Proteins

Tishk International University,

Education Faculty, Biology Dept,

Biochemistry, 1st Semester/W3

Outlines:

- Functions of proteins
- Structure of proteins
- Classification of proteins

What do proteins do?

- Proteins make up about %15 of the mass of the average person.
- Proteins are the most versatile macromolecules in living systems and serve crucial functions in essentially all biological processes.
  - Support,
  - Provide mechanical transport and immune protection,
  - Enzimes (catalyze chemical reactions),
  - Coordinate of hormonal activities,
  - Transmit nerve impulses,
  - Defensive proteins; protect against disease (antibodies).

What is a protein?

- Proteins are linear polymers built of monomer units called amino acids, which are linked end to end by peptide bonds.

- There are about 300 amino acids occur in nature. Only 20 of them occur in proteins.

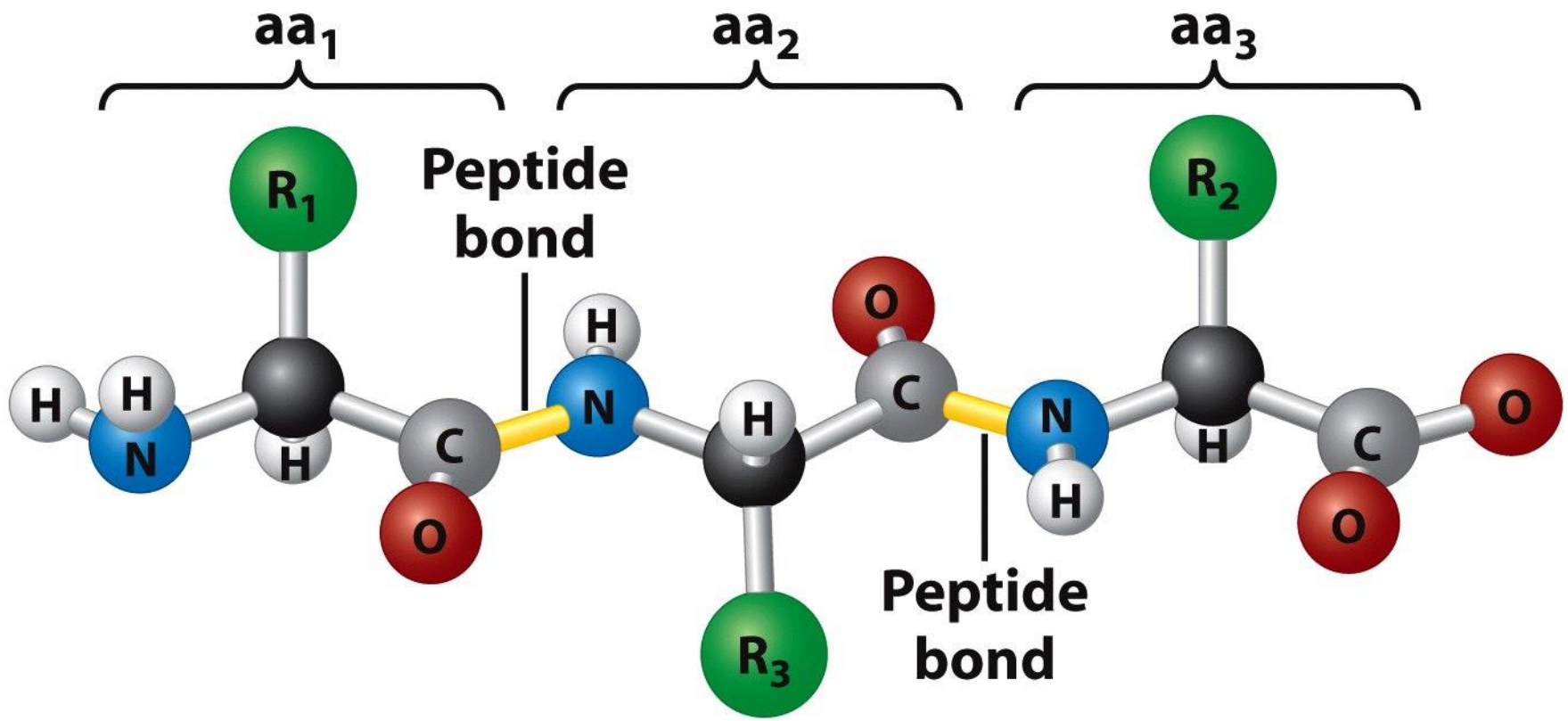


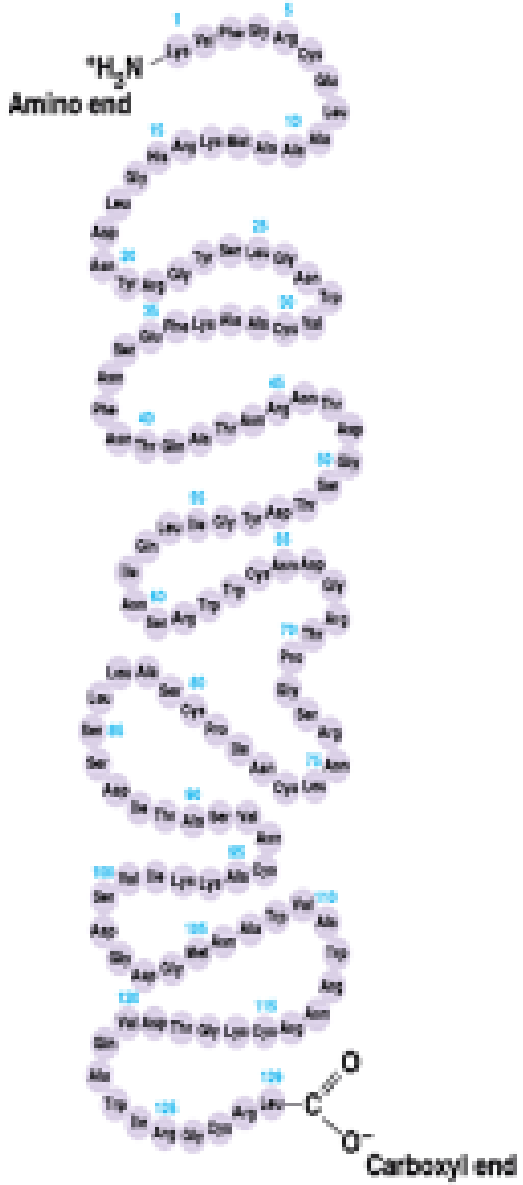
Figure 3-3c
Molecular Cell Biology, Sixth Edition

Protein structure:

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

Primary structure:

- The **primary structure** of a protein is its unique sequence of amino acids.
  - Lysozyme, an enzyme that attacks bacteria, consists of a polypeptide chain of 129 amino acids.
  - The precise primary structure of a protein is determined by inherited genetic information.
  - 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).

