**DNA Replication**

**Introduction:**

Biologists in the 1940s had difficulty in accepting [DNA](https://www.ncbi.nlm.nih.gov/books/n/mboc4/A4754/def-item/A5084/) as the genetic material because of the apparent simplicity of its chemistry. DNA was known to be a long [polymer](https://www.ncbi.nlm.nih.gov/books/n/mboc4/A4754/def-item/A5655/) composed of only four types of subunits, which resemble one another chemically. Early in the 1950s, DNA was first examined by x-ray diffraction analysis, a technique for determining the three-dimensional atomic structure of a [molecule](https://www.ncbi.nlm.nih.gov/books/n/mboc4/A4754/def-item/A5486/) (discussed in Chapter 8). The early x-ray diffraction results indicated that DNA was composed of two strands of the polymer wound into a helix. The observation that DNA was double-stranded was of crucial significance and provided one of the major clues that led to the Watson-Crick structure of DNA. Only when this model was proposed did DNA's potential for replication and information encoding become apparent. In this [section](https://www.ncbi.nlm.nih.gov/books/n/mboc4/A4754/def-item/A5785/) we examine the structure of the DNA molecule and explain in general terms how it is able to store hereditary information.

**A DNA Molecule Consist of Two Complementary Chains Of Nucleotides:**

A [DNA](https://www.ncbi.nlm.nih.gov/books/n/mboc4/A4754/def-item/A5084/) [molecule](https://www.ncbi.nlm.nih.gov/books/n/mboc4/A4754/def-item/A5486/) consists of two long polynucleotide chains composed of four types of [nucleotide](https://www.ncbi.nlm.nih.gov/books/n/mboc4/A4754/def-item/A5567/) subunits. Each of these chains is known as a DNA chain, or a DNA strand. Hydrogen bonds between the [base](https://www.ncbi.nlm.nih.gov/books/n/mboc4/A4754/def-item/A4875/) portions of the nucleotides hold the two chains together.

**DNA replication:**

The [double helix](https://en.wikipedia.org/wiki/Double_helix) is unwound and each strand acts as a template (blue) for the next strand. [Bases](https://en.wikipedia.org/wiki/Nucleotides) are matched to synthesize the new partner strands (green).

In [molecular biology](https://en.wikipedia.org/wiki/Molecular_biology), DNA replication is the biological process of producing two identical replicas of DNA from one original [DNA](https://en.wikipedia.org/wiki/DNA) molecule. This process occurs in all [living organisms](https://en.wikipedia.org/wiki/Life) and is the basis for [biological inheritance](https://en.wikipedia.org/wiki/Heredity). DNA is made up of a [double helix](https://en.wikipedia.org/wiki/Nucleic_acid_double_helix) of two complementary strands. During replication, these strands are separated. Each strand of the original DNA molecule then serves as a template for the production of its counterpart, a process referred to as [semiconservative replication](https://en.wikipedia.org/wiki/Semiconservative_replication). Cellular [proofreading](https://en.wikipedia.org/wiki/Proofreading_%28Biology%29) and error-checking mechanisms ensure near perfect fidelity for DNA replication.

In a [cell](https://en.wikipedia.org/wiki/Cell_%28biology%29), DNA replication begins at specific locations, or [origins of replication](https://en.wikipedia.org/wiki/Origin_of_replication), in the [genome](https://en.wikipedia.org/wiki/Genome). Unwinding of DNA at the origin and synthesis of new strands results in [replication forks](https://en.wikipedia.org/wiki/Replication_fork) growing bi-directionally from the origin. A number of [proteins](https://en.wikipedia.org/wiki/Protein) are associated with the replication fork to help in the initiation and continuation of DNA synthesis. Most prominently, [DNA polymerase](https://en.wikipedia.org/wiki/DNA_polymerase)synthesizes the new strands by adding [nucleotides](https://en.wikipedia.org/wiki/Nucleotides) that complement each (template) strand. DNA replication occurs during the S-stage of [interphase](https://en.wikipedia.org/wiki/Interphase).

DNA replication can also be performed [in vitro](https://en.wikipedia.org/wiki/In_vitro) (artificially, outside a cell). DNA polymerases isolated from cells and artificial DNA primers can be used to initiate DNA synthesis at known sequences in a template DNA molecule. The [polymerase chain reaction](https://en.wikipedia.org/wiki/Polymerase_chain_reaction) (PCR), a common laboratory technique, cyclically applies such artificial synthesis to amplify a specific target DNA fragment from a pool of DNA.

[](https://en.wikipedia.org/wiki/File:DNA_replication_split.svg)

**DNA structures:**

DNA usually exists as a double-stranded structure, with both strands coiled together to form the characteristic [double-helix](https://en.wikipedia.org/wiki/Double-helix). Each single strand of DNA is a chain of four types of [nucleotides](https://en.wikipedia.org/wiki/Nucleotide). Nucleotides in DNA contain a [deoxyribose](https://en.wikipedia.org/wiki/Deoxyribose) sugar, a [phosphate](https://en.wikipedia.org/wiki/Phosphate), and a [nucleobase](https://en.wikipedia.org/wiki/Nucleobase). The four types of [nucleotide](https://en.wikipedia.org/wiki/Nucleotide) correspond to the four [nucleobase](https://en.wikipedia.org/wiki/Nucleobase)[adenine](https://en.wikipedia.org/wiki/Adenine), [cytosine](https://en.wikipedia.org/wiki/Cytosine), [guanine](https://en.wikipedia.org/wiki/Guanine), and [thymine](https://en.wikipedia.org/wiki/Thymine), commonly abbreviated as A,C, G and T. Adenine and guanine are [purine](https://en.wikipedia.org/wiki/Purine) bases, while cytosine and thymine are [pyrimidine](https://en.wikipedia.org/wiki/Pyrimidine). These nucleotides form [phosphodiester bonds](https://en.wikipedia.org/wiki/Phosphodiester_bonds), creating the phosphate-de-oxyribose backbone of the DNA double helix with the nuclei bases pointing inward (i.e., toward the opposing strand). Nucleotides (bases) are matched between strands through [hydrogen bonds](https://en.wikipedia.org/wiki/Hydrogen_bonding) to form [base pairs](https://en.wikipedia.org/wiki/Base_pair). Adenine pairs with thymine (two hydrogen bonds),

strands of the double helix are anti-parallel with one being 5' to 3', and the opposite strand 3' to 5'. These terms refer to the carbon atom in deoxyribose to which the next phosphate in the chain attaches. Directionality has consequences in DNA synthesis, because DNA polymerase can synthesize DNA in only one direction by adding nucleotides to the 3' end of a DNA strand.

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