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DNA Replication: Paper Clip Activity

Quick Review:

- Each DNA molecule has a unique structure that makes it different from other DNA molecules (or genes.)
- This difference occurs because the sequence of A, T, C, and G vary from one molecule or gene to another.

What You Need to Know About DNA Replication:

- To “replicate” means to produce a copy of itself. DNA is the only known molecule that can do this.
- DNA is able to make an exact replica of itself because of the base pairing characteristics stressed earlier (A with T and C with G).
- When DNA makes a duplicate molecule of itself, the two strands unwind.
- After the two strands have pulled apart, new bases (A, T, C, & G) as well as new sugar and phosphate units come into place according to the base pairing rules.
- A comes in opposite of T, and C is opposite of G.
- When this occurs, two identical DNA molecules are created.

Activity Overview:

You will be making a short sequence of a human gene that controls the body’s production of the growth hormone, which causes growth during childhood and adolescence. Genetic engineers call this gene the hGH (human Growth Hormone) gene. This gene is actually made of 573 nucleotide base pairs. You will only construct the first ten bases in the gene.

For this activity, each pair of students will need the following:

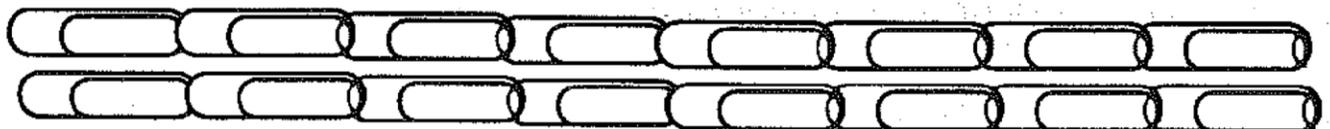
- 14 blue clips = Adenine (A)
- 14 purple clips = Thymine (T)
- 9 red clips = Cytosine (C)
- 9 green clips = Guanine (G)

STEP ONE: Use the colored paper clips according to the key above and construct the top strand of the hGH according to the diagram of the gene below. Link the ten appropriate colored clips for the top chain shown below.

1 2 3 4 5 6 7 8 9 10
 A- A- G- C- T- T- A- T- G- G
 T- T- C- G- A- A- T- A- C- C

Notice that the bottom strand of the DNA molecule follows the “rule of complementarity,” which means that A bonds with T, and C bonds with G.

STEP TWO: Now construct the bottom strand of the hGH gene by linking ten more clips into a chain according to the pattern above. The entire sequence of this gene is known. Your DNA model should resemble the following:





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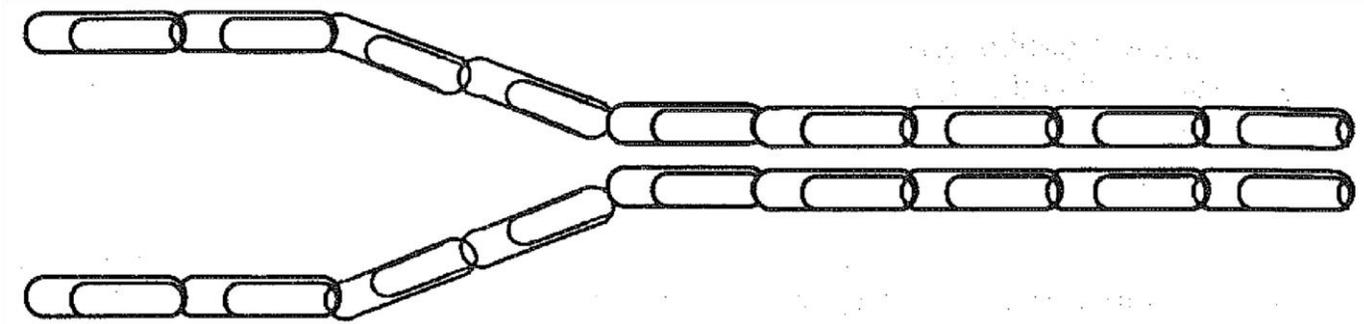
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STEP THREE: Set the two chains side-by-side as shown in the drawing above so that A bonds with T, and C bonds with G.

