

Tutorial 23: Proteins

Goals:

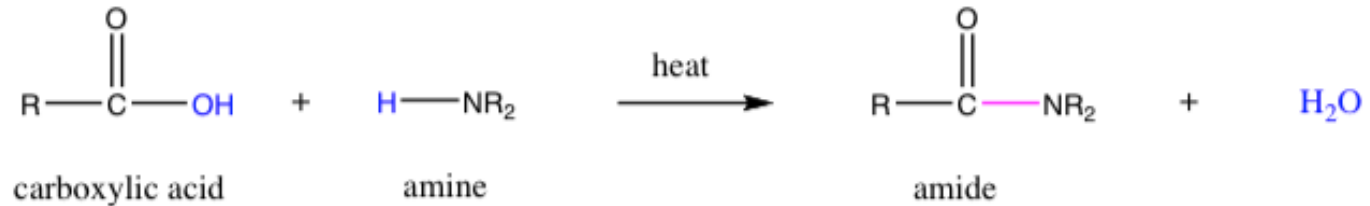
- ✓ To understand how amide bonds are formed and hydrolyzed.
- ✓ To be able to describe and draw the general structure of an amino acid.
- ✓ To be able to classify amino acid side groups as polar or nonpolar.
- ✓ To understand the general roles of proteins in the body.
- ✓ To be able to describe the structure of proteins, including the primary, secondary, tertiary and quaternary structures.
- ✓ To understand how proteins can be denatured and lose biological function.

Proteins

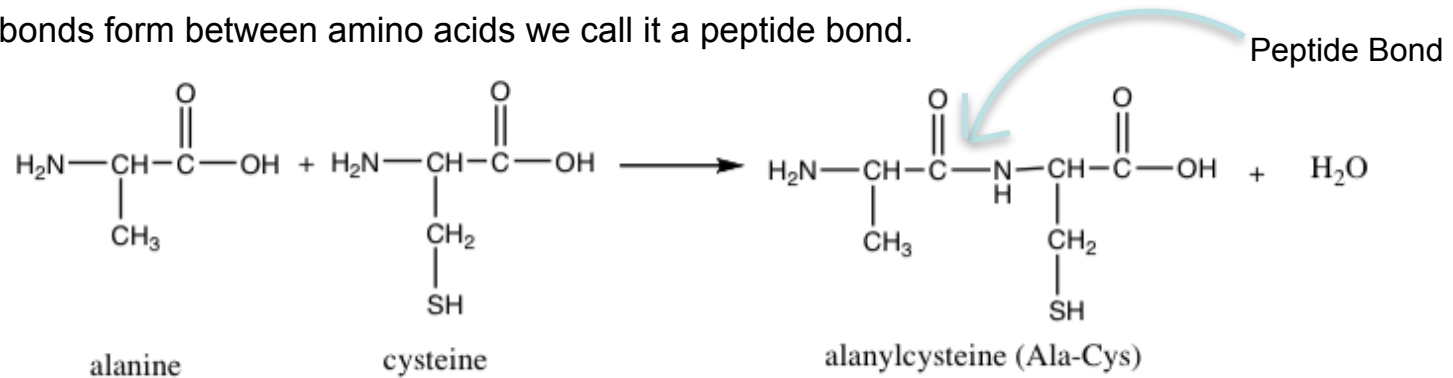
- Roles of proteins:
 - Almost all enzymes are proteins
 - Many hormones are proteins or peptides
 - Proteins form structural tissue
 - Storage and transportation of many molecules is possible due to proteins
 - The immune system uses specialized proteins to identify and attack foreign invaders such as bacteria

Amide Bond Formation

- Amide bonds form upon reaction of carboxylic acids with ammonia, primary amines or secondary amines.



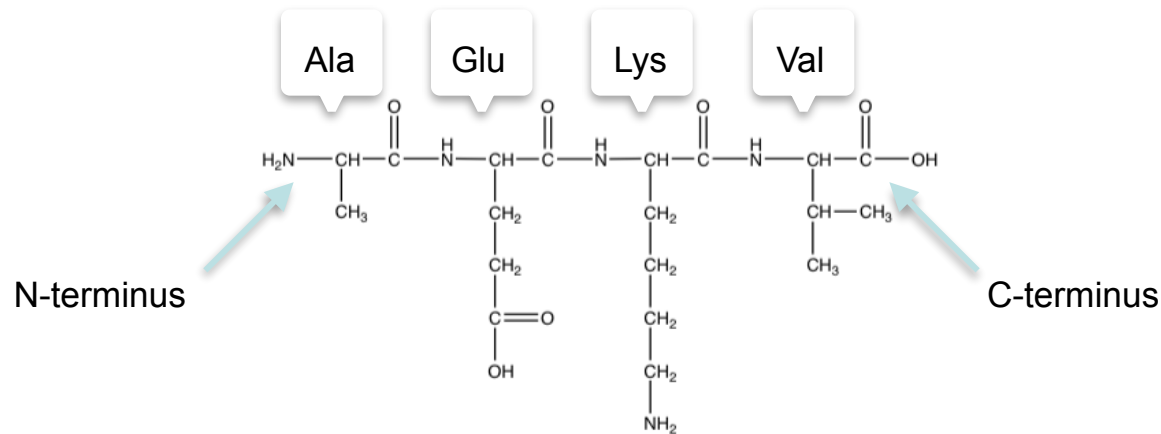
- When amide bonds form between amino acids we call it a peptide bond.



- Two amino acids link together to form a dipeptide. Multiple amino acids linked together form a polypeptide (also just called a peptide). Large polypeptides containing 50 or more amino acids linked together are called proteins.

Levels of Protein Structure

- **Primary Structure** refers to the sequence of amino acids in a protein chain held together by amide bonds (peptide bonds)



- **Secondary Structure** refers to the regular and repeating spatial organization of neighboring segments of protein chains (either the alpha-helix or the beta-sheet) stabilized by hydrogen bonding that occurs between the C=O and the N-H of backbone amino acids units.
- **Tertiary Structure** refers to the bending and folding of a protein. Stabilizing interactions involve the side groups of amino acids, and include noncovalent interactions such as: hydrogen bonding, ionic attractions (salt bridges), and hydrophobic interactions. A covalent bond known as a disulfide bond may form between two cysteine units in close proximity.
- **Quaternary Structure** refers to the clustering of different polypeptide or proteins chains. The separate chains are held together by the same type of noncovalent interactions and covalent bonds as were discussed for the tertiary structure.

Denaturation of Proteins

- When the secondary, tertiary and/or quaternary structure of a protein has changed so that the protein cannot perform its job as usual, we say it has been **denatured**.
- Note that denaturation does NOT change the primary structure. Loss of the primary structure is the result of hydrolysis of the peptide bonds.
- Causes of denaturation:
 - Heat and UV Radiation
 - Agitation
 - Detergents
 - Polar organic compounds
 - Changes in pH
 - Salts