Name _____ Period _____ Date _____

**Topic 2.7 DNA Replication, Transcription and Translation Part II**

Review question

1. Transcription and translation is also known as *protein synthesis*, and is **the expression of genes**. The genetic code determines the amino acid sequence of a polypeptide, and the properties of the amino acids give the final structure and function of the protein. *Other than membrane proteins, state four functions of proteins in the cell.*

2.7.U4 Transcription is the synthesis of mRNA copied from the DNA base sequences by RNA polymerase.

2. Outline the process of transcription in the nucleus, including the roles of RNA polymerase, ribonucleoside triphosphates and complementary base pairing.

2.7.U5 Translation is the synthesis of polypeptides on ribosomes.

3. Complete the table to compare and contrast the processes of transcription and translation.

| | **Transcription** | **Translation** |
|---|---|---|
| Begins with… | | mRNA |
| Ends with… | | |
| Location | | |
| Uses… | RNA polymerase | |

4. Ribosomes are the cell components that carry out the process of translation. Outline the structure of the ribosome and explain how it is adapted to carry out translation.

2.7.U6 The amino acid sequence of polypeptides is determined by mRNA according to the genetic code.

2.7.U7 Codons of three bases on mRNA correspond to one amino acid in a polypeptide.

5. Define mRNA in terms of it's function
6. Suggest why the length of mRNA molecules varies.
7. Describe what is meant by the term 'genetic code'.
8. Define the term codon.
9. Calculate the number of different codons combinations.
10. State the number of amino acids that can be translated by ribosomes.
11. Explain what is meant by the term degenerate. Refer to the last two questions in your answer.

2.7.U8 Translation depends on complementary base pairing between codons on mRNA and anticodons on tRNA.

12. State the molecule on which anti-codons, which are complementary to codons, can be found.
13. Complete the steps to outline the process of translation.
    a. mRNA binds to the _____ of the ribosome.
    b. The mRNA contains a series of _____ each of which codes for an amino acid.
    c. tRNA molecules contain _____which are complementary to the _____ on the _____.
    d. tRNA molecules bind to a _____ that corresponds to the anticodon
    e. The _____ binds to the small subunit of the ribosome.
    f. There are ____ binding sites on the _____ of the ribosome, but only _____ can contain tRNA molecules at a time
    g. The _____ moves along the mRNA and presents codons in the first two _____.

h. _____ with anticodons _____ to the codons bind (the bases are linked by the formation of _____ )

i. A _____ is formed between the two amino acids (carried by the tRNAs)

j. As the _____ moves along _____ a tRNA moves to the _____ binding site and _____.

k. Another _____ carrying an amino acid binds to the _____ site and a second _____ is formed.

l. The process (i.e. the last two steps) repeats forming a _____.

2.7.S1 Use a table of the genetic code to deduce which codon(s) corresponds to which amino acid.

2.7.S3 Use a table of mRNA codons and their corresponding amino acids to deduce the sequence of amino acids coded by a short mRNA strand of known base sequence.

2.7.S4 Deducing the DNA base sequence for the mRNA strand.

Use the genetic code table to help answer the questions below.

**The genetic code – how mRNA codons translate to amino acids**

http://www.ib.bioninja.com.au/_Media/genetic_code.jpeg

| First letter | Second letter: U | Second letter: C | Second letter: A | Second letter: G | Third letter |
|---|---|---|---|---|---|
| U | UUU Phe, UUC Phe, UUA Leu, UUG Leu | UCU Ser, UCC Ser, UCA Ser, UCG Ser | UAU Tyr, UAC Tyr, UAA STOP, UAG STOP | UGU Cys, UGC Cys, UGA STOP, UGG Trp | U C A G |
| C | CUU Leu, CUC Leu, CUA Leu, CUG Leu | CCU Pro, CCC Pro, CCA Pro, CCG Pro | CAU His, CAC His, CAA Gln, CAG Gln | CGU Arg, CGC Arg, CGA Arg, CGG Arg | U C A G |
| A | AUU Ile, AUC Ile, AUA Ile, AUG Met | ACU Thr, ACC Thr, ACA Thr, ACG Thr | AAU Asn, AAC Asn, AAA Lys, AAG Lys | AGU Ser, AGC Ser, AGA Arg, AGG Arg | U C A G |
| G | GUU Val, GUC Val, GUA Val, GUG Val | GCU Ala, GCC Ala, GCA Ala, GCG Ala | GAU Asp, GAC Asp, GAA Glu, GAG Glu | GGT Gly, GGC Gly, GGA Gly, GGG Gly | U C A G |

Key:

Ala = Alanine (**A**)
Arg = Arginine (**R**)
Asn = Asparagine (**N**)
Asp = Aspartate (**D**)
Cys = Cysteine (**C**)
Gln = Glutamine (**Q**)
Glu = Glutamate (**E**)
Gly = Glycine (**G**)
His = Histidine (**H**)
Ile = Isoleucine (**I**)
Leu = Leucine (**L**)
Lys = Lysine (**K**)
Met = Methionine (**M**)
Phe = Phenylalanine (**F**)
Pro = Proline (**P**)
Ser = Serine (**S**)
Thr = Threonine (**T**)
Trp = Tryptophan (**W**)
Tyr = Tyrosine (**Y**)
Val = Valine (**V**)

14. Deduce the codon(s) that translate for Aspartate.
15. If mRNA contains the base sequence CUGACUAGGUCCGGA
    a. deduce the amino acid sequence of the polypeptide translated.
    b. deduce the base sequence of the DNA antisense strand from which the mRNA was transcribed.
    c. If mRNA contains the base sequence ACUAAC deduce the base sequence of the DNA sense strand.
16. Transcribe and translate this DNA sequence.

| **DNA** | **T** | **A** | **C** | **G** | **G** | **G** | **C** | **C** | **C** | **G** | **T** | **G** | **A** | **C** | **A** | **G** | **C** | **C** | **A** | **C** | **T** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **mRNA** | | | | | | | | | | | | | | | | | | | | | |
| **Amino acid** | | | | | | | | | | | | | | | | | | | | | |

17. An mRNA strand has 76 codons. How many amino acids will be in the polypeptide?
18. A polypeptide contains 103 amino acids. What is the length of the gene (unit = base pairs)?
19. A gene is 105kbp (kilobase pairs). How many amino acids are in the polypeptide?

2.7.A2 Production of human insulin in bacteria as an example of the universality of the genetic code allowing gene transfer between species.

20. Diabetes in some individuals is due to destruction of cells in the pancreas that secrete the hormone insulin. It can be treated by injecting insulin into the blood. Despite the differences in the amino acid sequence between animal and human insulin, they all bind to the human insulin receptor and cause lowering of blood glucose concentration. However, some diabetics develop an allergy to animal insulin, so it is preferable to use human insulin. In 1982 human insulin became commercially available for the first time. It was produced using genetically modified E. coli bacteria. Since then methods of production have been developed using yeast cells and more recently safflower plants. Describe what is meant by the term ‘universality of the genetic code’.