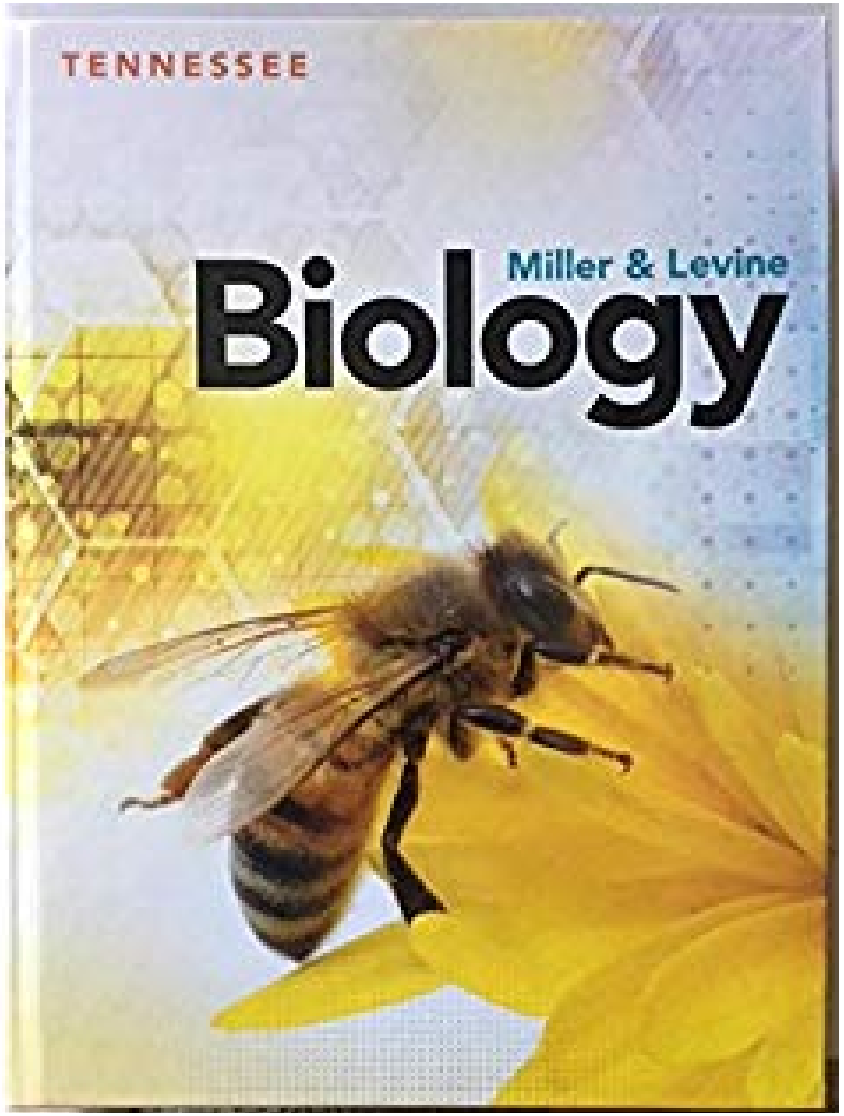


13.3 DNA Replication

Copying the Code

Base pairing in the double helix explained how DNA could be copied, or replicated, because each base on one strand pairs with only one base on the opposite strand.

Each strand of the double helix has all the information needed to reconstruct the other half by the mechanism of base pairing.

Because each strand can be used to make the other strand, the strands are said to be complementary.

