclusions can you make about mutations of the base in the second position of the codons?**

**Substitutions in the second position always result in a change in the amino acid sequence**

1. Complete the tables below to show the effect of mutations on the sequence below. You do not need to find a start codon for this particular exercise.

Original sequence:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | A | A | T | G | A | G | G | G | G | C | C | T | A | G | A | A | G | G |
| mRNA | **U** | **U** | **A** | **C** | **U** | **C** | **C** | **C** | **C** | **G** | **G** | **A** | **U** | **C** | **U** | **U** | **C** | **C** |
| Amino acids | **Leu** | | | **Leu** | | | **Pro** | | | **Gly** | | | **Ser** | | | **Ser** | | |

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Mutated Sequence #4:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | **G** | A | T | **C** | | A | G | **A** | | G | G | **T** | | C | T | **G** | | G | A | **T** | | C | G |
| mRNA | **C** | **U** | **A** | **G** | | **U** | **C** | **U** | | **C** | **C** | **A** | | **G** | **A** | **C** | | **C** | **U** | **A** | | **C** | **C** |
| Amino acids | **Leu** | | | | **Val** | | | | **Ser** | | | | **Arg** | | | | **Pro** | | | | **Thr** | | |

1. **Do the changes in the base sequence lead to a change in the protein? If so, what?**

**Changes in the base sequence almost always lead to a change in the protein with the exception of Leucine encoded by the six codons UUA, UUG, CUU, CUC, CUA, and CUG**

1. **What conclusions can you make about mutations of the base in the first position of the codons?**

**Answered in 31**

1. **From these three mutation examples, which base is the most critical, meaning that if you have a mutation in that position you will always get a change in the amino acid sequence?**

**A mutation in the second position is the most critical in changing the amino acid sequence**

1. Complete the tables below to show the effect of mutations on the sequence below. You do not need to find a start codon for this particular exercise.

Original sequence:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | T | G | G | A | G | A | T | A | T | A | C | A | G | A | A | C | C |
| mRNA | **C** | **A** | **C** | **C** | **U** | **C** | **U** | **A** | **U** | **A** | **U** | **G** | **U** | **C** | **U** | **U** | **G** | **G** |
| Amino acids | **His** | | | **Leu** | | | **Tyr** | | | **Met** | | | **Ser** | | | **Trp** | | |

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Mutated Sequence #5:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | T | G | G | | A | G | A | | T | **T** | T | | A | C | A | | G | A | A | | C | **T** |
| mRNA | **C** | **A** | **C** | **C** | | **U** | **C** | **U** | | **A** | **A** | **A** | | **U** | **G** | **U** | | **C** | **U** | **U** | | **G** | **A** |
| Amino acids | **His** | | | | **Leu** | | | | **STOP** | | | | **Met** | | | | **Ser** | | | | **STOP** | | |

1. **Do the changes in the base sequence lead to a change in the protein? If so, what?**

**Yes, the changes lead to a STOP in the amino acid sequence**

1. In the mutation below, the DNA polymerase added an extra base, which has been highlighted in red. This type of mutation is called a frameshift. Complete the tables below to show the effect of mutations on the sequence below. You do not need to find a start codon for this particular exercise.

Original sequence (same as in #14):

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | T | G | G | A | G | G | G | G | C | C | T | A | G | A | C | A | T |
| mRNA | **G** | **A** | **C** | **C** | **U** | **C** | **C** | **C** | **C** | **G** | **G** | **A** | **U** | **C** | **U** | **G** | **U** | **A** |
| Amino acids | **Asp** | | | **Leu** | | | **Pro** | | | **Gly** | | | **Ser** | | | **Val** | | |

Mutated Sequence #6:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | T | G | **C** | | G | A | G | | G | G | | G | C | C | T | A | G | A | C | A |
| **mRNA** | **G** | **A** | **C** | **G** | | **C** | **U** | **C** | | **C** | **C** | | **C** | **G** | **G** | **A** | **U** | **C** | **U** | **G** | **U** |
| **Amino acids** | **Asp** | | | | **Ala** | | | | **Pro** | | | **Arg** | | | | **Ile** | | | **Cys** | | |

1. **Does the addition of a base lead to a change in the protein at and/or after the mutation? (in other words ignore the first amino acid because it is not affected by the mutation) If so, what?**

**The addition of a base lead to a change in the protein at and after the mutation. The second, third, fourth, fifth, and sixth codon / amino acid changed.**

1. In the mutation below, the DNA polymerase has removed a base between the two bases that have been highlighted in red. This type of mutation is also called a frameshift. Complete the tables below to show the effect of mutations on the sequence below. You do not need to find a start codon for this particular exercise.

Original sequence (same as in #14):

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | T | **G** | G | **A** | G | G | G | G | C | C | T | A | G | A | C | A | T |
| mRNA | **G** | **A** | **C** | **C** | **U** | **C** | **C** | **C** | **C** | **G** | **G** | **A** | **U** | **C** | **U** | **G** | **U** | **A** |
| Amino acids | **Glu** | | | **Leu** | | | **Pro** | | | **Gly** | | | **Ser** | | | **Val** | | |

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Mutated Sequence #9:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| DNA | C | T | **G** | **A** | G | G | G | G | C | C | | T | A | G | | A | C | A | | T | A |
| mRNA | **G** | **A** | **C** | **U** | **C** | **C** | **C** | **C** | **G** | **G** | | **A** | **U** | **C** | | **U** | **G** | **U** | | **A** | **U** |
| Amino acids | **Glu** | | | **Ser** | | | **Pro** | | | | **Asp** | | | | **Leu** | | | | **Tyr** | | |

1. **Does the deletion of a base lead to a change in the protein? If so, what?**

**Yes, the change is at and after the point of deletion.**

1. **What conclusions can you make about frameshift mutations?**

**Frameshift mutations change the amino acid sequence at the point of the additon/deletion of a base.**

1. **Of the mutations that you have looked at (substitution or frameshift), which type is always the worse kind of mutation? Why?**

**Frameshift mutations are always the worse kind because that change the amino acid sequence at the point of addition/deletion of a base. Substitution mutations in the first and third codon positions sometimes do not have an effect on protein synthesis.**