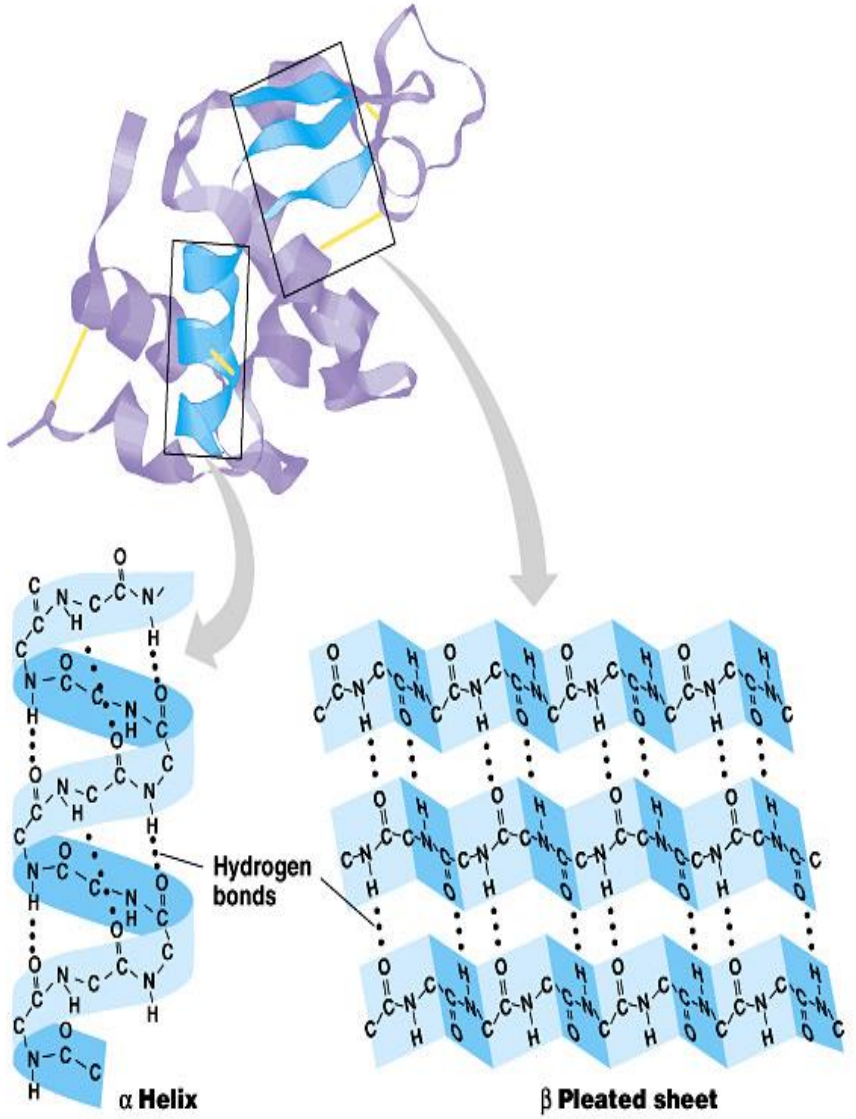


2- Secondary structure:

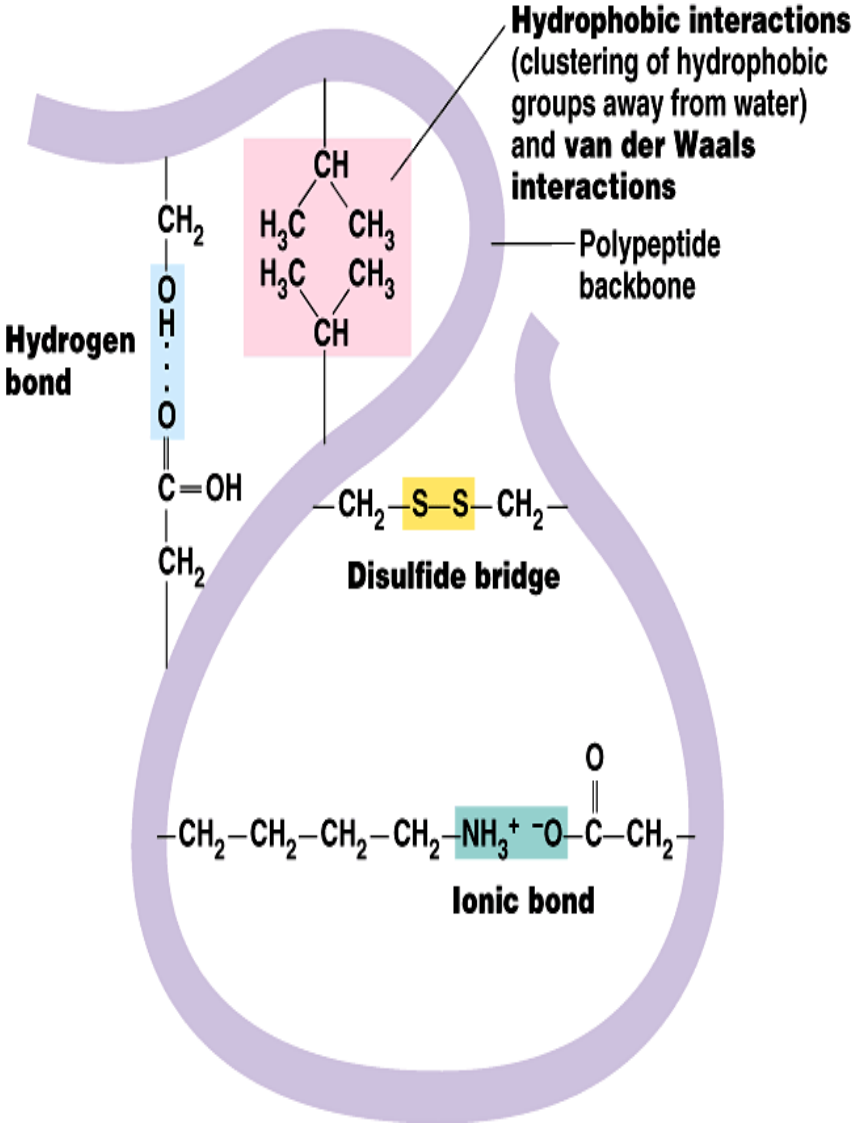
Results from hydrogen bond formation between hydrogen of –NH group of peptide bond and the carbonyl oxygen of another peptide bond. According to H-bonding there are two main forms of secondary structure:

