3.4B: The DNA Double Helix

The DNA double helix looks like a twisted staircase, with the sugar and phosphate backbone surrounding complementary nitrogen bases.

Learning Objectives

- Describe the structure of DNA

Key Points

- The structure of DNA is called a double helix, which looks like a twisted staircase.
- The sugar and phosphate make up the backbone, while the nitrogen bases are found in the center and hold the two strands together.
- The nitrogen bases can only pair in a certain way: A pairing with T and C pairing with G. This is called base pairing.
- Due to the base pairing, the DNA strands are complementary to each other, run in opposite directions, and are called antiparallel strands.

Key Terms

- **mutation**: any error in base pairing during the replication of DNA
- **sugar-phosphate backbone**: The outer support of the ladder, forming strong covalent bonds between monomers of DNA.
- **base pairing**: The specific way in which bases of DNA line up and bond to one another; A always with T and G always with C.
A Double-Helix Structure

DNA has a double-helix structure, with sugar and phosphate on the outside of the helix, forming the sugar-phosphate backbone of the DNA. The nitrogenous bases are stacked in the interior in pairs, like the steps of a staircase; the pairs are bound to each other by hydrogen bonds. The two strands of the helix run in opposite directions. This antiparallel orientation is important to DNA replication and in many nucleic acid interactions.

Figure \(\PageIndex{1}\): DNA is a Double Helix: Native DNA is an antiparallel double helix. The phosphate backbone (indicated by the curvy lines) is on the outside, and the bases are on the inside. Each base from one strand interacts via hydrogen bonding with a base from the opposing strand.

Base Pairs

Only certain types of base pairing are allowed. This means Adenine pairs with Thymine, and Guanine pairs with Cytosine. This is known as the base complementary rule because the DNA strands are complementary to each other. If the sequence of one strand is AATTGGCC, the complementary strand would have the sequence TTAACCGG.
Antiparallel Strands: In a double stranded DNA molecule, the two strands run antiparallel to one another so one is upside down compared to the other. The phosphate backbone is located on the outside, and the bases are in the middle. Adenine forms hydrogen bonds (or base pairs) with thymine, and guanine base pairs with cytosine.

DNA Replication

During DNA replication, each strand is copied, resulting in a daughter DNA double helix containing one parental DNA strand and a newly synthesized strand. At this time it is possible a mutation may occur. A mutation is a change in the sequence of the nitrogen bases. For example, in the sequence AATTGGCC, a mutation may cause the second T to change to a G. Most of the time when this happens the DNA is able to fix itself and return the original base to the sequence. However, sometimes the repair is unsuccessful, resulting in different proteins being created.