Name _____ Date _____ Period _____

MODELING DNA REPLICATION

PURPOSE:

In this investigation, you will model the process of DNA replication, which takes place during the S phase of the cell. By completing this activity, you will see how Chargaff's rules, antiparallel strands, and three different enzymes contribute to the process of DNA replication in a cell.

HYPOTHESIS:

If a DNA molecule is replicated, then the two resulting strands will be _____.

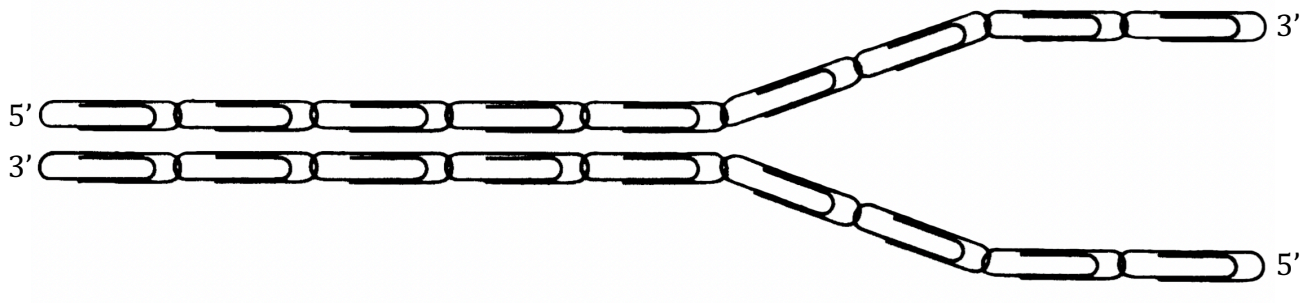
WORD BANK FOR HYPOTHESES: identical / non-identical

MATERIALS:

- 10 paper clips of four different colors:

  A = _____
  T = _____
  C = _____
  G = _____

- 1 paper cut-out model of Helicase
- 2 paper cut-out models of DNA Polymerase
- 1 paper cut-out model of Ligase
- 6 paper cut-out models of 5' END
- 6 paper cut-out models of 3' END



PROCEDURE:

1. Decide which colors will represent A, T, C, and G. Record this information in the materials section of the lab handout.

2. Link the paper clips together to form the following DNA sequence:

   5'-A-A-G-C-T-G-A-G-C-T-3'

   The sequence listed above will represent the top strand of DNA. Label the left side with the **5' END** cut-out and the right side with the **3' END** cut-out.

3. Write the complementary base sequence in the space below. Create the bottom strand of DNA by linking paper clips together. Do not attach the top strand to the bottom strand. Since this strand will be anti-parallel to the top strand, label the left side with the **3' END** cut-out and the right side with the **5' END** cut-out. **Take a photo of the parental DNA strands.**

   _____

4. Open up the two strands, starting on the right side. Use the helicase cut-out and wedge it between the right side of the two strands, forming a sideways "v". Separate out the first four bases. At this point, the helicase cut-out should be wedged in between the parental DNA strands four bases from the right side.

5. Use one of your DNA Polymerase cut-outs to add complementary bases (paper clips), one at a time, beneath the top strand. Add the bases beginning from the 5' end (the right side) of the daughter strand. Link the paper clips together, but do not link them to the parental strand. Make sure that the ends of your daughter strand are labeled with the **5' END** and **3' END** cut-outs.

6. Use the other DNA Polymerase cut-out to add complementary bases (paper clips), one at a time, above the bottom strand. Add the bases beginning from the 5' end (the part of the strand closest to helicase at the replication fork). Link the paper clips together, but do not link them to the parental strand. Make sure that the ends of your daughter strand are labeled with the **5' END** and **3' END** cut-outs. **Take a photo of the DNA strands.**

7. Slide the helicase cut-out to the left to separate out three additional bases. At this point, the helicase cut-out should be wedged in between the parental DNA strands seven bases from the right side.

8. Repeat a process similar to step 5 to continue extending the leading strand. Make sure that you link your bases (paper clips) to the four existing bases of the growing strand. Remember that this strand should not be linked to the parental strand. The **3' END** cut-out will have to be moved in order to complete this step.

9. Repeat a process similar to step 6 to continue extending the lagging strand. Do not link your second fragment to your first fragment or to the parental strand. Make sure that the ends of **each fragment** are labeled with the **5' END** and **3' END** cut-outs. **Take a photo of the DNA strands.**

10. Slide the helicase cut-out all the way to the left side of the parental DNA molecule. The two parental strands should now be fully separated.

11. Repeat a process similar to steps 5 and 8 to finish building the leading strand. Make sure that you link your bases (paper clips) to the seven existing bases of the growing strand. Do not link the leading strand to the parental strand. The **3' END** cut-out will have to be moved in order to complete this step.

12. Repeat a process similar to steps 6 and 9 to finish building the lagging strand. Do not link your third fragment to either of the first two fragments or to the parental strand. Make sure that the ends of **each fragment** are labeled with the **5' END** and **3' END** cut-outs.

13. Use the ligase cut-out to join the fragments together to form the lagging strand. Remove the **5' END** and **3' END** cut-outs from the inner regions of the lagging stand. **Take a photo of the DNA strands.**

RESULTS:

There should be four data tables for this lab:

1. The first data table should include a photo and a labeled diagram showing the parental strands.

2. The second data table should include a photo and a labeled diagram showing the first part of DNA replication.

3. The third data table should include a photo and a labeled diagram showing the second part of DNA replication.

4. The fourth data table should include a photo and a labeled diagram showing the final results of DNA replication.

DISCUSSION:

1. How did you apply Chargaff's rules to the process of DNA replication? Explain using CLAIM → EVIDENCE → REASONING.

2. Compare both strands of the top DNA molecule with both strands of the bottom DNA molecule. What can you conclude? Explain using CLAIM → EVIDENCE → REASONING.

3. DNA replication is often referred to as a **semi-conservative** process. Support this CLAIM using EVIDENCE and REASONING from this lab.

4. Why was one daughter strand created continuously, whereas the other was created in fragments? Explain using CLAIM → EVIDENCE → REASONING.

POST-LAB QUESTIONS:

1. Why is the structure of DNA described as a double helix? In other words, what does **double** refer to and what does **helix** refer to?

2. Hypothesize what would happen to the DNA molecule if a point mutation occurred during the replication process. Then rewrite the original strand of DNA (listed in step 2 of the procedure) with **any** point mutation.

3. Hypothesize what would happen to the DNA molecule if a frame-shift mutation occurred during the replication process. Then rewrite the original strand of DNA (listed in step 2 of the procedure) with **any** frame-shift mutation.

4. Prokaryotes lack the enzymes needed to fix mistakes that naturally occur during DNA replication. Predict whether you think this **increases** or **decreases** the rate at which bacteria evolve through natural selection. Explain your choice.

5. In what type of cells would mutations contribute to natural selection? Choose between **body (somatic) cells** or **sex cells (gametes)**. Explain your choice.

QUESTIONS TO HELP YOU WITH YOUR LAB REPORT:

1. Was your hypothesis correct? Explain using CLAIM → EVIDENCE → REASONING.

2. Identify 1 or 2 sources of error for this lab. Explain your answer(s).

3. Identify 1 or 2 ways to improve this lab. Explain your answer(s).

4. What conclusion(s) can you draw regarding the process of DNA replication?