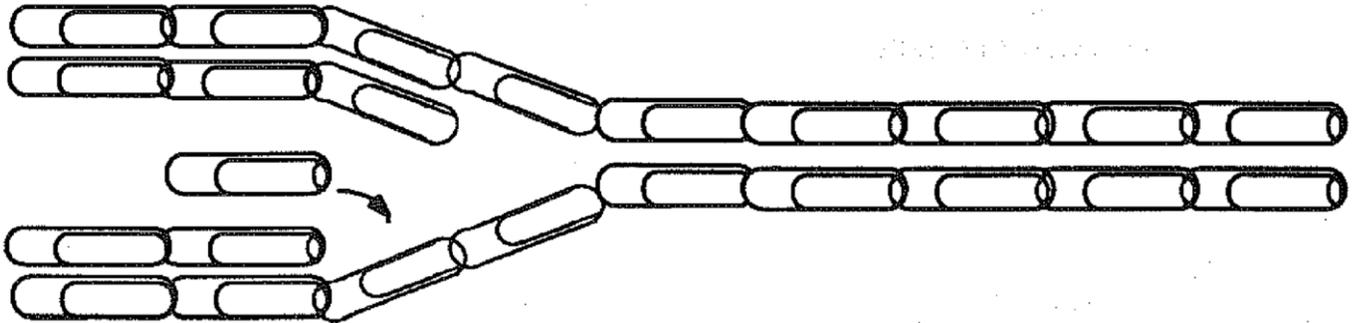
You now have a model of the hGH gene (the first ten bases only.)

Compare the two chains with each other side-by-side to verify that C bonds with G, and A bonds with T. When this gene replicates in the nucleus of a cell, the double-strand begins to separate at one end. As it separates, new nucleotide bases are moved into place by enzymes, which form the beginning of two new identical molecules. These A, T, C, and G bases are present in the nucleus of each cell and come from food molecules. When these new bases are brought into place, the A bonds with T, and the C bonds with G.

STEP FOUR: Open your hGH DNA molecule as shown below:



STEP FIVE: Now use the other available clips to create the beginning of two new strands. Remember A with T and C with G. Connect the clips as follows:



STEP SIX: Continue separating the strands and bring in appropriate new bases (clips) to create two complete new double-stranded hGH gene molecules. Remember that A bonds opposite to T, and C is opposite of G. You should have six clips left. Save them for later.

Answer the questions that follow:

1. Examine the two double-stranded DNA molecules. Are they identical or different in any way?
2. If you were asked to replicate each of the two DNA molecules on your table to create four identical DNA molecules, how would you go about doing this?



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3. You now have two copies of a segment of the hGH gene on your table. During periods of growth and cell division, the chromosomes, which are made up of genes, must divide. What features about DNA replication causes each new DNA molecules to be exactly like the original?

*Cells can divide along with their DNA in this manner without any errors for thousands of replications. On occasion an error can occur. When this type of error occurs in a cell that is destined to become an egg or a sperm cell, it is called a “mutation.” So what is a gene mutation?

STEP SEVEN: To demonstrate a gene mutation, place one of your paper clip hGH DNA strands in front of you. Identify the second nucleotide base called Adenine (A), which is blue. To cause a mutation, remove this 2nd blue clip and replace it with a red Cytosine (C) clip. You have just demonstrated how a mutation occurs. This replacement usually occurs when the DNA is replicating.

4. When this mutated DNA molecule replicates, will the resulting new DNA be similar or different from the hGH gene? Explain.

*This type of mutation can be caused by a variety of circumstances, including radiation, chemical exposure, or it can occur spontaneously without known cause.

5. Draw structures of the new double-stranded mutated gene you created by using the letters A, T, C, and G in a manner similar to that shown earlier.

*Since the sequence of bases is different in this molecule, the genetic code is different. This gene CANNOT direct the cell to produce normal human growth hormone.

6. In your own words, explain how mutations can occur in cells and how this might affect the new organism with the mutation.

(When you have completed this activity, please separate all the paper clips and count them – you need to have 14 blue and 14 yellow, 9 red and 9 green. Then put them all back in the Ziploc baggie.)



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Answer the questions on the back of this page

7. Why does DNA need to replicate?

8. How do base-pairing rules make DNA replication possible?

9. Explain three main steps in the process of DNA replication.

a. _____

b. _____

c. _____

Use this space to answer the Standardized Test Prep Questions on page 359 (1-11).