

DNA Structure & Replication

Examining DNA Structure:

1. Pick out one of each of the 4 types of nucleotides, (1) A, (1) G, (1) T, and (1) C.
2. Draw one nucleotide and label the sugar, the phosphate group, and the nitrogenous base.
3. What are the structural similarities between the 4 nucleotides? What are the differences?

Building a Model of Double-stranded DNA:

4. Pick out 5 of each type of nucleotide and build a model of double-stranded DNA with 10 nucleotides in each strand. Make the correct complementary pairs with nitrogenous bases facing inward. Connect the pieces using the attached Velcro.
 - a) Look at an adenine – thymine base pair. How many bonds (connections) do you see?
 - b) Look at a guanine – cytosine base pair. How many bonds do you see?
5. Adenine makes up 25% of the nucleotides in a DNA sample from an organism. Approximately what percentage of nucleotides in this sample will be thymine?
6. Cytosine makes up 42% of the nucleotides in a sample of DNA from an organism. Approximately what percentage of the nucleotides in this sample will be thymine?
7. A single strand of DNA has the following sequence of nitrogenous bases:

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

Write the sequence of the complementary strand, labeling the complementary strand's 3' and 5' ends.

8. A nucleotide substitution occurs in the sequence of the original strand above, resulting in the following:

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

- a. Circle the mismatched bases.
- b. If the upper strand were copied by the cell, list the sequence of the new complementary strand, labeling the 5' and 3' ends.

DNA Replication

9. Pick up your model DNA molecule by one end. Which bonds separate most easily?
10. Which bonds separate when a replication fork forms in a double-stranded DNA molecule?
11. Use the nucleotide pieces to build a new DNA strand complementary to the template on the poster.
12. In your own words, summarize the process of DNA replication including the terms **leading strand** and **lagging strand** and the role of the enzymes **helicase**, **DNA polymerase**, and **DNA ligase**.

Teaching Tips for Peer Mentors

In this activity students will use 2D models of DNA nucleotides to build a short stretch of double-stranded DNA. The goals are for them to learn the structural definition of a nucleotide, to practice the complementary base-pairing rules, to learn the structural difference between the 3' and 5' end of the DNA strand, to apply Chargaff's Rule to calculate ratios of the 4 bases, and to apply knowledge of 3' and 5' structure to figure out the direction of replication on each DNA strand.

Part 1: DNA Structure

Students have to be able to label the sugar, phosphate group, and nitrogenous base (general, not specific recognition of adenine, guanine, cytosine, and thymine) on a structural diagram, so make sure each person draws a diagram and labels it. Ask them to tell you how to distinguish A from G or T or C.

Part 2: Building the double-stranded DNA model

Have students work in pairs to build the models. Circulate and ask them to tell you the base pairing rules. Ask them questions 4a and 4b and make sure they know what kind of bond is represented by the lines! If students haven't taken 1361, encourage them to review the section on Weak Chemical Bonds, especially hydrogen bonds in Chapter 2 of the textbook.

Questions 5 and 6 are based on Chargaff's Rule. If students don't know where to start, ask them to tell you Chargaff's Rule and encourage them to use algebra to set up the problem. Don't set it up for them, they need practice thinking through the answer.

Questions 7 and 8 require students to apply the complementary base pairing rules and the fact that the complementary strands are oriented anti-parallel (head-to-tail). Assure them that they will have questions like 5 – 8 on the exam.

Part 3: DNA replication

Have students work in groups of 2 – 4 to build complementary leading and lagging strands on the replication fork poster.

After they build leading and lagging strands, have them write definitions of the terms in question 12 and a description of what helicase does, what DNA polymerase does, and what DNA ligase does.

Summarize

Show the DNA replication Bioflix on Mastering Biology.

As you load the animation, show them that you are finding this in the Study Area tab.

Click the Bioflix Quiz option and call on different groups to answer the questions.

You could divide students into 2 teams, ask each team to give an answer, then see who is correct.

Team with most correct answers gets candy (optional).

Notes to Faculty

Supplies: The manipulatives kit is 2 dimensional and consists of laminated paper parts. The kit is available from Wards Scientific, www.wardsci.com, catalog number 6731058.