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

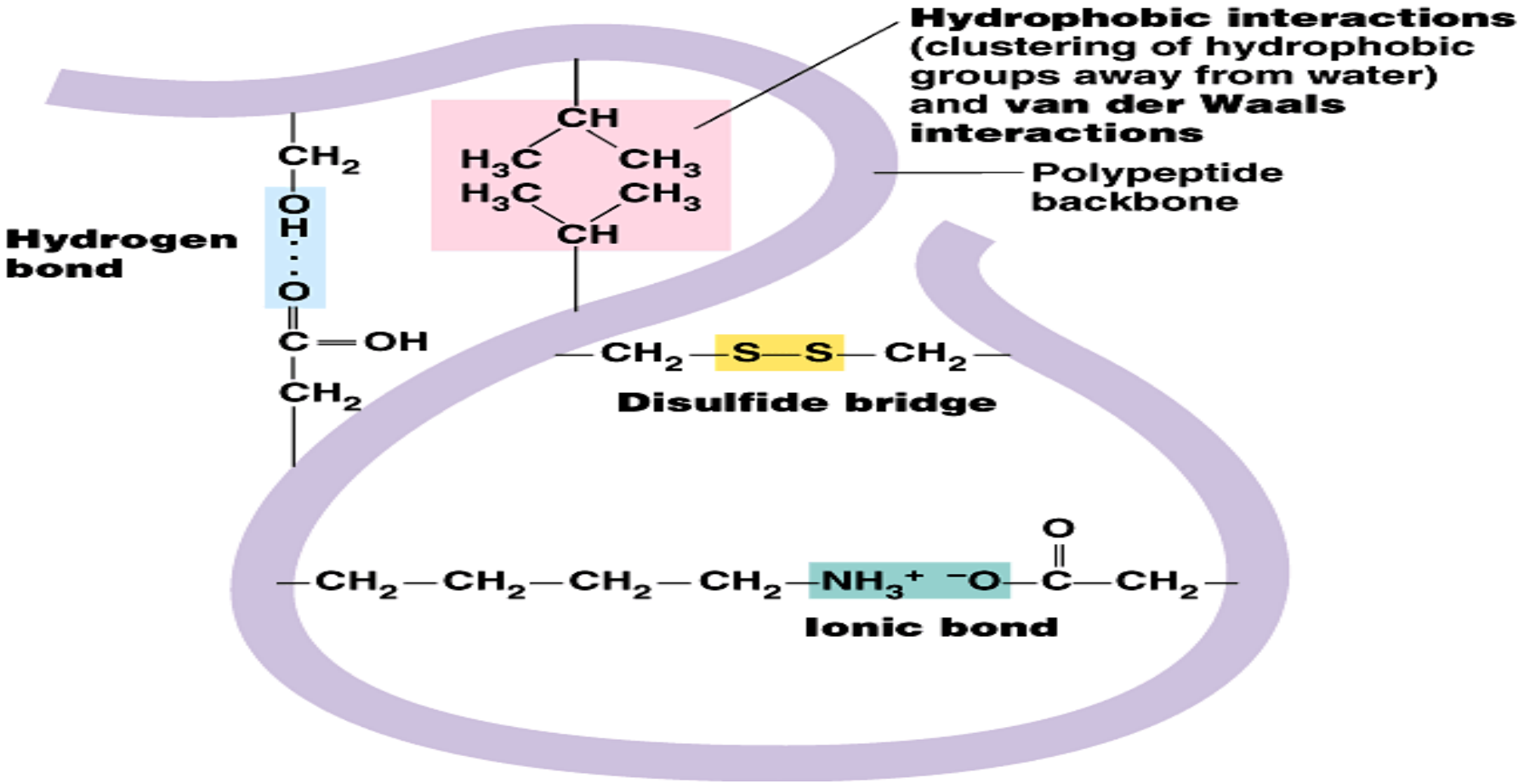
β-sheets: is another form of secondary structure in which two or more polypeptides (or segments of the same peptide chain) are linked together by hydrogen bond between H- of NH- of one chain and carbonyl oxygen of adjacent chain (or segment).



