

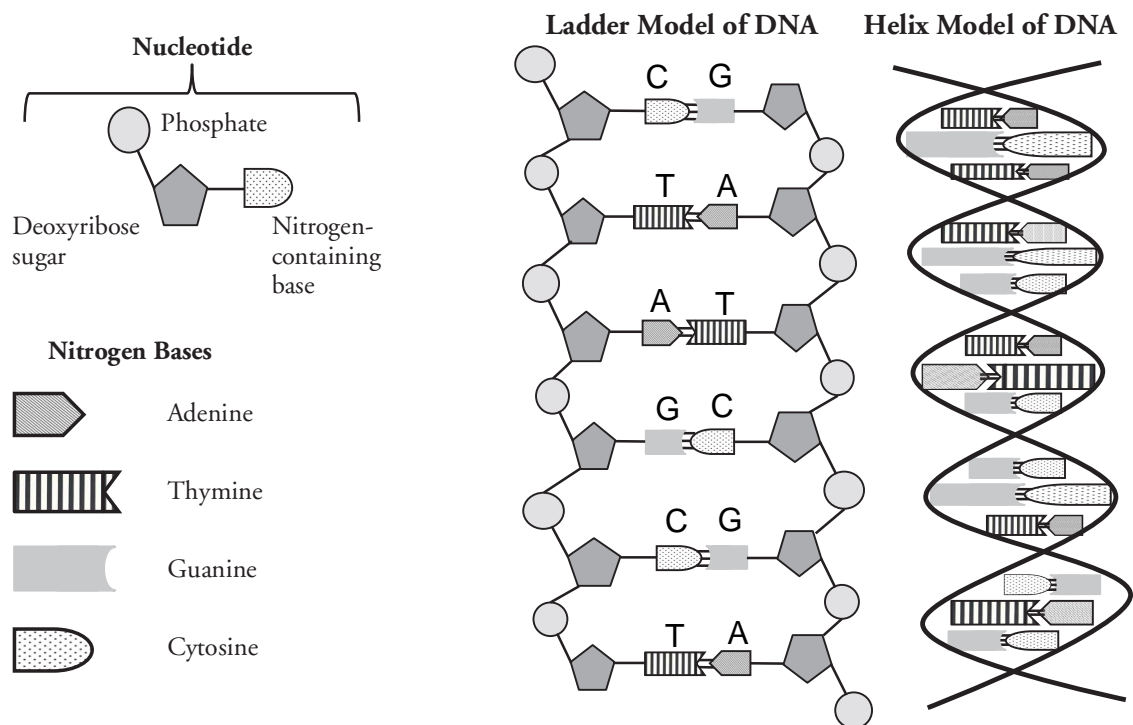
# DNA Structure and Replication

How is genetic information stored and copied?

## Why?

Deoxyribonucleic acid or **DNA** is the molecule of heredity. It contains the genetic blueprint for life. For organisms to grow and repair damaged cells, each cell must be capable of accurately copying itself. So how does the structure of DNA allow it to copy itself so accurately?

## Model 1 – The Structure of DNA



1. Refer to the diagram in Model 1.

a. What are the three parts of a nucleotide?

Deoxyribose sugar, phosphate and nitrogen-containing base.

b. What kind of sugar is found in a nucleotide?

Deoxyribose

c. Which nucleotide component contains nitrogen?

The base

d. Name the four nitrogen bases shown in Model 1.

Adenine (A), thymine (T), guanine (G) and cytosine (C)

2. DNA is often drawn in a “ladder model.” Locate this drawing in Model 1.

a. Circle a single nucleotide on each side of the ladder model of DNA.

Two complete nucleotides should be circled, each containing the base, sugar and phosphate group.

- b. What part(s) of the nucleotides make up the rungs of the “ladder”?

**Nitrogen bases**

- c. What parts of the nucleotides make up the sides (backbone) of the “ladder”?

**Sugar and phosphate**

- d. Look at the bottom and top of the “ladder” in Model 1. Are the rungs **parallel** (the ends of the strands match) or **antiparallel** (the ends of the strands are opposites)?

**The strands are antiparallel**

3. On the ladder model of DNA label each of the bases with the letter A, T, C or G.



4. Refer to Model 1. When one nucleotide contains adenine, what type of base is the adenine attached to on the opposite nucleotide strand?

**Thymine**

5. The two strands of DNA are held together with **hydrogen bonds** between the nitrogen bases. These are weak bonds between polar molecules. How many hydrogen bonds connect the two bases from Question 4?



**Two**

6. Refer to Model 1. When one nucleotide contains cytosine, what type of base is the cytosine attached to on the opposite nucleotide strand?

**Guanine**

7. How many hydrogen bonds connect the two bases from Question 6?

**Three**

8. With your group, use a complete sentence to write a rule for how the bases are arranged in the ladder model of DNA.

**A pairs with T and C pairs with G**



## Read This!

Erwin Chargaff (1905–2002), an Austrian-American biochemist, investigated the ratio of nucleotide bases found in the DNA from a variety of organisms. From his research, as well as research by Rosalind Franklin and Maurice Wilkins, Watson and Crick developed the **complementary base-pair** rule during their race to discover the structure of DNA. The complementary base-pair rule states that adenine and thymine form pairs across two strands, and guanine and cytosine form pairs across two strands.

