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Topic: Proteins; Structure & classification

Proteins; Structure & classification

Proteins represent the structural composition of all living organisms. All living organisms, from the biggest animal to the most microscopic organisms, are mainly made up of proteins. Proteins contribute to the biochemical processes that preserve life.

Proteins are complex macromolecules (polymers). They have high molecular weight and are made up of structural units (monomers) called amino acids.

Amino acids are the protein's building units. They are organic compounds made up of hydrogen, oxygen, carbon and nitrogen atoms.

Amino acids are made up of a basic group (amino group $NH_{2)}$, an acidic group (carboxyl group COOH), a hydrogen atom, and a terminal group R which differs from one amino acid to another.

Proteins are made up of repeated units of amino acids which link with each other via peptide bonds.

The combination of two amino acids is called a dipeptide compound, and the protein chain formed of several amino acids is called a polypeptide.

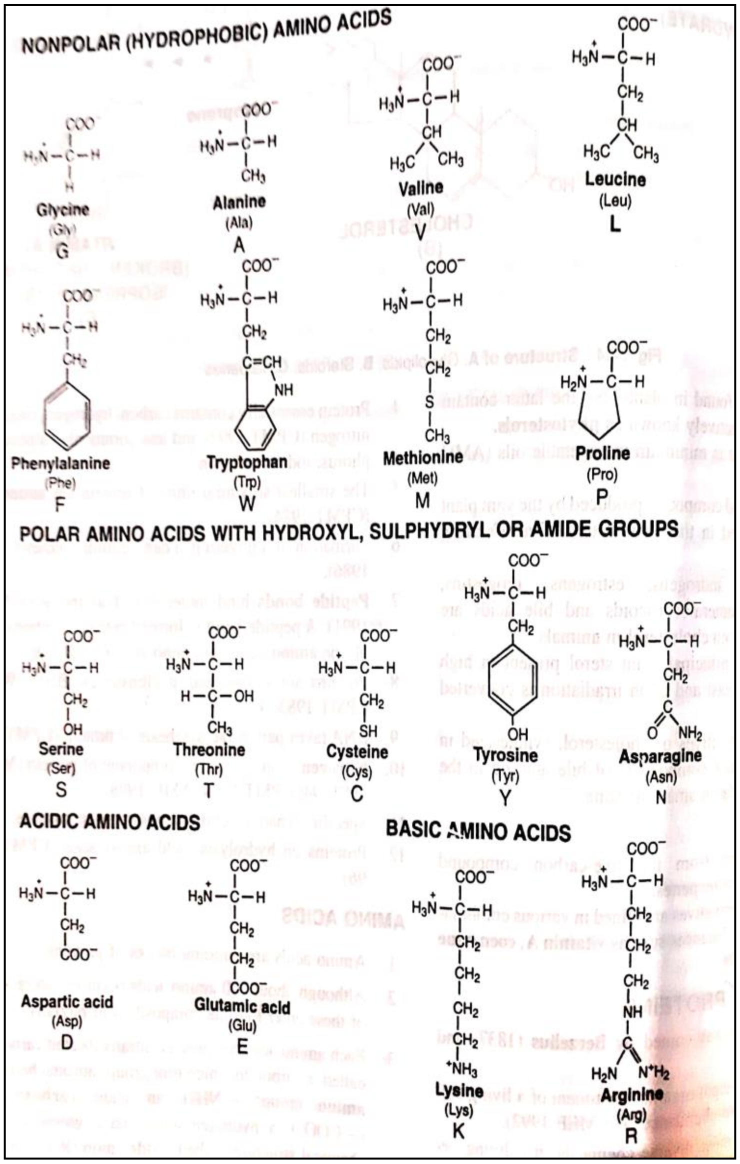
When protein is being formed, it is not conditional for the combination to occur among similar amino acids. Therefore this gives us many varying ways to form proteins, depending on the types, order, and number of amino acids in the chain. About 20 amino acids participate in building the proteins such as **glycine, alanine, and valine.**

There are several ways to classify the amino acids:

i. Common amino acids found in proteins
ii. Uncommon amino acids
iii. Amino acid not found in proteins.

