Name Date Period \_\_\_\_\_

RNA and Protein Synthesis

Besides ensuring the exact replication of chromosomes, the sequence, or order, and pairings of bases are a genetic code of the instructions for the entire cell. How does a cell “read” and “translate” the chemical message encoded in its DNA in the form of specific base sequences? Part of the answer lies with a second molecule in the nucleus of cells called ribonucleic acid (RNA). By understanding DNA and RNA, scientists understand how chromosomes in the cell nucleus can direct the formation of specific proteins outside the nucleus.

**Objectives**

In this lab you will:

* Learn the names of the parts which make up RNA
* Use models to show how the base sequence code in DNA is transferred exactly to RNA
* Demonstrate how the code from RNA is decoded to form proteins
* Compare and contrast the nucleic acids DNA and RNA

**Materials** DNA nucleotide pieces from previous lab, scissors, RNA nucleotides sheet

**Procedure**

PART A- RNA STRUCTURE

RNA is the molecule that carries the information on the chromosomes out of the nucleus to the ribosomes where proteins are made. RNA is similar to DNA in that its molecules also form nucleotides. However, instead of being double-stranded and in the form of a double helix as DNA, RNA is single-stranded and not twisted. Furthermore, deoxyribose and thymine are not found in RNA. Two other molecules, ribose and uracil, are present. Ribose replaces the sugar deoxyribose, and uracil replaces the base thymine.

1. What are three ways that DNA differs from RNA?

1. Examine the shape of the uracil model. Using it and what you know of DNA and RNA, which base could uracil match with to form a complete rung?

PART B- RNA SYNTHESIS

* Using your DNA model pieces, construct a piece of DNA in which the order of nucleotides on the left strand from top to bottom are the following:

C T G A G C

* Add in the complementary DNA strand on the right.
* Cut out the RNA nucleotides from the sheet. *Remember, cut only along the solid lines.*
* Open or unzip the DNA chromosomes along the base pair points of attachment and separate the two halves
* Using the right side of your DNA model as a pattern, match RNA nucleotides with the proper nucleotides of the DNA halves.

1. Is the order of bases in RNA different from the unused left side of the original DNA molecule. (Note: do not consider uracil replacing thymine as a change in sequence.)

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1. Do the RNA half-rung bases pair exactly as they would if this were DNA replication?

1. Explain how specific pairing of adenine with only uracil and cytosine with only guanine helps ensure exact transfer of the code from DNA to RNA.

* Remove the RNA nucleotide series from DNA pattern, and close the DNA molecule back up with its original left side.

PART C- PROTEIN SYNTHESIS

RNA is a single-stranded molecule. Thus, the series of DNA nucleotides formed from DNA represents an RNA molecule. The piece of RNA which you formed is more specifically called **messenger RNA (mRNA)**. It is called this because after its formation, this mRNA leaves the nucleus of the cell and goes to the ribosomes, where proteins are made. It carries the DNA message of base sequences in the exact same order.

When mRNA gets to the ribosomes, the code that it has brought from the DNA needs to be decoded. The nucleotide sequence functions as a sort of code, in which three bases form a code word, or **codon**. Each codon codes for a specific amino acid. The table below shows which codes specify which amino acids.

SECOND BASE IN CODON

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | U | A | C | G |  |
| U | Phenylalanine  Phenylalanine  Leucine  Leucine | Serine  Serine  Serine  Serine | Tyrosine  Tyrosine  Stop Codon  Stop Codon | Cysteine  Cysteine  Stop Codon  Tryptophan | U  C  A  G |
| C | Leucine  Leucine  Leucine  Leucine | Proline  Proline  Proline  Proline | Histidine  Histidine  Glutamine  Glutamine | Arginine  Arginine  Arginine  Arginine | U  C  A  G |
| A | Isoleucine  Isoleucine  Isoleucine  Methionine | Threonine  Threonine  Threonine  Threonine | Asparagine  Asparagine  Lysine  Lysine | Serine  Serine  Arginine  Arginine | U  C  A  G |
| G | Valine  Valine  Valine  Valine | Alanine  Alanine  Alanine  Alanine | Aspartic Acid  Aspartic Acid  Glutamic Acid  Glutamic Acid | Glycine  Glycine  Glycine  Glycine | U  C  A  G |

There are a total of 64 codons, and only 20 amino acids. Therefore, many codons are **synonyms** for the same amino acid. The ribosomes read the code from the mRNA and put the specified amino acids together. A chain of amino acids forms a **protein**; therefore, this is how DNA directs the synthesis of proteins.

1. What is a codon?
2. If there are 64 codons, but only 20 amino acids they code for, how is this problem resolved?
3. Starting with a piece of DNA in the nucleus, briefly describe the process of how proteins are made. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. Suppose you have a right strand of DNA with the following nucleotide sequence. Determine what the left DNA strand, mRNA strand, and amino acid sequence will be. For this problem, be sure to code your mRNA strand from your left DNA strand.

Right DNA T A C G C C T A A C G T C T G A G G T A C

Strand:

Left DNA

Strand:

mRNA Strand:

(coded from left DNA)

Amino Acids:

10.)Complete the chart below:

|  |  |  |
| --- | --- | --- |
|  | DNA | RNA |
| Ribose present |  |  |
| Deoxyribose present |  |  |
| Phosphoric acid present |  |  |
| Adenine present |  |  |
| Thymine present |  |  |
| Uracil present |  |  |
| Guanine present |  |  |
| Cytosine present |  |  |
| Double stranded |  |  |
| Single stranded |  |  |
| Remains in nucleus |  |  |