Ministry of Higher Education and Scientific Research
AL-Mustaqbal University

Biochemistry

المحاضرة السادسة

البيتيدات والبروتينات

By
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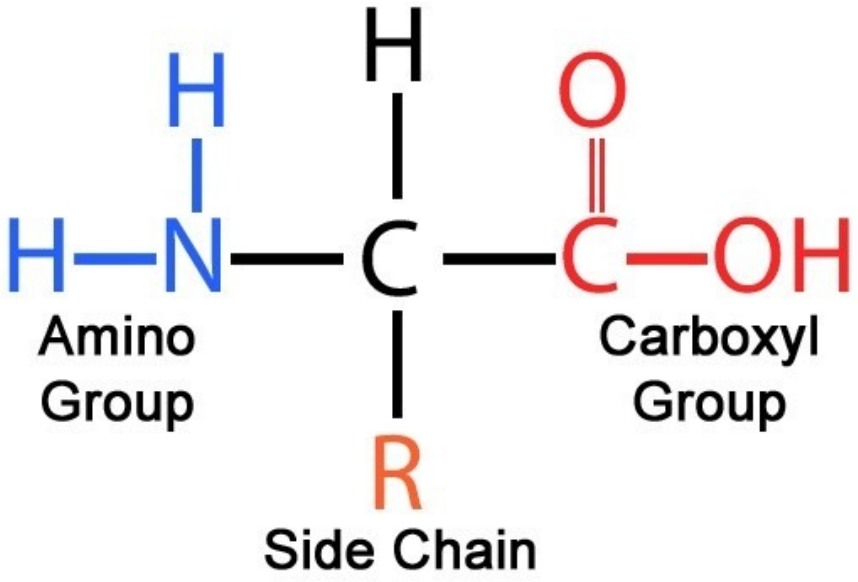
Amino Acids and Proteins

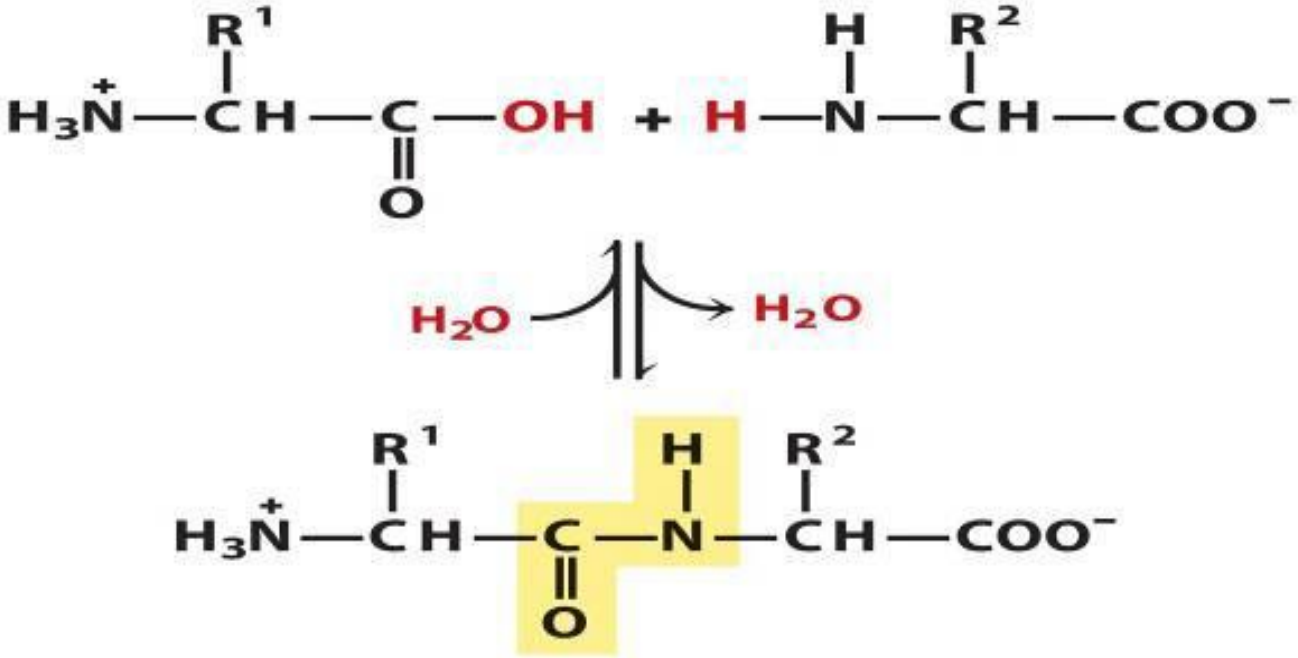
Amino Acids (AA): are the building bases of proteins

Contain:

Central carbon atom + 4 subgroups {amino group (—NH_2), carboxyl group (—COOH), hydrogen atom, and side chain (R)}



Peptides and Proteins: It consists of two or more amino acids linked together by a peptide bonds from the linkage of the alpha-carboxyl group of one amino acid with the alpha-amino of another amino acid. As a result, a water molecule is released.



