AP BIOLOGY · UNIT 6 · TOPIC 6.1

DNA and RNA Structure

Learning objective 6.1.A Describe the structure and function of DNA and RNA.

Name: Date: Period:

Use the tool **Two Strands, One Rule**. Part 1 uses **Build the partner strand**, Part 2 uses **Where Chargaff comes from** and Part 3 uses **Which molecule is it?** Almost everything in this topic follows from one rule (**A pairs with T, G pairs with C**), together with the fact that the two strands run in opposite directions.

Part 1 · Write the partner strand

Work each row out on paper first: take the complement of the given strand, then **reverse it**, because the partner is read from the other end. Then check with **Build the partner strand**.

Given strand (5′→3′)	Complement	Partner strand (5′→3′)	GC %	H-bonds
ATGCCGTA				
GGCCTAAG				
TTAATTAA				
GCGCATGC				

1. (a) Describe what “antiparallel” means for the two strands of DNA.

(b) Explain why the complement of a given strand must be reversed to write the partner strand 5′ to 3′.

2. All four strands in the Part 1 table are 8 bases long, but their hydrogen-bond totals differ.
(a) Identify the strand with the most hydrogen bonds and the strand with the fewest.

(b) Explain why these two strands have different numbers of hydrogen bonds.

Part 2 · Where Chargaff's rules come from

On Build the partner strand, type ATGCGATACG in the Your strand box. Then click the Where Chargaff comes from tab. The chart shows the count of each base twice: for one strand only and for both strands. Record both sets of counts.

	A	T	G	C	A = T?	G = C?
One strand only						
Both strands						

3. Describe Chargaff's rules, including the condition under which they hold.

4. Explain why the amounts of A and T must be equal when both strands of DNA are counted.

5. A double-stranded DNA sample is 32% guanine. Calculate the percentage of each of the other three bases. Show your work.

Part 3 · Which molecule is it?

Click the **Which molecule is it?** tab. Press Sample 1, Sample 2, Sample 3 and Sample 4 in turn, and answer the two questions in order for each sample.

Sample	Thymine or uracil?	So it is	Complementary bases equal?	So it is
Sample 1				
Sample 2				
Sample 3				
Sample 4				

6. Using the Part 3 table, explain why neither question alone is enough to identify a nucleic acid.

7. A student claims that "a molecule that contains uracil is RNA, and RNA is single-stranded." Using the Part 3 table, evaluate the student's claim.

Part 4 · Putting it together

Answer questions 8 to 11 without the tool.

8. (a) Identify the three parts of a nucleotide.

(b) Identify the part that differs from one nucleotide to the next along a strand of DNA.

9. (a) Using the base-pairing rules, explain why every base pair in DNA joins a purine to a pyrimidine.

(b) Explain how purine-pyrimidine pairing affects the width of the double helix.

10. Explain why a region of DNA rich in G and C requires a higher temperature to separate its strands than an AT-rich region of the same length.

11. (a) Describe the differences between DNA and RNA in their sugar, their bases and their usual number of strands.

(b) Explain how each difference in part (a) suits the function of the molecule.

What the model simplifies

The ladder is drawn flat. Real DNA is a double helix with a major and a minor groove, and the twist matters to the proteins that read it, but nothing on this page depends on the twist, so it is left out.

Hydrogen bonds are counted as two per A-T pair and three per G-C pair. That is the standard figure and it is what makes GC-rich DNA harder to separate, but real melting temperature also depends on which bases are next to each other, on length and on the surrounding salt concentration.

'RNA is single-stranded' is the usual summary and is right about messenger RNA, but a single RNA strand routinely folds back and pairs with itself, which is how transfer RNA and ribosomal RNA get their shapes. One of the identification samples is a genuinely double-stranded RNA, which some viruses have.

Base counts in the identification samples are whole numbers chosen so the arithmetic is checkable. A real measurement would carry error, and 22 against 23 would not by itself rule out a paired molecule.