

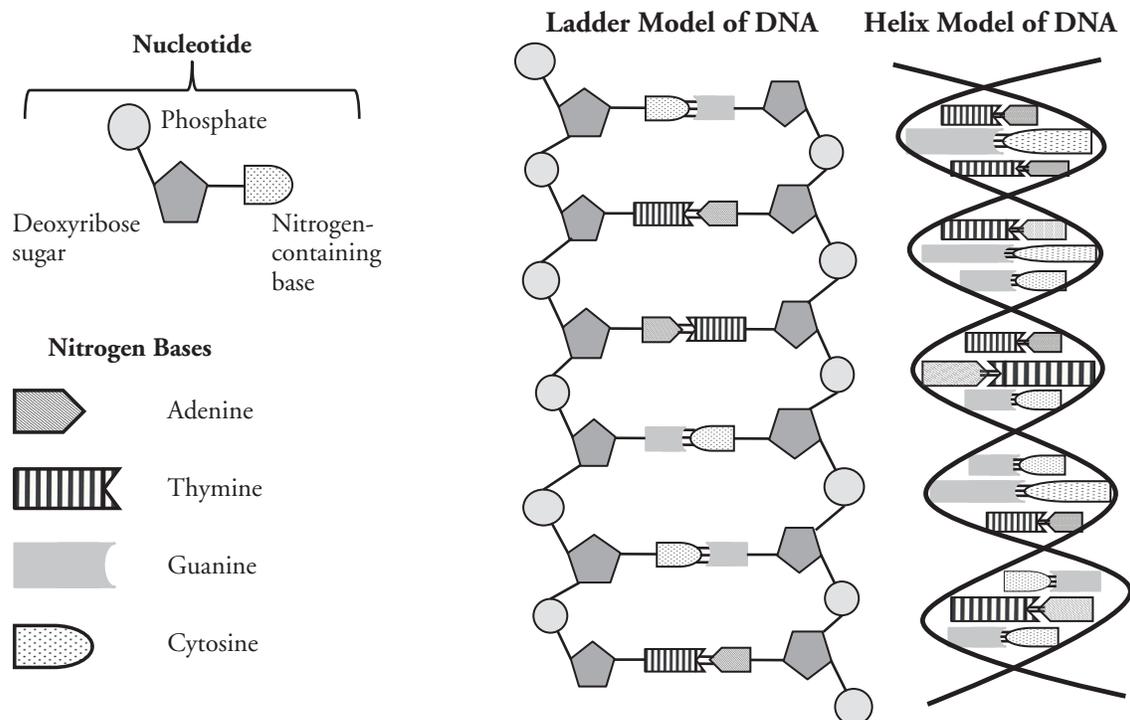
# DNA Structure and Replication

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?
  - b. What kind of sugar is found in a nucleotide?
  - c. Which nucleotide component contains nitrogen?
  - d. Name the four nitrogen bases shown in Model 1.
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.

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



6. Refer to Model 1. When one nucleotide contains cytosine, what type of base is the cytosine attached to on the opposite nucleotide strand?
7. How many hydrogen bonds connect the two bases from Question 6?
8. With your group, use a complete sentence to write a rule for how the bases are arranged in the ladder model of DNA.



## Read This!

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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.

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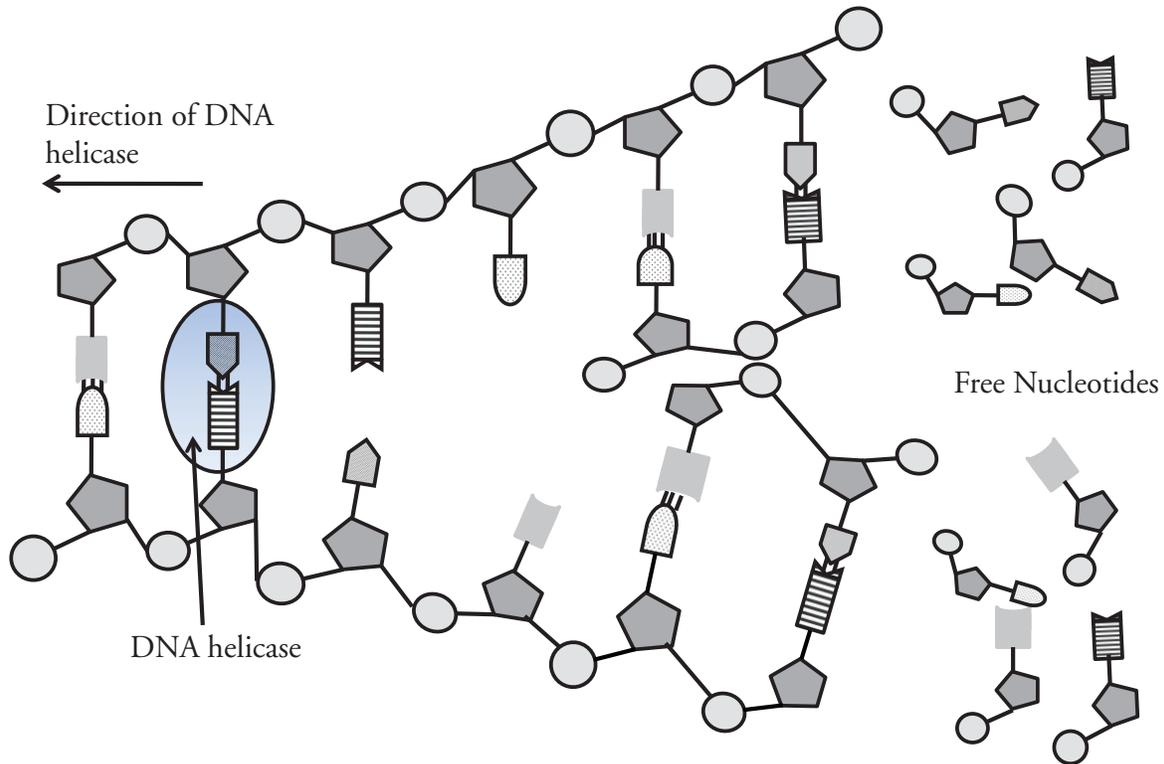
9. Fill in the **complementary** bases on the strand below according to the base-pair rule.

