AL-MUSTAQBAL UNIVERSITY COLLEGE

Department of Biomedical Engineering

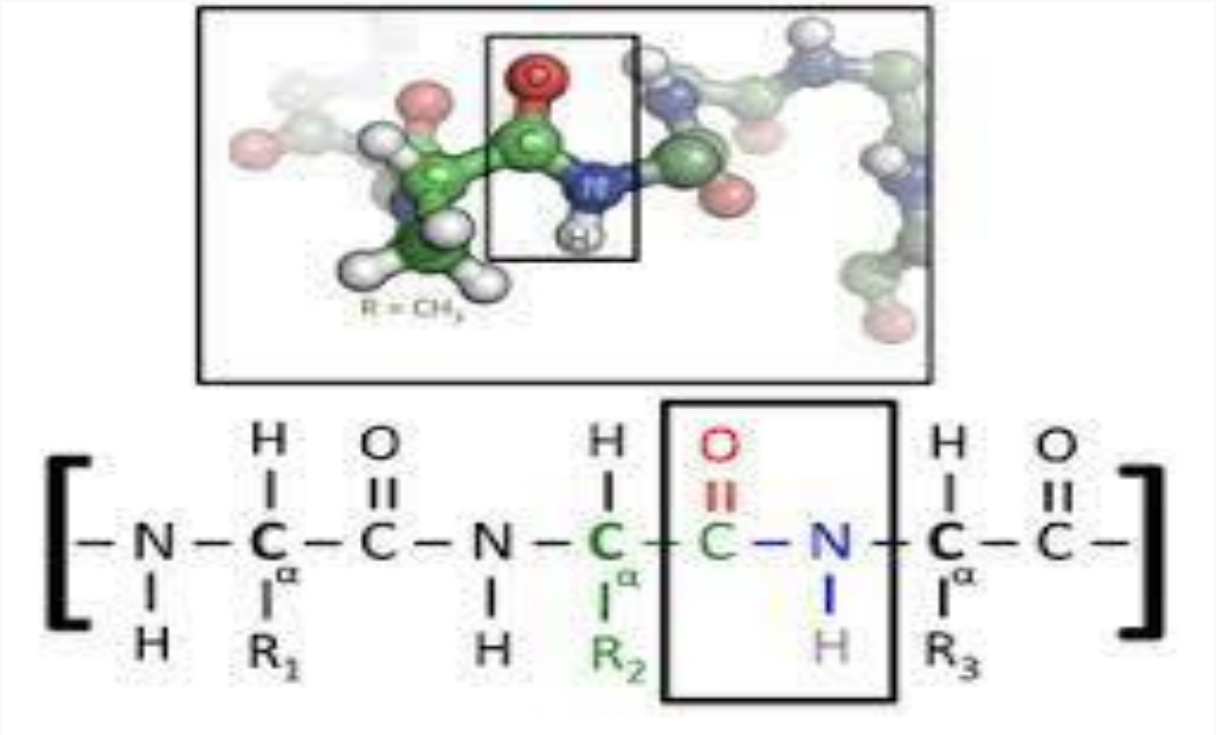
Biochemistry

(Protein structure and function)

Lecturer : M. Sc. Mohammed Ali

Protein structure and function

Proteins: Proteins are biological polymers made of amino acids. The amino acids, linked to each other by peptide bonds, form a polypeptide chain. One or more polypeptide chains twisted into a three-dimensional shape make up the protein. Proteins have complex shapes that include various folds, loops, and curves. Folding in proteins occurs automatically. Chemical bonding between parts of the polypeptide chain that helps hold the protein together and give it its shape. There are two general classes of protein molecules: globular proteins and fibrous proteins. Globular proteins are generally compact, soluble and globular in shape. Fibrous proteins are usually elongated and soluble. Fibrous and globular proteins may exhibit one or more of four types of protein structure. The types of infrastructure are called primary, secondary, tertiary and quaternary.



• Proteins are the most prevalent cellular molecules

About 50% or more of the dry cell weight.

• Proteins are various cellular components, including enzymes and hormones.