Peptide Bond

Peptides and Proteins:

20 amino acids are commonly found in protein.
These 20 amino acids are linked together through "peptide bond forming peptides and proteins.

The chains containing less than 50 amino acids are called "peptides", while those containing greater than 50 amino acids are called "proteins".

Chemical structure of peptides & protein

A- Peptides: fewer than 50 amino acids

1- Dipeptides: 2 amino acids

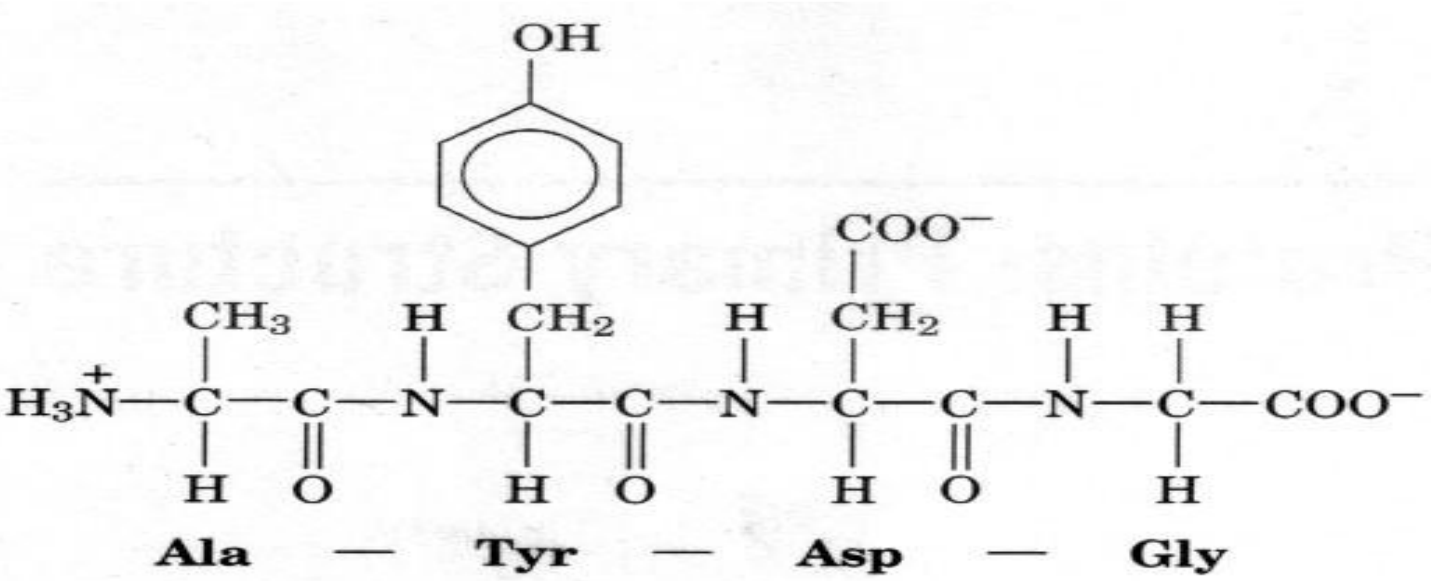
2- Tri-peptides: 3 amino acids

3- Polypeptides: more than 10 amino acids

B- Proteins: more than 50 amino acids

Peptide bond formation: -

Each polypeptide chain starts on the left side by free amino group of the first amino acid enter in chain formation . It is termed (N- terminus). - Each polypeptide chain ends on the right side by free COOH group of the last amino acid and termed (C-terminus).



Fullname:Alanyltyrosylaspartylglycine

Examples on Peptides:

1- Dipeptide

(two amino acids joined by one peptide bond):

Example: Aspartame which acts as sweetening agent being used in replacement of cane sugar. It is composed of aspartic acid and phenyl alanine.

2-Tripeptides

(3 amino acids linked by two peptide bonds).

Example: GSH which is formed from 3 amino acids: glutamic acid, cysteine and glycine. It helps in protects against free radical which causes cell damage.

3- Octapeptides:

(8 amino acids)

Examples: Two hormones; oxytocine and vasopressin (ADH).

4- Oligopeptide:

short polymer of residues linked by peptide bonds; up to10-20 residues.

5- Polypeptides:

longer polymer of residues linked by peptide bonds; larger sizes.