The Replication Process

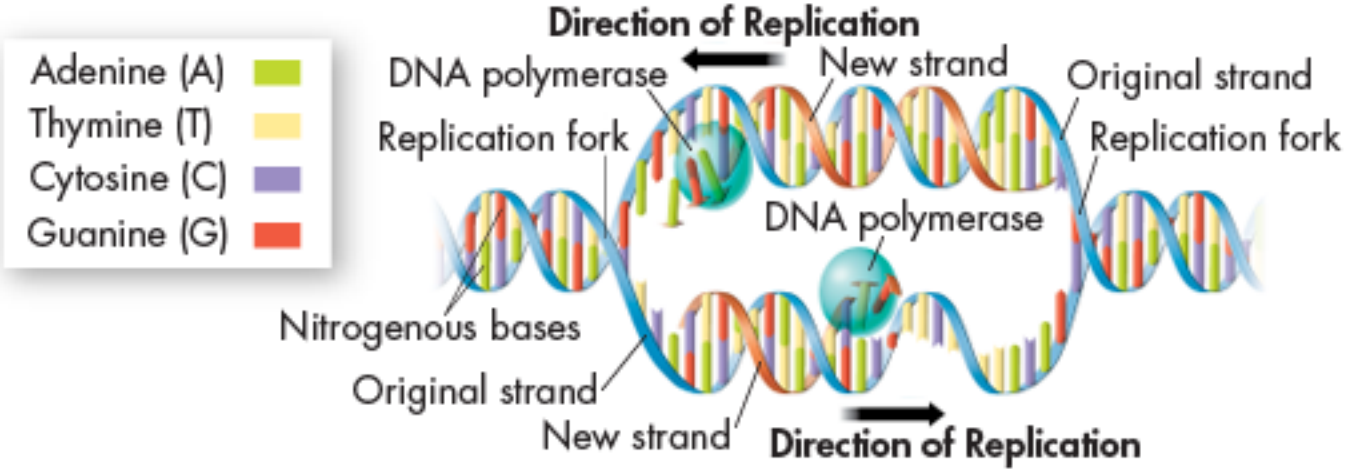
Before a cell divides, it duplicates its DNA in a copying process called **replication**.

This process ensures that each resulting cell has the same complete set of DNA molecules.

The Replication Process

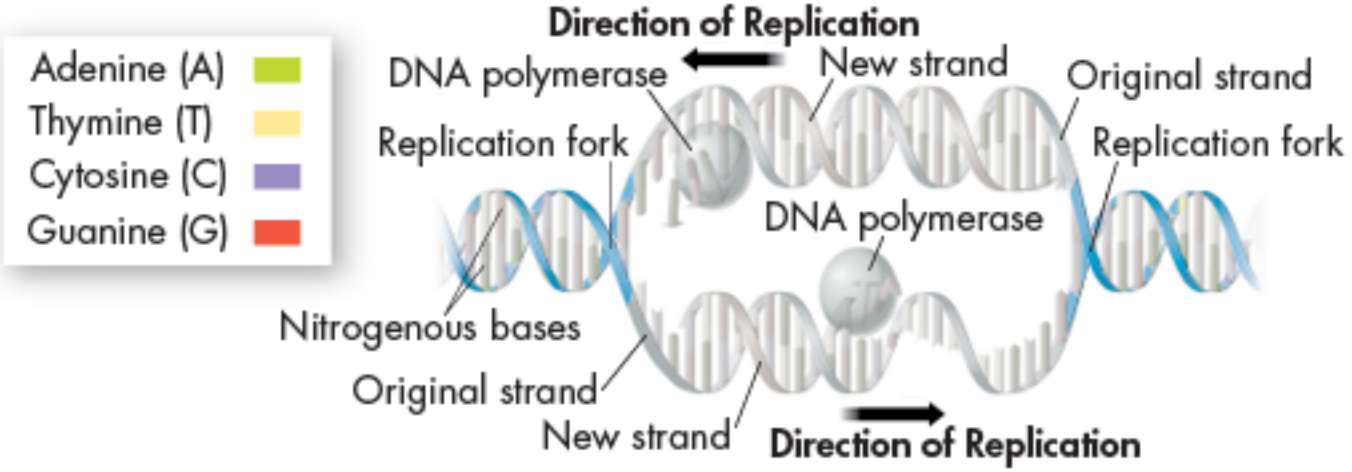
During replication, the DNA molecule separates into two strands and then produces two new complementary strands following the rules of base pairing.

Each strand of the double helix of DNA serves as a template, or model, for the new strand.



The Replication Process

The two strands of the double helix separate, or “unzip,” allowing two replication forks to form.