Proteins are made up of carbon, oxygen, hydrogen, nitrogen and sulfur elements

-The proportions of these elements are as follows:

%24 – 19=O_2

7.3 - 6 % = H 55 - 50 = C

N_2 =0% 2.5 -0.3 S= %19-15

There may also be chlorine, bromine and iodine in a very small proportion

Amino acids

Proteins are linear polymers made up of small units of amino acids called monomers. Amino acids are thus building blocks of proteins. The general formula of an α-amino acid is shown in Figure

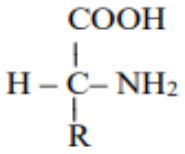
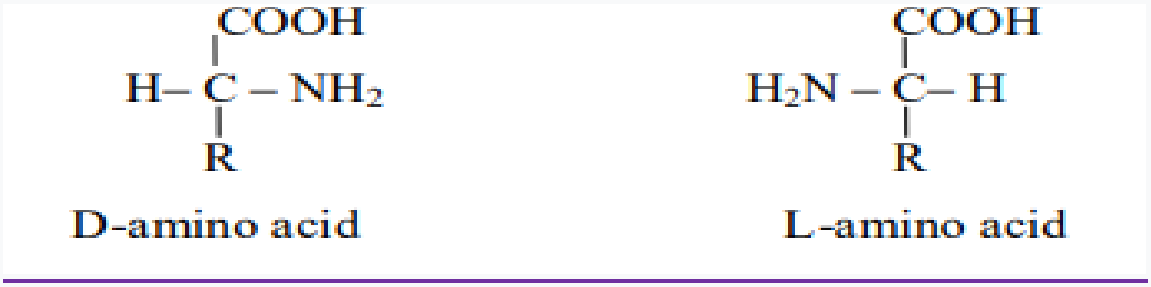


Figure 1: General formula of an amino acid

The central carbon atom is called α-carbon which is linked to four different groups; –COOH group, NH2 group, -H, and -R group called side chain. Because of binding with four different groups α-carbon of amino acids is chiral or asymmetric. Because of this asymmetric α-

carbon amino acids are present in two optically active forms or mirror image forms; L isomers and the D isomers (Figure 2). R can be -H as in the case of glycine or it can be a -CH3 as in alanine.



The basic building blocks of proteins:

1- Neutral amino acids: - the number of base groups = acidic, including (glycine -

Alanin - Valen - Leucine and others).

2- Basic amino acids: they have more base groups than acid groups

Including (lysine - arginine - histidine - proline - hydroxyproline).

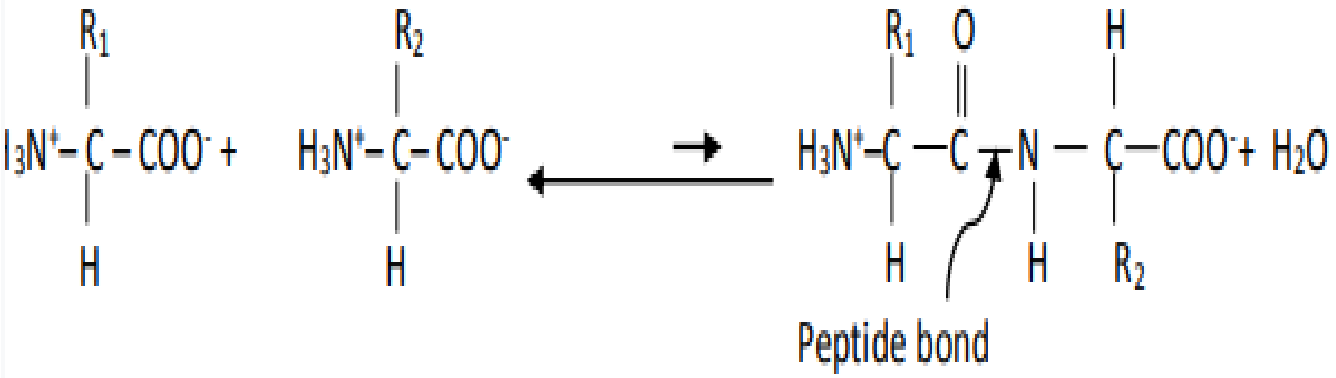
3 - Aspartic amino acids: they contain the number of groups, including (glutamic).

Conformation of peptide bond

The α-COOH of one amino acid links to α-NH2 group of another amino acid through a peptide bond (also called amide bond) to form linear polymer. Formation of a peptide bond from two amino acids is accompanied by the loss of water molecule. The equilibrium of this reaction lies on the side of the hydrolysis rather than synthesis. Hence the biosynthesis of peptide bond requires an input of free energy.