6- Protein:

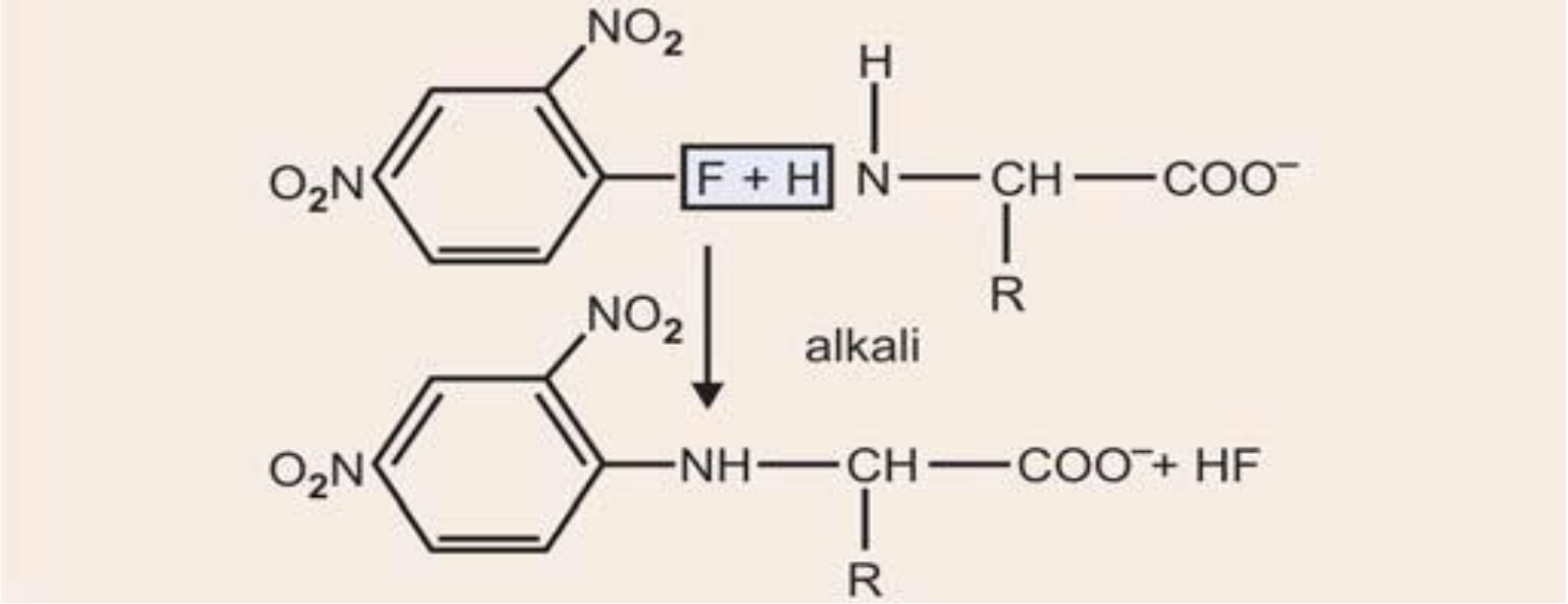
one or more polypeptide chains

Identification of N-terminal Residue:

(a):- N-terminal residue can be identified by using a reagent that bond covalently with its α-NH_2 group. Because the bond is stable to hot acid hydrolysis, the derivative of the N-terminal residue can be identified by chromatographic procedures after the protein has been hydrolysed.

Two reagents are commonly used

1- Sanger's reagent: The reagent contains 1-fluoro-2,4-dinitrobenzene (FDNB). It reacts with free –NH2 group in an alkaline medium.



The compound so formed can be isolated after protein hydrolysis and identified.

Sanger was first to sequence a polypeptide. He determined the complete primary structure of the hormone insulin.

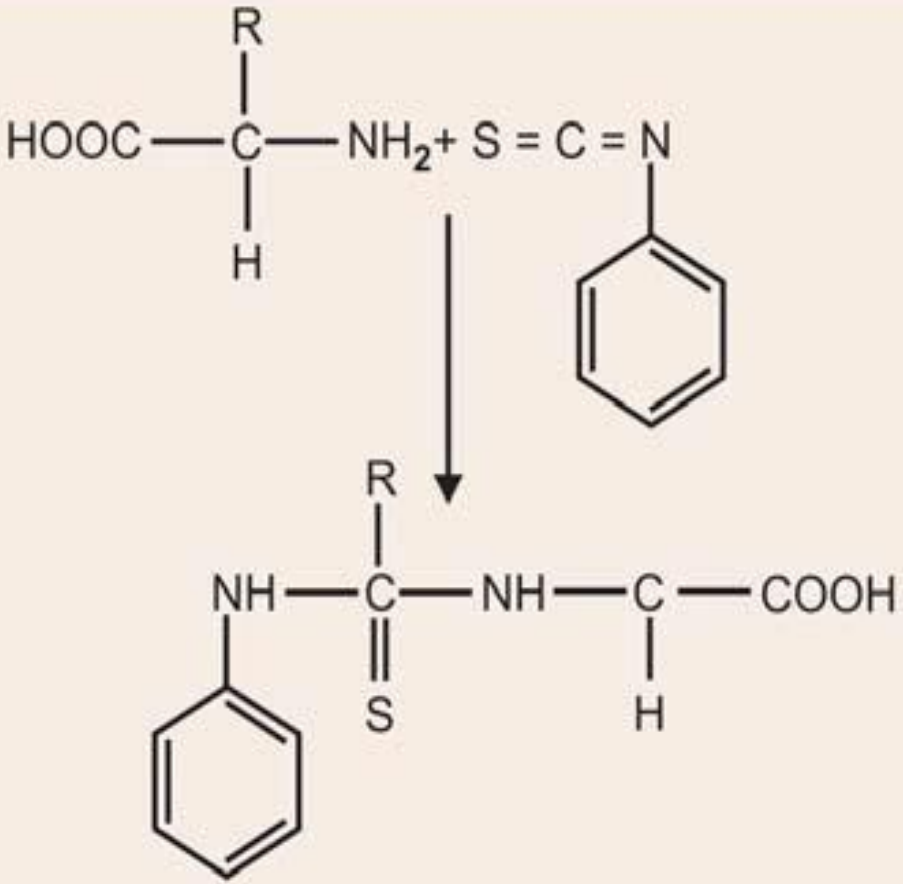
2. Reaction with Dansyl Chloride:

The N-terminal–NH_2 group can also combine with Dansyl chloride(1-dimethyl aminonaphthalene-5-sulphonyl chloride) to form a fluorescent Dansyl derivative which can be isolated and identified.

(b) Edman reaction:

A similar reaction with –NH2 group an occur with the reagent phenyl isothiocyanate and thus enables the identification of the N-terminal amino acid.

Edman Reaction



Proteins:

Proteins are the most abundant molecules in living cells, constituting 40% - 70% of their dry weight. Proteins are built from amino acid monomers.

Typical protein functions:

1-Catalyze Reactions (enzymes).
2-Chemical Signaling (hormones).
3-Storage (e.g. myoglobin stores oxygen).
4-Structural (e.g. collagen in skin and tendons).
5-Protective (e.g. antibodies).
6-Contractile (e.g. myosin in muscle).
7-Transport (e.g. hemoglobin).

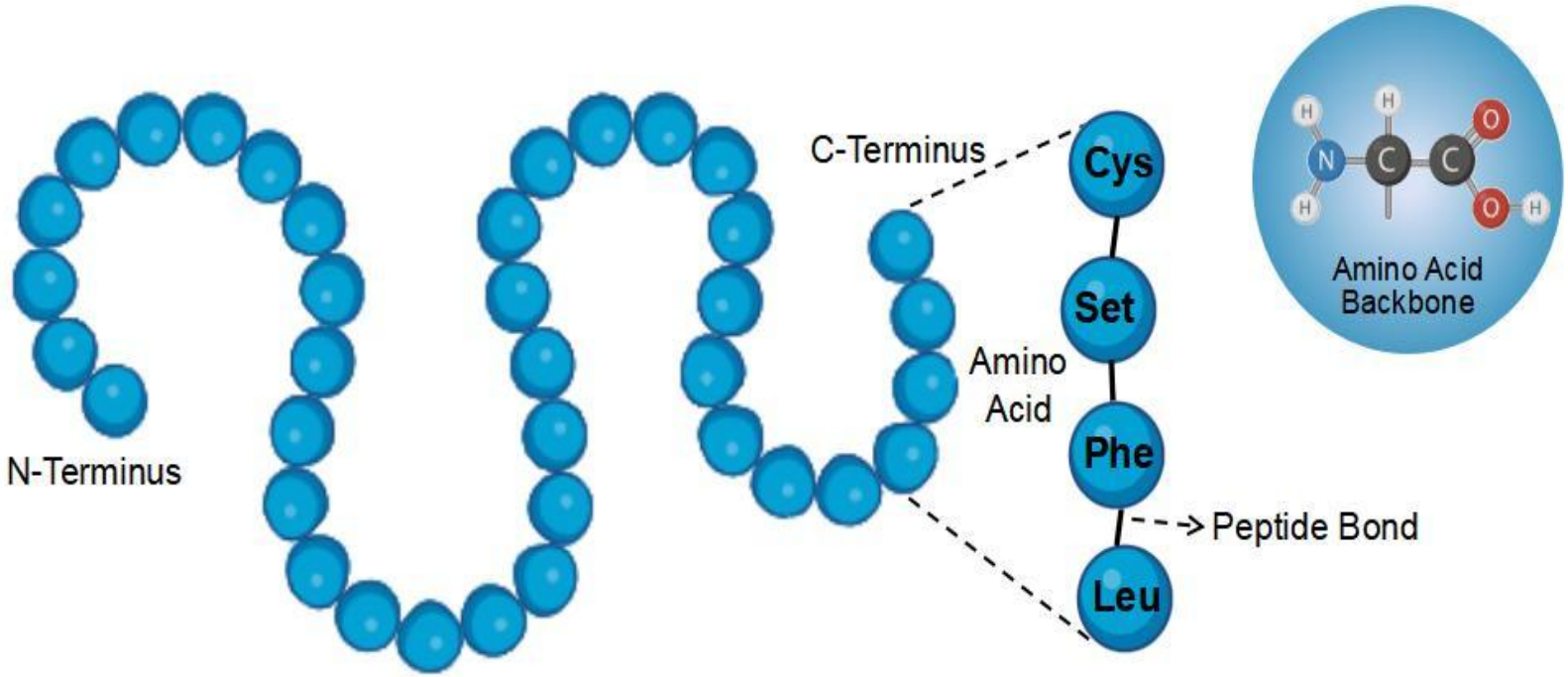
Protein structure:

There are four levels of protein structure (primary, secondary, tertiary and quaternary)

1-Primary structure:

- The primary structure of a protein is its unique sequence of amino acids
- 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).

Protein structure



2- Secondary structure:

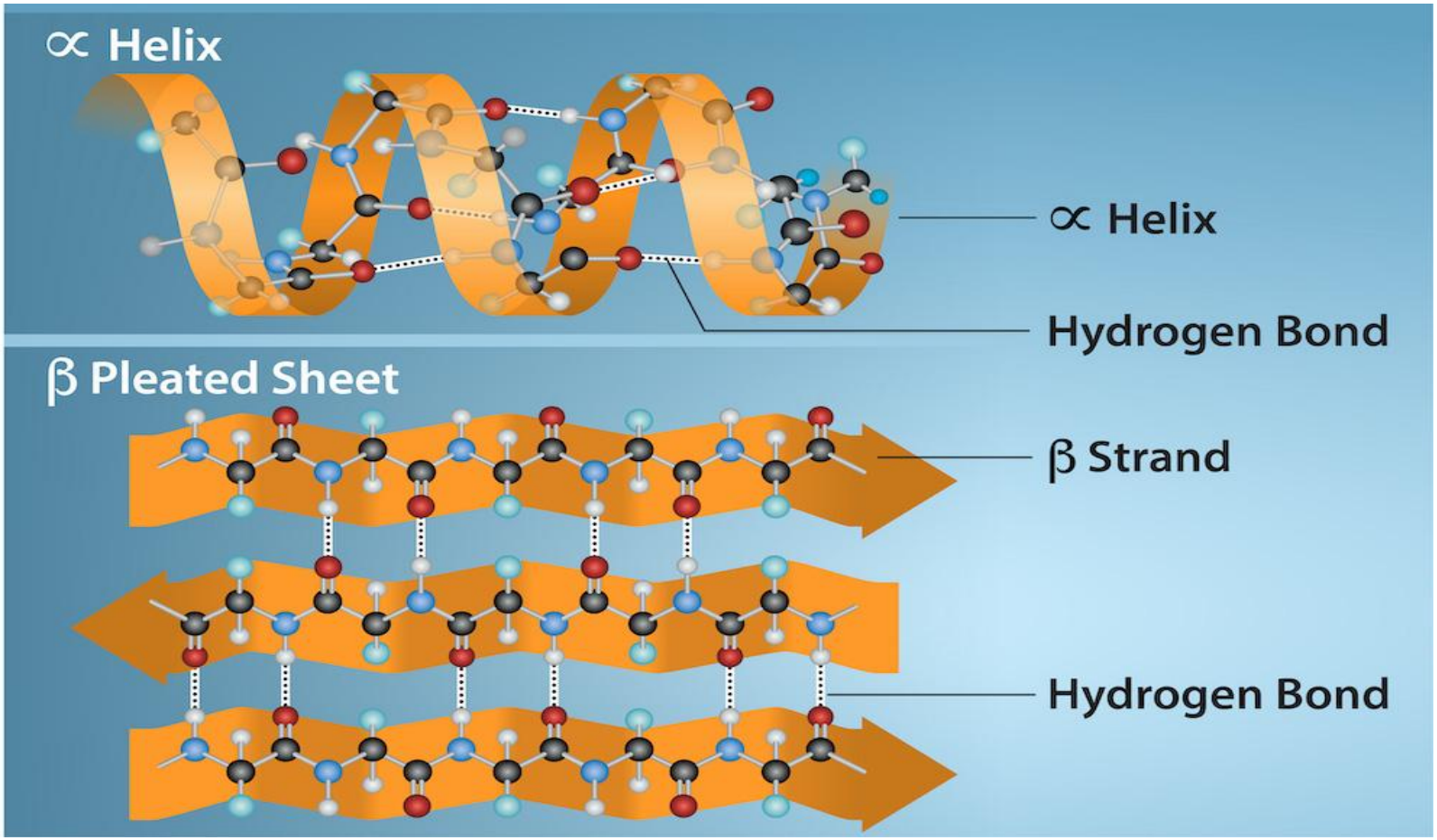
Results from hydrogen bond formation between hydrogen of –NH group of peptide bond and the carbonyl oxygen of another peptide bond.