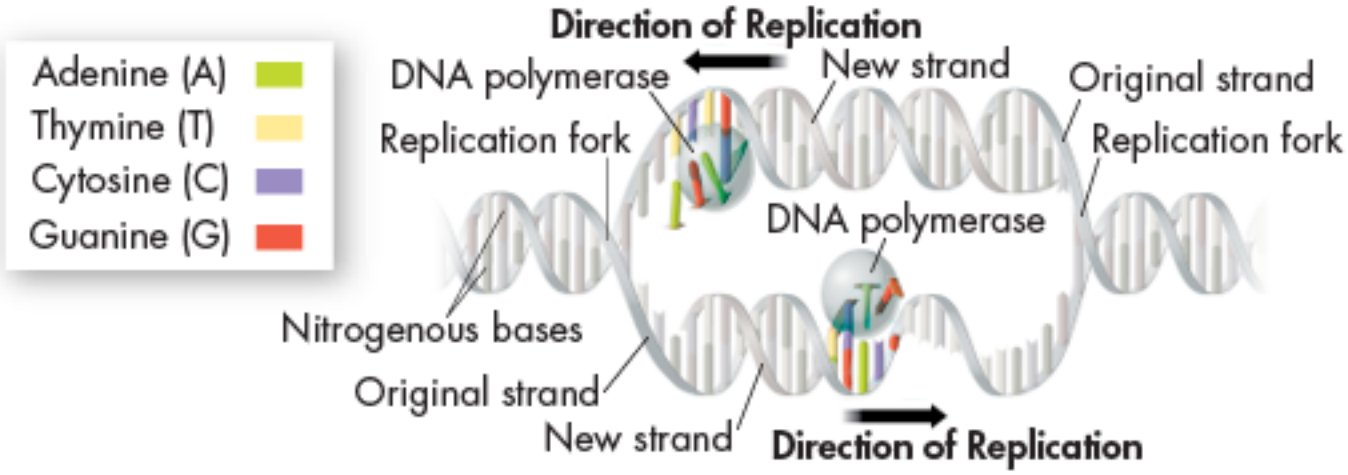


The Replication Process

As each new strand forms, new bases are added following the rules of base pairing.

If the base on the old strand is adenine, then thymine is added to the newly forming strand.

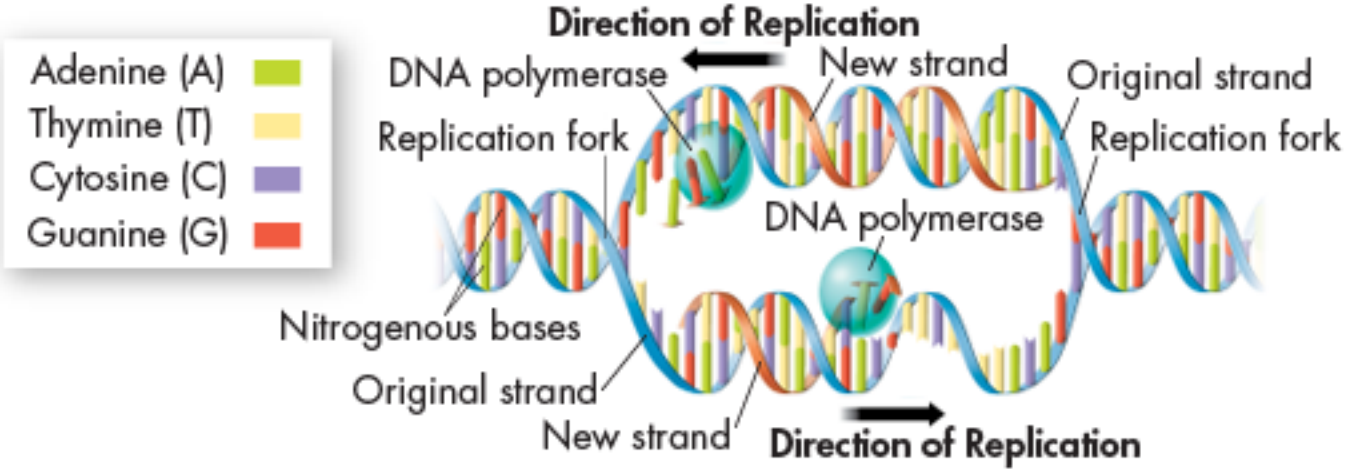
Likewise, guanine is always paired to cytosine.