The peptide bond which links amino acid residues in polypeptide chain is planar. For a pair of

amino acids linked by a peptide bond, six atoms lie in the same plane. These atoms are αcarbon atom and C=O group from the first amino acid and NH group and α-carbon from the
second amino acid.



Types of protein structure:

The four protein levels are distinguished from each other by the degree of complexity of the polypeptide chain. A single protein molecule may contain one or more types of protein structure.

1-Primary Structure - Describes the unique arrangement in which amino acids are linked together to form a protein. Proteins are created from a group of 20 amino acids. In general, amino acids have the following structural properties:

Carbon (alpha carbon) associated with the four groups below:
*hydrogen atom (H)
*Carboxyl group (-COOH)
*amino group (-NH2)
*set "variable" or set "R"

2-Secondary Structure - Refers to the twisting or folding of the polypeptide chain that gives the protein its three-dimensional shape. There are two secondary structures observed in proteins. One type is the alpha (alpha) helix structure. This structure resembles a coiled spring and is held by a hydrogen bond in the polypeptide chain. The second type of secondary structure in proteins is the beta flexor sheet (β).
3-Tertiary Structure - Refers to the overall three-dimensional structure of the polypeptide chain of a protein. There are several types of bonds and forces that contain a protein in its tertiary structure. Hydrophobic interactions contribute significantly to protein folding and formation. The "R" group of amino acids is either hydrophobic or hydrophilic. Amino acids with hydrophobic “R” groups will seek to contact their aqueous environment, while amino acids with hydrophobic “R” groups will seek to avoid water and position themselves toward the center of the protein.
4-Quaternary structure - refers to the structure of a protein molecule consisting of interactions between polypeptide chains. Each polypeptide chain is referred to as a subunit. Proteins with a quaternary structure may consist of more than one type of the same protein subtype. It may also be made up of different subunits. **Hemoglobin** is an example of a protein with a quaternary structure. Hemoglobin, found in the blood, is an iron-containing protein that binds oxygen molecules. It contains four subunits: two alpha units and two beta units.

Some proteins with a well-known structure:

1- Insulin:Hypoglucemic hormone secreted by the pancreas. Insulin consists of 51 amino acid residues distributed over two peptide chains, the A chain containing 21 amino acid residues and the B chain containing 30 amino acid residues. These two chains are connected by two sulfur bridges.

1-Fibrin: is secreted by silkworm larvae in the form of fine silk filaments. It is a linear protein consisting of polypeptide chains linked by a large number of hydrogen bonds (beta-structure), with a high molecular weight of about 100 thousand. The amino acid residues are located in the peptide chain in the following order:

X-Gly-Ala-Gly-Ala-Gly

3-Albumin:Egg albumin has a molecular weight of 45 thousand and constitutes 64% of the main mass of the proteins of chicken eggs. As for blood albumin, its molecular weight is 65 thousand, and it constitutes 60% of blood serum proteins

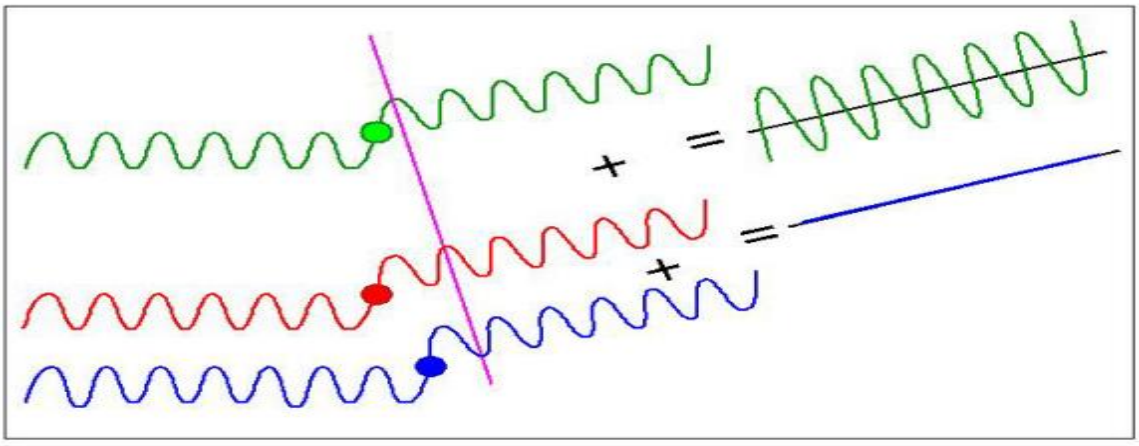
4-Hemoglobin It is the main component of red blood cells. The hemoglobin molecule contains four iron atoms, each atom located in the center of the heme group. The globin protein portion consists of 574 amino acid residues.