A    T    C    C    A    G

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.



## Model 2 – DNA Replication



11. Examine Model 2. Number the steps below in order to describe the replication of DNA in a cell.
  - \_\_\_\_\_ Hydrogen bonds between nucleotides form.
  - \_\_\_\_\_ Hydrogen bonds between nucleotides break.
  - \_\_\_\_\_ Strands of DNA separate.
  - \_\_\_\_\_ 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?
  - b. What is the role of DNA helicase in the replication of DNA?
13. What rule is used to join the free nucleotides to the exposed bases of the DNA?
-  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.

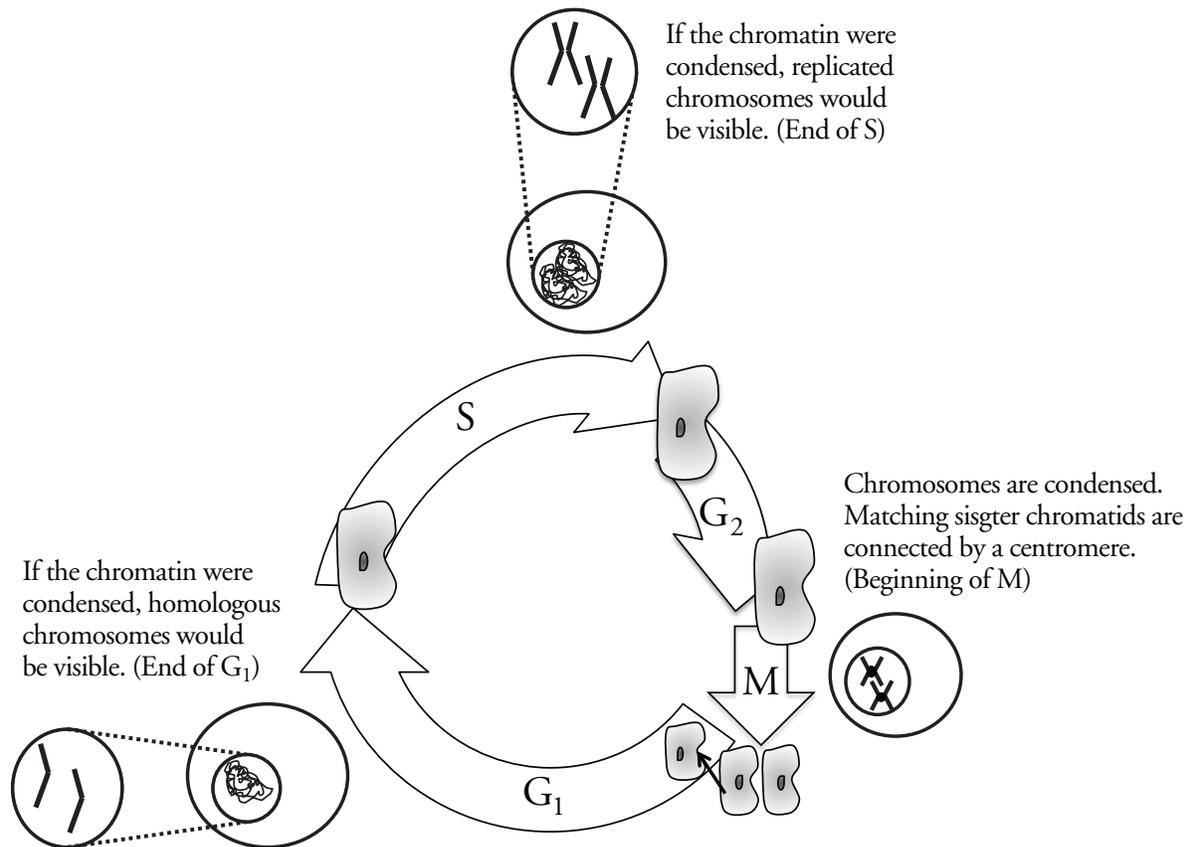
15. DNA molecules can be tens of thousands of base pairs in length. Mistakes in DNA replication lead to mutations, which may or may not be harmful to an organism. How does semi-conservative replication help prevent mutations during DNA replication?
16. The proportions of the bases are consistent within 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	
Cow	28	22		
Salmon			21	29
Wheat	27			
Yeast	31	19		



## Extension Questions

### Model 3 – Timing of DNA Replication



17. According to Model 3, what term refers to loose DNA inside of a nucleus?
18. During what part of the cell cycle is the DNA in a cell's nucleus replicated?
19. During what part of the cell cycle is the DNA in a cell condensed into chromosomes?
20. Replicated chromosomes are often illustrated as an X shape to match how they look in real life just before cell division.
  - a. According to Model 3, which of the following diagrams correctly show an original set of homologous chromosomes (grey) and their sister chromatids (black)—the replicated portion?



- b. What structure holds the two sister chromatids together as they prepare for cell division?