The Replication Process

The result of replication is two DNA molecules identical to each other and to the original molecule.

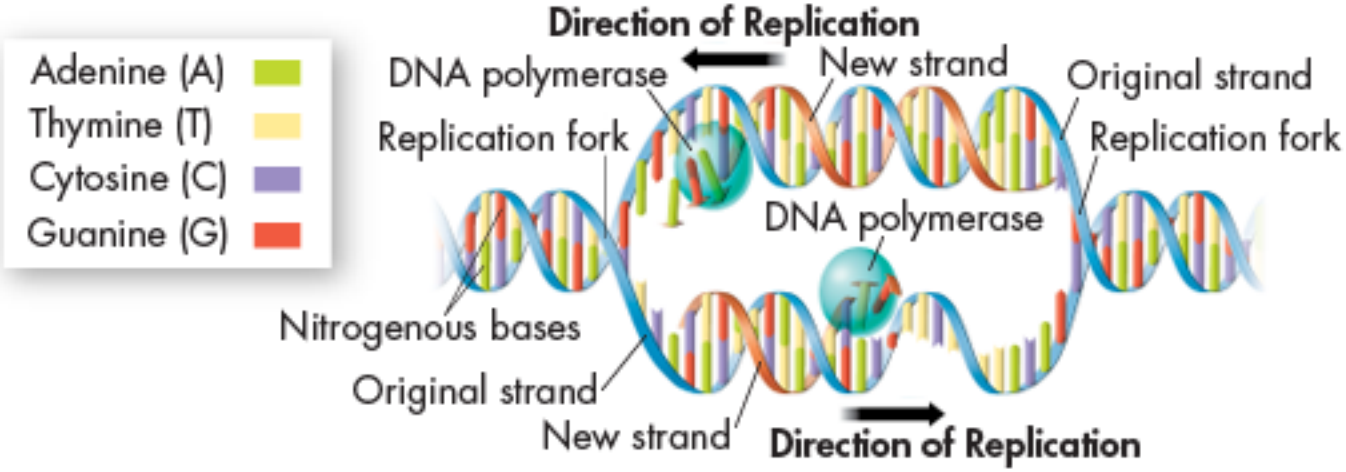
Each DNA molecule resulting from replication has one original strand and one new strand.



The Role of Enzymes

DNA replication is carried out by a series of enzymes. **Helicase** is the enzyme that "unzips" a molecule of DNA by breaking the hydrogen bonds between base pairs and unwinding the two strands of the molecule.

Each strand then serves as a template for the attachment of complementary bases.