5-Growth hormone: Produced by the anterior lobe of the human pituitary, it consists of a single peptide chain containing 245 amino acid residues with a molecular weight of 27 thousand. Growth hormone activates the synthesis of enzymes and proteins in every cell.

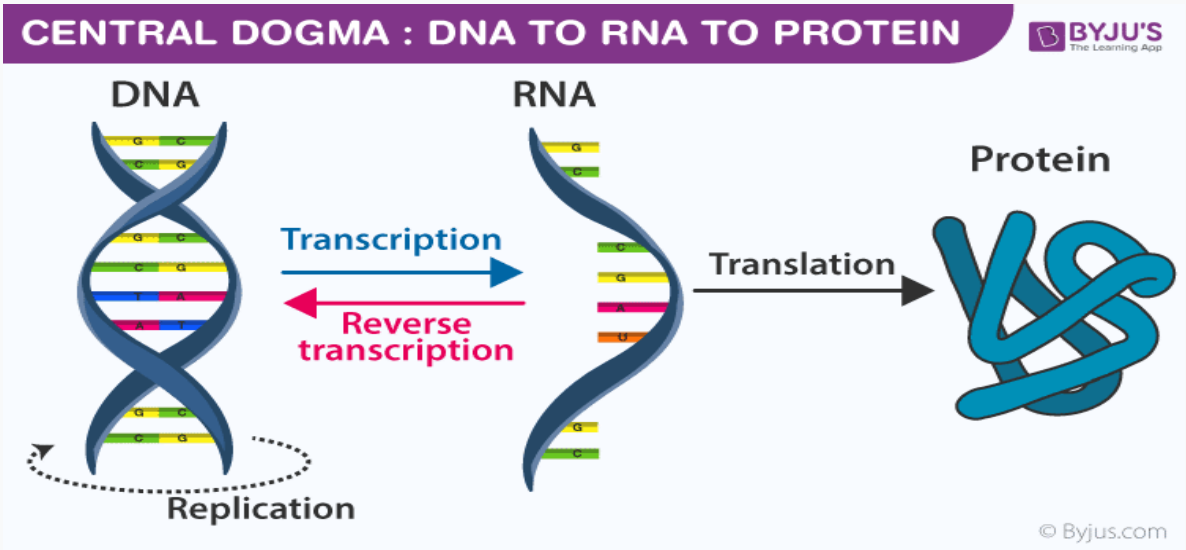
How to determine the type of protein structure:

The three-dimensional shape of a protein is determined by its primary structure. The arrangement of amino acids determines the protein's structure and specific function. The distinct instructions for the arrangement of amino acids are determined by the genes in the cell. When a cell sees the need for protein synthesis, the DNA is unfolded and transcribed into a copy of RNA for the genetic code. This process is called DNA replication. The RNA transcript is then translated to produce a protein. The genetic information in DNA determines the specific sequence of amino acids and the specific protein that is produced. Proteins are examples of one type of biological polymer. Together with proteins, carbohydrates, lipids, and nucleic acids they form the four main classes of organic compounds in living cells

• X-ray crystallography is one of the primary means of getting highresolution protein structures. It is based on Bragg scattering of xrays ($\lambda = 0.2 – 2$ Å) from electron density surrounding the atoms in a protein. Higher electron density leads to more scattering.



What are the main compounds that contribute to protein synthesis?



The following compounds contribute to the process of synthesis of proteins in a living cell: DNA (DNA), RNA, RNA, mRNA ,tRNA , rRNA.

The idea of protein synthesis is often known as the central dogma since it the most elementary concept required to understand all of biology. All living things undergo the process of protein synthesis. The three major players in the central dogma are DNA, RNA and proteins.

The main sources of protein:

-eggs,chicken breast,the milk,cottage cheese,tuna fish,Beef ,shrimp,fish

Protein benefits:

-Muscle Building.
-Boost your immune system
-Helps relieve muscle pain.
-Increase fat burning.
-Weight loss and feeling full.
-Reduces the risk of diabetes.