Nucleic Acids: Informational Polymers

- The amino acid sequence of a polypeptide is programmed by a **gene**.
- A gene consists of regions of DNA, a polymer of **nucleic acids**.
- DNA (and their genes) is passed by the mechanisms of inheritance.

- Each gene along a DNA molecule directs the synthesis of a specific type of messenger RNA molecule (mRNA).
- The mRNA interacts with the protein-synthesizing machinery to direct the ordering of amino acids in a polypeptide.
- Proteins are responsible for implementing the instructions contained in DNA.
- The flow of genetic information is from DNA ➔ RNA ➔ protein.
  - Protein synthesis occurs in cellular structures called ribosomes.
  - In eukaryotes, DNA is located in the nucleus, but most ribosomes are in the cytoplasm with mRNA as an intermediary.

A nucleic acid strand is a polymer of nucleotides

- Nucleic acids are polymers of monomers called **nucleotides.**
- Each nucleotide consists of three parts: ***a nitrogen base***, ***a pentose sugar***, and ***a phosphate group***.

- The nitrogen bases, rings of carbon and nitrogen, come in two types: ***purines*** and ***pyrimidines.***
  - Pyrimidines have a single six-membered ring.
  - The three different pyrimidines, cytosine (C), thymine (T), and uracil (U) differ in atoms attached to the ring.
  - Purines have a six-membered ring joined to a five-membered ring.
  - The two purines are adenine (A) and guanine (G).
- The pentose joined to the nitrogen base is **ribose** in nucleotides of RNA and **deoxyribose** in DNA.
  - The only difference between the sugars is the lack of an oxygen atom on carbon two in deoxyribose.
  - The combination of a pentose and nucleic acid is a nucleoside.
- The addition of a phosphate group creates a nucleoside monophosphate or nucleotide.

- Polynucleotides are synthesized by connecting the sugars of one nucleotide to the phosphate of the next with a phosphodiester link (a covalent bond).
- This creates a repeating backbone of sugar-phosphate units with the nitrogen bases as appendages.

Inheritance is based on replication of the DNA double helix

- An RNA molecule is single polynucleotide chain.
- DNA molecules have two polynucleotide strands that spiral around an imaginary axis to form a **double helix.**

  - The double helix was first proposed as the structure of DNA in 1953 by James Watson and Francis Crick.
- The sugar-phosphate backbones of the two polynucleotides are on the outside of the helix.
- Pairs of nitrogenous bases, one from each strand, connect the polynucleotide chains with hydrogen bonds.
- Most DNA molecules have thousands to millions of base pairs.

- Because of their shapes, only some bases are compatible with each other.
  - Adenine (A) always pairs with thymine (T) and guanine (G) with cytosine (C).
  - In RNA, Adenine (A) pairs with uracil (U)
- With these base-pairing rules, if we know the sequence of bases on one strand, we know the sequence on the opposite strand.
- The two strands are ***complementary***.