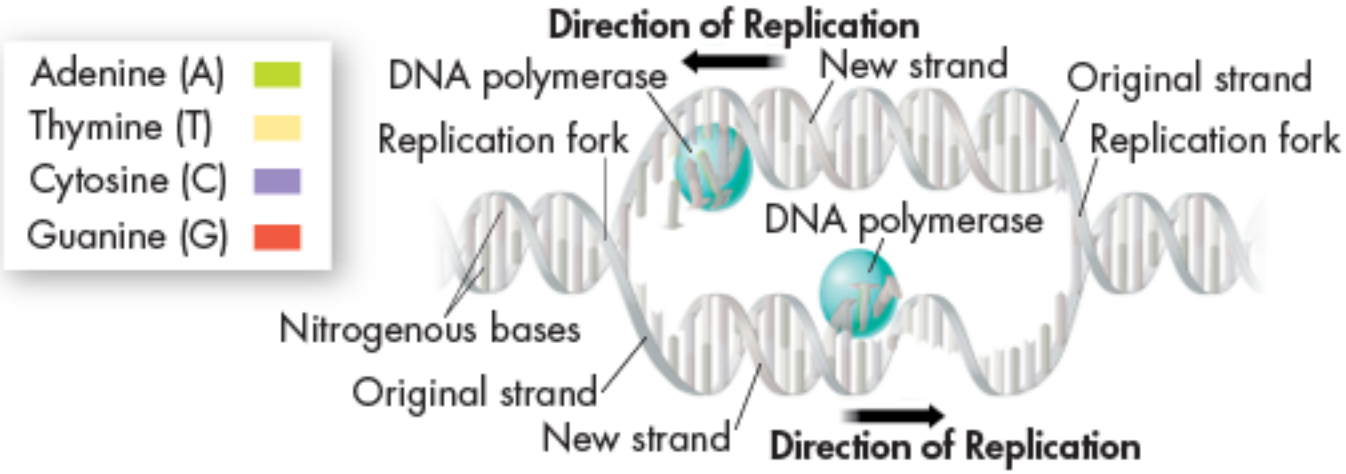


The Role of Enzymes

The principal enzyme involved in DNA replication is called **DNA polymerase.**

DNA polymerase is an enzyme that joins individual nucleotides to produce a new strand of DNA.

DNA polymerase also “proofreads” each new DNA strand, ensuring that each molecule is a perfect copy of the original.



Telomeres

The tips of chromosomes are known as **telomeres**.

The ends of DNA molecules, located at the telomeres, are particularly difficult to copy.

Over time, DNA may actually be lost from telomeres each time a chromosome is replicated.

An enzyme called telomerase compensates for this problem by adding short, repeated DNA sequences to telomeres, lengthening the chromosomes slightly and making it less likely that important gene sequences will be lost from the telomeres during replication.

Replication in Living Cells

- How does DNA replication differ in prokaryotic cells and eukaryotic cells?

- Replication in most **prokaryotic** cells starts from a **single point** and proceeds in **two directions** until the entire chromosome is copied.

  In **eukaryotic** cells, replication may **begin at dozens or even hundreds** of places on the DNA molecule, proceeding **in both directions** until each chromosome is completely copied

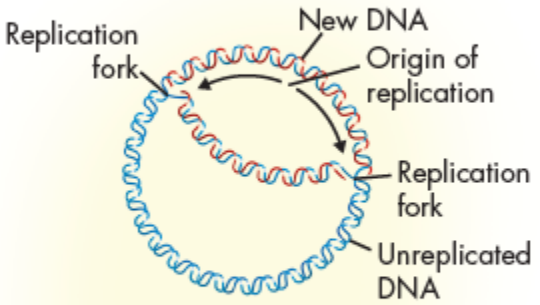
The cells of most **prokaryotes** have a **single, circular DNA** molecule in the cytoplasm, containing nearly all the cell's genetic information.

Eukaryotic cells, on the other hand, can have up to 1000 times **more DNA** that is arranged **in linear form**. Nearly all of the DNA of eukaryotic cells is found in the nucleus

Prokaryotic DNA Replication

In most prokaryotes, DNA replication does not start until regulatory proteins bind to a single starting point on the chromosome. This triggers the beginning of DNA replication.

Replication in most prokaryotic cells starts from a single point and proceeds in two directions until the entire chromosome is copied.



Prokaryotic DNA

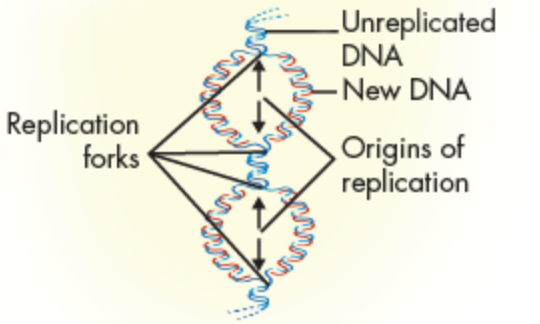
Prokaryotic DNA Replication

Often, the two chromosomes produced by replication are attached to different points inside the cell membrane and are separated when the cell splits to form two new cells.

Eukaryotic DNA Replication

Eukaryotic chromosomes are generally much bigger than those of prokaryotes.

In eukaryotic cells, replication may begin at dozens or even hundreds of places on the DNA molecule, proceeding in both directions until each chromosome is completely copied.



Eukaryotic DNA

Eukaryotic DNA Replication

The two copies of DNA produced by replication in each chromosome remain closely associated until the cell enters prophase of mitosis.

At that point, the chromosomes condense, and the two chromatids in each chromosome become clearly visible.

They separate from each other in anaphase of mitosis, producing two cells, each with a complete set of genes coded in DNA.