9. Fill in the **complementary** bases on the strand below according to the base-pair rule.

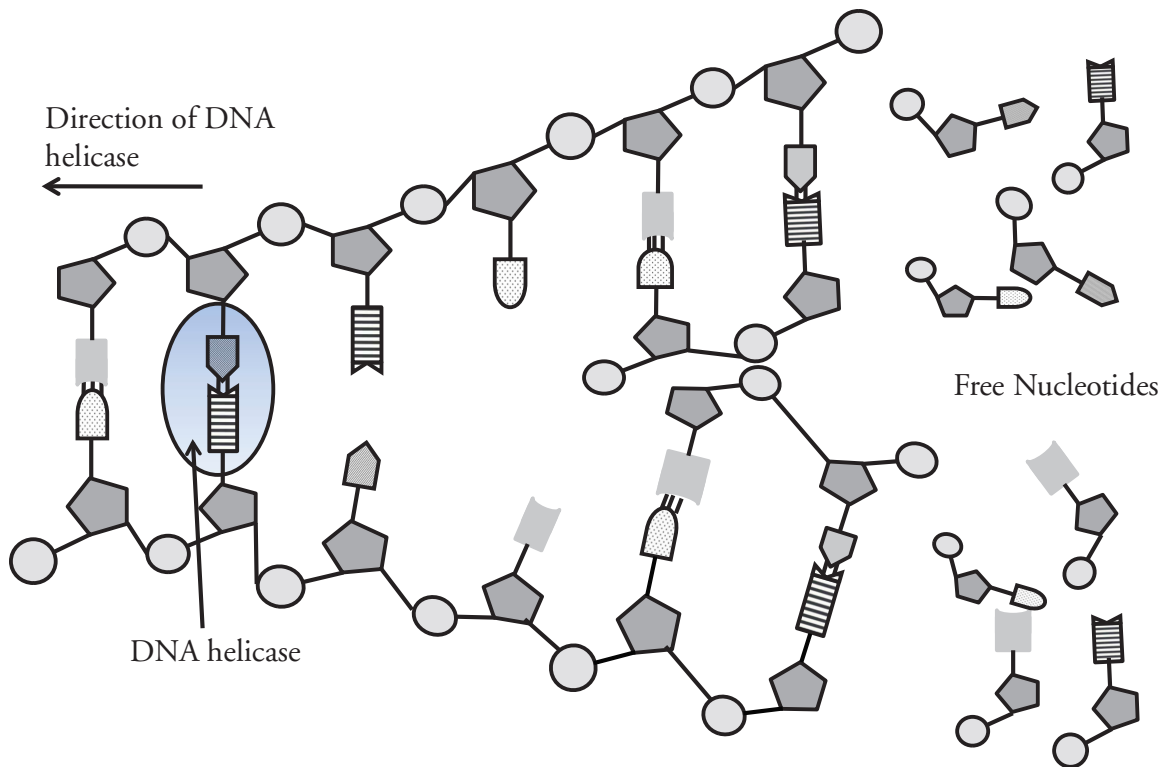
A	T	C	C	A	G
T	A	G	G	T	C

10. The ladder model of DNA is a simplified representation of the actual structure and shape of a DNA molecule. In reality, the strands of DNA form a **double helix**. Refer to the double helix diagram in Model 1 and describe its shape using a complete sentence.



**A double helix has two strands coiled around each other.**

## Model 2 – DNA Replication



11. Examine Model 2. Number the steps below in order to describe the replication of DNA in a cell.

- 4 Hydrogen bonds between nucleotides form.
- 1 Hydrogen bonds between nucleotides break.
- 2 Strands of DNA separate.
- 3 Free nucleotides are attracted to exposed bases on the loose strands of DNA.

12. Locate the DNA helicase on Model 2.

a. What type of biological molecule is DNA helicase?

An enzyme

b. What is the role of DNA helicase in the replication of DNA?

To unwind and separate the DNA strands.

13. What rule is used to join the free nucleotides to the exposed bases of the DNA?

The complementary base-pair rule (A-T; C-G).



14. This type of replication is called **semi-conservative replication**. Considering the meaning of these words (semi—half; conserve—to keep), explain why DNA replication is called semi-conservative.

During replication, half of the original molecule is kept and the other half is synthesized from free nucleotides.

15. DNA molecules can be tens of thousands of base pairs in length. Mistakes in DNA replication lead to mutations, which may or may not be harmful to an organism. How does semi-conservative replication help prevent mutations during DNA replication?

One half of the original molecule is kept and the new strand is made from free nucleotides, which can only join according to the complementary base-pair rule, so it lessens the likelihood that the wrong nucleotide sequences is created.

16. The proportions of the bases are consistent within a species; however they do vary between species. Using the base-pair rules, complete the following table to show the percentage of each type of base in the five different organisms.

Organism	Percentage of each type of base			
	Adenine	Guanine	Cytosine	Thymine
Human	31	19	19	31
Cow	28	22	22	28
Salmon	29	21	21	29
Wheat	27	23	23	27
Yeast	31	19	19	31