According to H-bonding there are two main forms of secondary structure:

α-helix: It is a spiral structure resulting from hydrogen bonding between one peptide bond and the fourth one.

β-sheets: is another form of secondary structure in which two or more polypeptides (or segments of the same peptide chain) are linked together by hydrogen bond between H- of NH- of one chain and carbonyl oxygen of adjacent chain (or segment).

Secondary structure

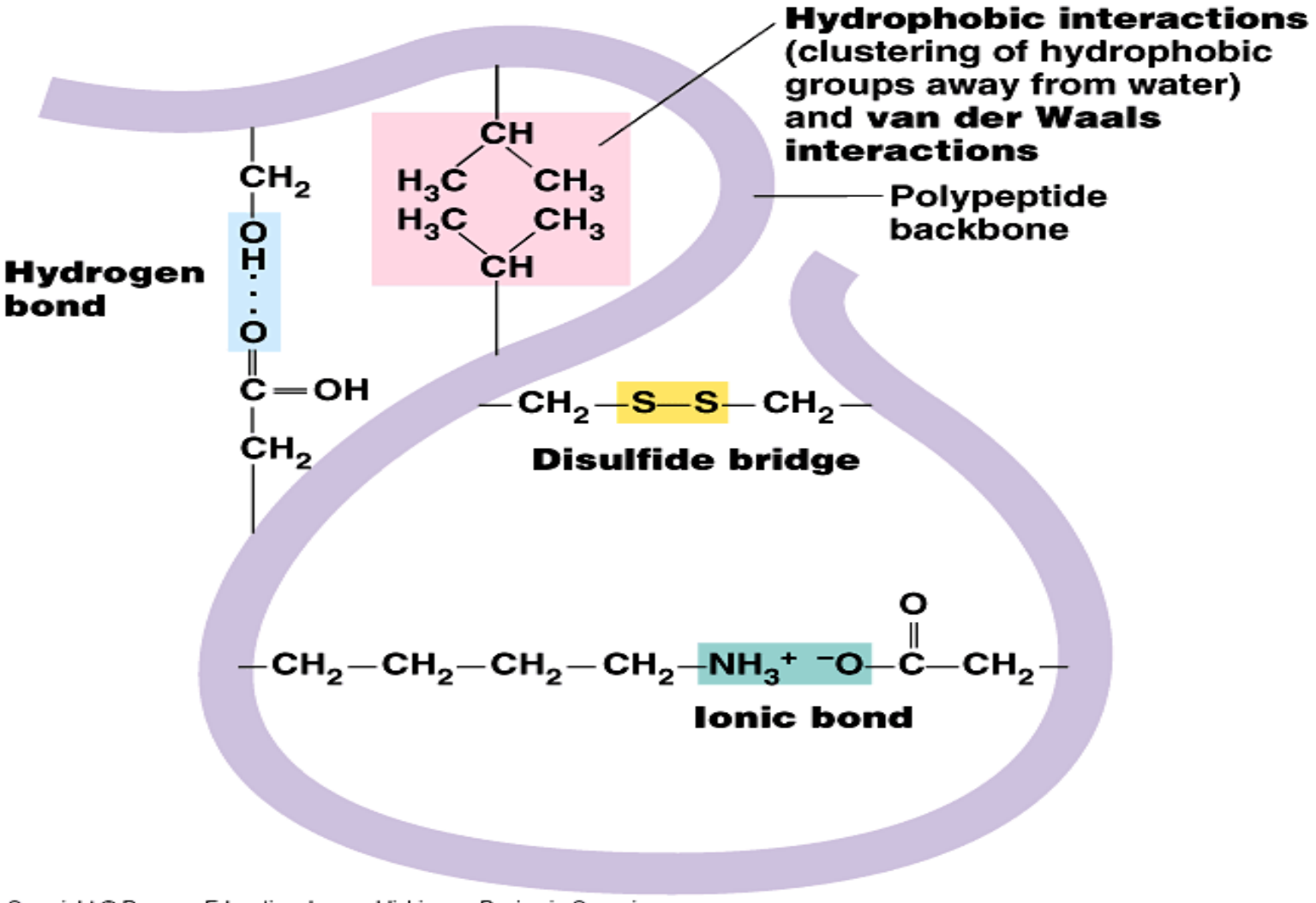


3-Tertiary structure:

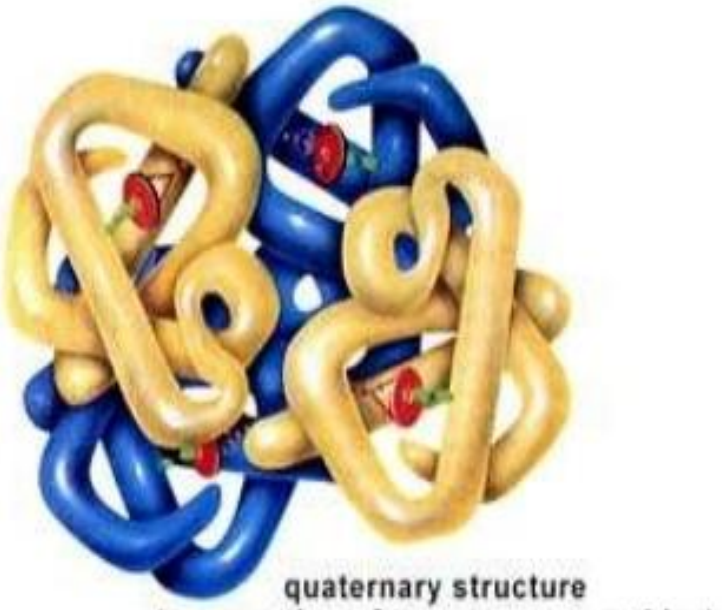
Tertiary: chain folding: fibrous and globular.
Chain folding causes changes in physical properties and biological function.

Fibrous proteins tend to have length >> diameter, tend to be water insoluble.

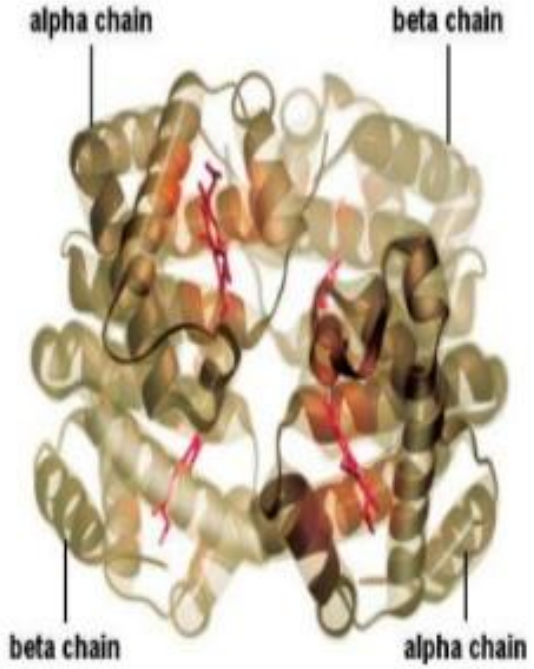
Globular proteins have spherical shape. Contributing factors are the hydrophobic effects, hydrogen bonding, ionic bond, and disulfide linkages by cysteine units.



4-Quaternary Protein Structure



quaternary structure
(aggregation of two or more peptides)



Haemoglobin structure

Some systems exist as larger "assemblies" several polypeptide chains.

Quaternary structures are held together by a variety of interactions including hydrogen bonding, Van der Waals interactions, ionic bonding and occasionally disulfide bonds.

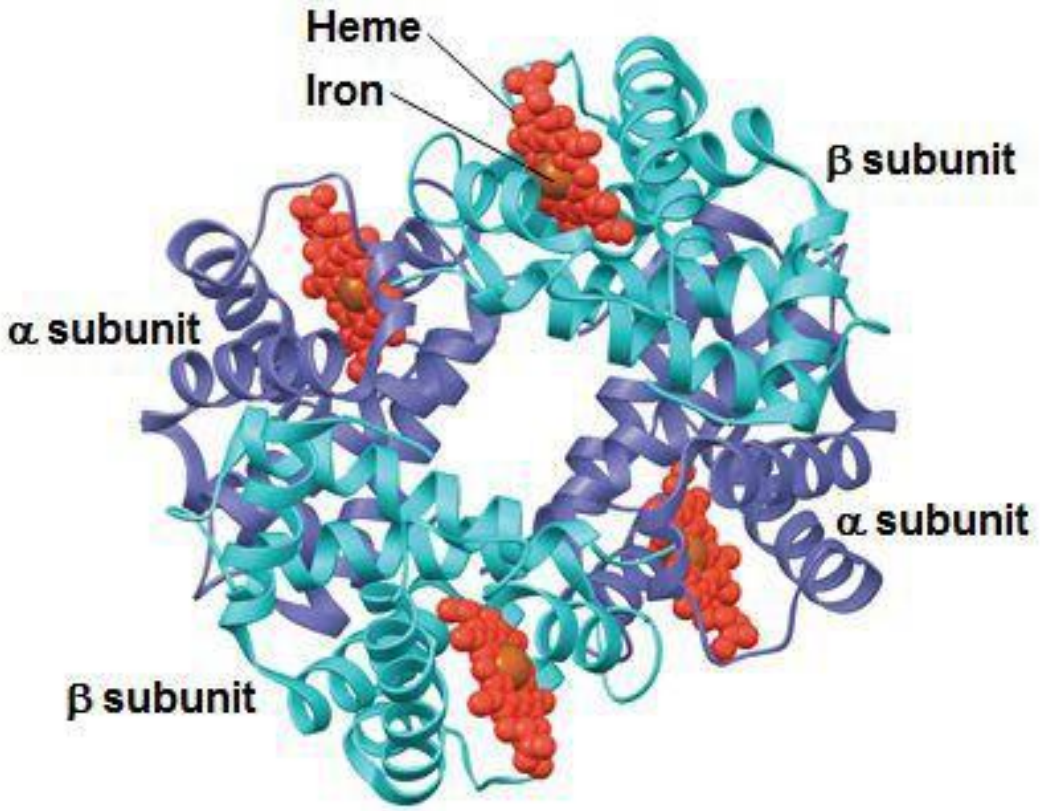
Example:

1- Collagen is a fibrous protein of three polypeptides (trimeric).

2- Hemoglobin polypeptide is a globular protein with four polypeptide chains (tetrameric) – Insulin : two chains (dimeric).

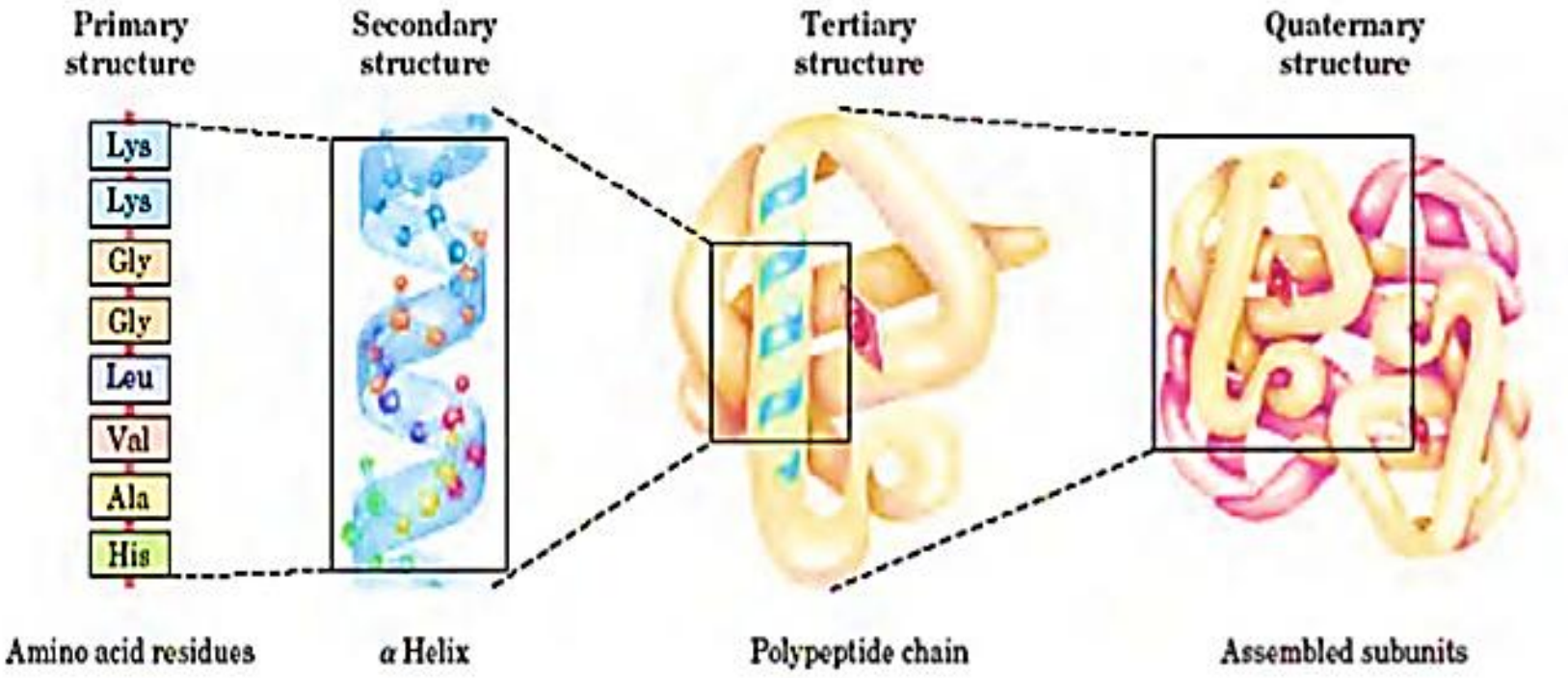
- **Collagen** is a fibrous protein consisting of three polypeptides coiled like a rope.

- **Hemoglobin** is a globular protein consisting of four polypeptides: two alpha and two beta chains



Hemoglobin

Levels of Protein Structure:



Thank you

Quiz 2

Q1/ Define the amino acid and give its general structure.

Q2/ Draw the structure of each the following amino acids.

Ala, Leu, Cys, Glu, Arg