Name _____ Class _____ Date _____

Skills Practice Lab

Modeling DNA Replication and Protein Synthesis

OBJECTIVES

Construct and analyze a model of DNA.

Use a model to simulate the process of replication.

Use a model to simulate the process of protein synthesis.

PROCESS SKILLS

- demonstrating
- identifying
- manipulating a model

MATERIALS

- plastic soda straws of two different colors, cut into 3 cm sections (54)
- metric ruler
- scissors
- permanent marker
- 54 pushpins (12 red, 12 blue, 12 yellow, 12 green, and 6 white)
- 54 paper clips
- 3 in. × 5 in. note cards
- oval-shaped card

Background

1. Describe the structure of DNA.

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2. State the base-pairing rules.

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3. List the steps involved in the copying of DNA before cell division.

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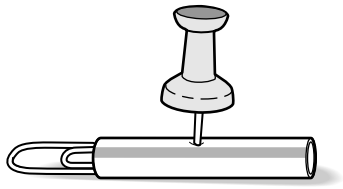
4. What are the roles of mRNA, rRNA and tRNA in protein synthesis?

5. Describe the process of transcription and the process of translation.

PART A: MAKING A MODEL OF DNA

1. **CAUTION Sharp or pointed objects may cause injury. Handle pushpins carefully.** Insert a pushpin midway along the length of each straw segment of one color, as shown in the figure. Push a paper clip into one end of each straw segment until the clip touches the pin.



2. Keeping the pins in a straight line, insert the paper clip from a blue-pushpin segment into the open end of a red-pushpin segment. Add additional straw segments to the red-segment end in the following order: green, yellow, blue, yellow, blue, yellow, green, red, red, and green. Use the permanent marker to label the blue-segment end "top." This chain of segments is one-half of your first model.

3. Assign nucleotides to the corresponding pushpin colors as follows: red = adenine, blue = guanine, yellow = cytosine, and green = thymine.

4. Construct the other half of your first model. Begin with a yellow segment across from the blue pushpin at the top of your first model. Keep the pins in a straight line. Link segments together in this second strand of DNA according to the base-pairing rules.

5. When you have completed your model of one DNA segment, make a sketch of the model in the space below. Use colored pencils or pens to designate the pushpin colors. Include a key that indicates which nucleotide each color represents in your sketch.

PART B: MODELING DNA REPLICATION

6. Place the chains parallel to each other on the table. The "top" blue pin of the first chain should face the "top" yellow pin of the second chain.

7. Demonstrate replication by simulating a replication fork at the top pair of pins. Add the remaining straw segments to complete a new DNA model. Be sure to follow the base-pairing rules.

8. Sketch the process of DNA replication in the space below. Label the replication fork, the segments of original DNA, and the segments of new DNA in your sketch.

PART C: MODELING PROTEIN SYNTHESIS

9. Place the chains of one of the DNA models parallel to each other on the table.

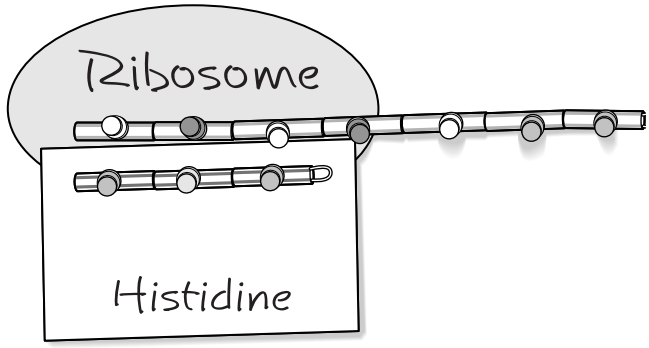
10. Repeat step 1, but use the straw segments of the second color.

11. Assign the uracil nucleotide to the white pushpins. Using the available pushpins and the second set of straw segments, construct a model of an mRNA transcript of the DNA segment. Begin by separating the two chains of DNA and pairing the mRNA nucleotides with the left strand of DNA as you transcribe from the top of the segment to the bottom of the segment.

12. In the space below, sketch the mRNA model that you transcribed from the DNA segment.

13. Refer to the figure at right. Label the note cards with amino acids that you will need to translate your mRNA model. Use the "ribosome" oval cards to model translation.

14. Write the sequence of amino acids that resulted from the translation.



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15. Clean up your materials before leaving the lab.

Analysis and Conclusions

1. Write the base-pair order for the DNA molecule you created by using the following code: red = adenine, blue = guanine, yellow = cytosine, and green = thymine.

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2. How does the replicated model of DNA compare with the original model of DNA?

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3. Predict what would happen if the nucleotide pairs in the replicated model were not in the same sequence as the pairs in the original model.

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4. What is the relationship between the anticodon of a tRNA and the amino acid the tRNA carries?

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5. Write the mRNA transcript of the DNA sequence presented below.

CTG TTC ATA ATT

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Next, write the tRNA anticodons that would pair with the mRNA transcript.

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Use the table in your textbook to write the amino acids coded for by the mRNA transcript.

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6. If you transcribed the "wrong" side of the DNA molecule, what would the result be? How might the proteins that the organism produced be affected?

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7. What are the advantages of having DNA remain in the nucleus of eukaryotic cells?

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Further Inquiry

Design models to represent a eukaryotic and a prokaryotic cell. Use these models along with the models you constructed in this investigation to demonstrate where replication, transcription, and the steps of protein synthesis occur.