Common amino acid found in proteins are grouped into

i. Nonpolar (hydrophobic) amino acid
ii. Polar amino acids (neutral amino acids)
iii. Acidic amino acids and
iv. Basic amino acids



Fig; Structure of the naturally occurring 20 amino acid

Levels of protein structure

1. Primary structure

Each type of protein is characterized by its own unique sequence of amino acids.

This describes the arrangement of amino acids in polypeptides of a certain protein.

This level determines the number, kind and arrangement of the amino acids forming a protein .

Amino acids, as their name indicates, contain both a basic amino group and an acidic carboxyl group. This di-functionality allows the individual amino acids to join together in long chains by forming peptide bonds: amide bonds between the -NH2 of one amino acid and the -COOH of another.

Sequences with fewer than 50 amino acids are generally referred to as peptides, while the terms protein or polypeptide are used for longer sequences.

A protein can be made up of one or more polypeptide molecules. The end of the peptide or protein sequence with a free carboxyl group is called the carboxy-terminus or C-terminus. The terms amino-terminus or N-terminus describe the end of the sequence with a free α-amino group.

2. Secondary Structure

This describes the way by which polypeptides are coiled. This structure is formed as a result of the hydrogen bonds between carboxyl and amine groups in close amino acid monomers.

The two main types of secondary structure are the α-helix and the ß-sheet.

Secondary structure depends on hydrogen bonds between –C=O and –NH group.

In α-helix, a single amino acid chain is coiled spirally by establishing hydrogen bonds between first and fourth amino acids.

3. Tertiary Structure

This describes the three-dimensional shape of proteins. This structure is formed as a result of the bonds between the side groups (R groups) of amino acids, which bend the different polypeptide chains and give protein its unique shape.

The overall three-dimensional shape of an entire protein molecule is the tertiary structure. The protein molecule will bend and twist in such a way so to achieve maximum stability or the lowest energy state.

Although the three-dimensional shape of a protein may seem irregular and random, it is fashioned by many stabilizing forces due to bonding interactions between the side-chain groups of the amino acids.

Tertiary structure is due to a variety of bonds and interactions between amino acid side chains like disulphide bonds, electrostatic (ionic) bonds, hydrogen bonds,' Vander waals' interactions and hydrophobic effect.

4. Quaternary Structure

This describes proteins which consist of two or more chains of polypeptides. This structure is formed as a result of the linkage of polypeptide chains with each other.

Many proteins are made up of multiple polypeptide chains, often referred to as protein subunits. These subunits may be the same (as in a homodimer) or different (as in a heterodimer).

The quaternary structure refers to how these protein subunits interact with each other and arrange themselves to form a larger aggregate protein complex.

Biological functions of proteins with examples.

Functional class	Examples
Enzymes	Ribonuclease Amylase Trypsin Catalase
Regulatory proteins	Insulin Growth hormone Parathormone
Transport proteins	Haemoglobin Serum albumin Glucose transporter
Storage proteins	Ovalbumin Casein Ferritin Gluterlins Globulins
Contractile and motile	Actin Myosin Tubulin Kinesin
Structural proteins	Collagen Elastin Chondrin
Protective proteins	Immunoglobulin Thrombin Fibrinogen
Exotic proteins	Antifreezr proteins Monellin Resilin Glue proteins

Representative conjugated proteins

Class	Examples
Nucleoprotein	Ribosomes , TMV
Metaollproteins	Ferritin
Chromoproteins	Haemoglobin
Phosphoproteins	Casein
Lipoproteins	Blood plasma lipoproteins
Glycoproteins	Proteoglycan
Flavoproteins	Succinic dehydrogenase NADH dehydrogenase

Keratin is a fibrous protein. It contains large amount of sulphur.

Feathers are made of β - keratin.

The most abundant protein in the human body is collagen.

Enzymes are functional proteins. An enzyme is formed by chemically bonding together amino acids.

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