# Proteins
# Many Structures, Many Functions

- **Proteins -** instrumental in about everything that an organism does.
  - **Functions include:
    structural support
    storage
    transport of other substances
    intercellular signaling
    movement
    defense against foreign substances.
  - Enzymes are proteins:
    regulate metabolism by selectively accelerating chemical reactions.
- Humans have tens of thousands of different proteins, each with their own structure and function.
- Proteins are the most structurally complex molecules known.
  - Each type of protein has a complex three-dimensional shape or conformation.
- All protein polymers are constructed from the same set of 20 monomers, called ***amino acids***.
- Polymers of proteins are called ***polypeptides***.
- A protein consists of one or more polypeptides folded and coiled into a specific conformation.

## A polypeptide is a polymer of amino acids connected in a specific sequence

- **Amino acids** consist of four components attached to a central carbon, the *alpha carbon*.
- These components include a hydrogen atom, a carboxyl group, an amino group, and a variable R group (or side chain).
  - Differences in R groups produce the 20 different amino acids.
- One group of amino acids has hydrophobic R groups *Why are these groups hydrophobic*?????.
- Amino acids are joined together by dehydration synthesis
  - The resulting covalent bond is called a **peptide bond**.

A protein's function depends
on its specific conformation

- Repeating the process over and over creates a long polypeptide chain.
  - At one end is an amino acid with a free ***amino group*** the (the N-terminus) and at the other is an amino acid with a free ***carboxyl group*** the (the C-terminus).
- The repeated sequence (N-C-C) is the polypeptide backbone.
- Attached to the backbone are the various R groups.
- Polypeptides range in size from a few monomers to thousands.

- A protein's specific conformation determines its function.
- ***In almost every case***, the function depends on its ability to recognize and bind to some other molecule.
- The folding of a protein from a chain of amino acids occurs spontaneously.
- Three levels of structure: ***primary, secondary, and tertiary*** structure, are used to organize the folding within a single polypeptide.
- ***Quarternary*** structure arises when two or more polypeptides join to form a protein.

- The **secondary structure** of a protein results from the coiling and/or folding of polypeptide chains due to hydrogen bonding between peptide linkages
  - Typical shapes that develop from secondary structure are coils (an alpha helix) or folds (beta pleated sheets).

- **Tertiary structure – the 3D shape of a protein -** determined by a variety of interactions among R groups and between R groups and the polypeptide backbone.
  - Weak hydrophobic interactions between non polar side chains
  - Weak H bonds
  - Weak ionic bonds
  - Disulfide bridges (S – S) – strong covalent bond between 2 cysteine monomers brought together by folding – stabilize the protein

- A protein's conformation can change in response to the physical and chemical conditions.
- Alterations in pH, salt concentration, temperature, or other factors can unravel or **denature** a protein.
  - These forces disrupt the hydrogen bonds, ionic bonds, and disulfide bridges that maintain the protein's shape.
- Some proteins can return to their functional shape after denaturation, but others cannot, especially in the crowded environment of the cell.