- **Tertiary structure** is determined by a variety of interactions (bond formation) among R groups and between R groups and the polypeptide backbone.
  a. **The weak interactions** include:
  - **Hydrogen bonds** among polar side chains
  - **Ionic bonds** between charged R groups (basic and acidic amino acids)
  - **Hydrophobic interactions** among hydrophobic (non polar) R groups.



b. **<u>Strong covalent bonds</u>** include **disulfide bridges**, that form between the sulfhydryl groups (SH) of cysteine monomers, stabilize the structure.



High orders of Protein structure

- **A functional protein** is **not just** a polypeptide chain, but **one or more** polypeptides precisely **twisted, folded and coiled** into a molecule of unique shape (**conformation).** This conformation is essential for some protein function e.g. Enables a protein to recognize and bind specifically to another molecule e.g. hormone/receptor; enzyme/substrate and antibody/antigen.
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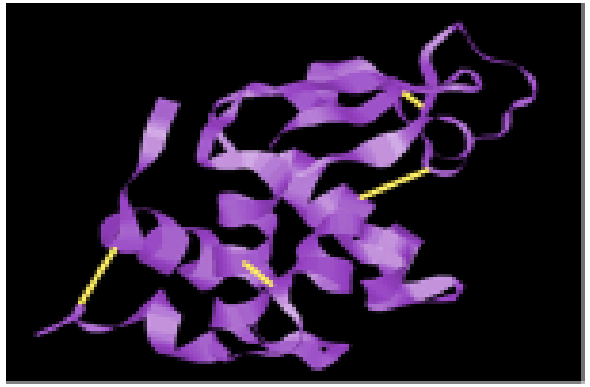
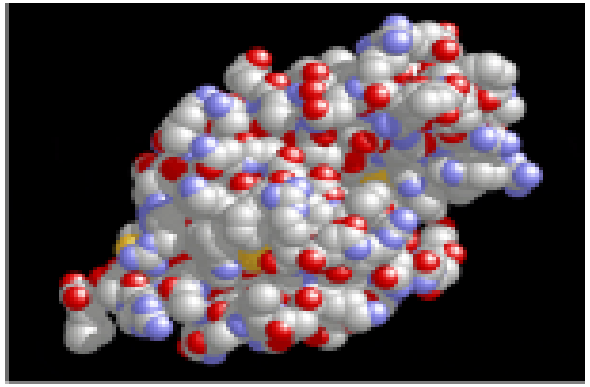
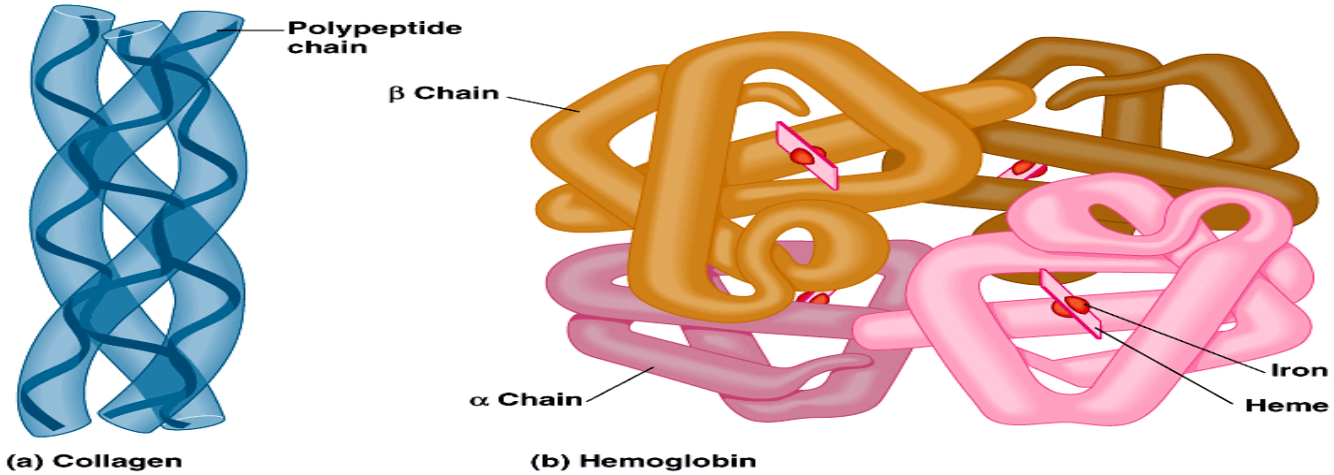
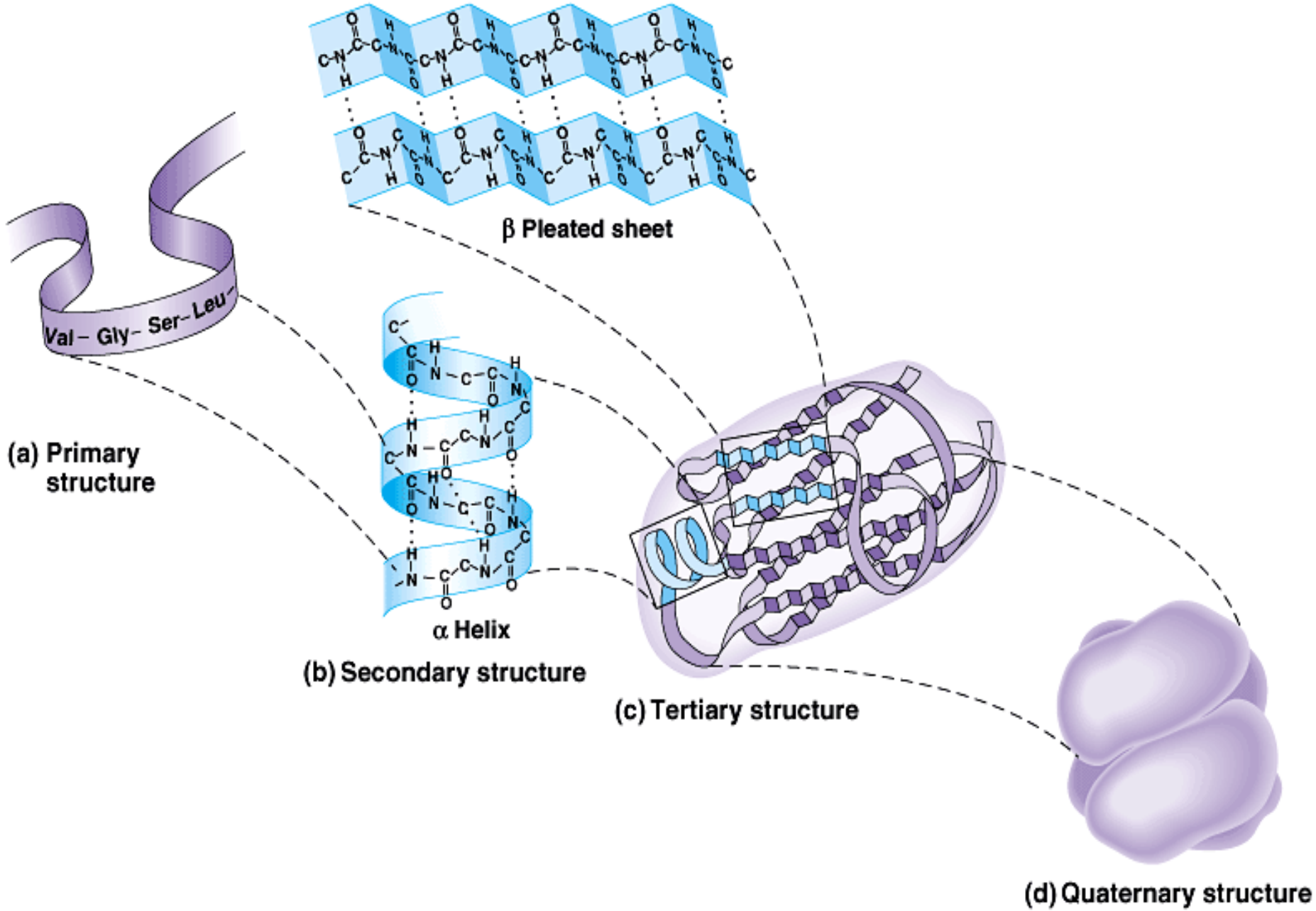




- **Quaternary structure:** results from the aggregation (combination) of two or more polypeptide subunits held together by non-covalent interaction like H-bonds, ionic or hydrophobic interactions.
- Examples on protein having quaternary structure:
  - **Collagen** is a fibrous protein of three polypeptides (trimeric) that are supercoiled like a rope.
    - This provides the structural strength for their role in connective tissue.
  - **Hemoglobin** is a globular protein with four polypeptide chains (tetrameric)
  - **Insulin** : two polypeptide chains (dimeric)



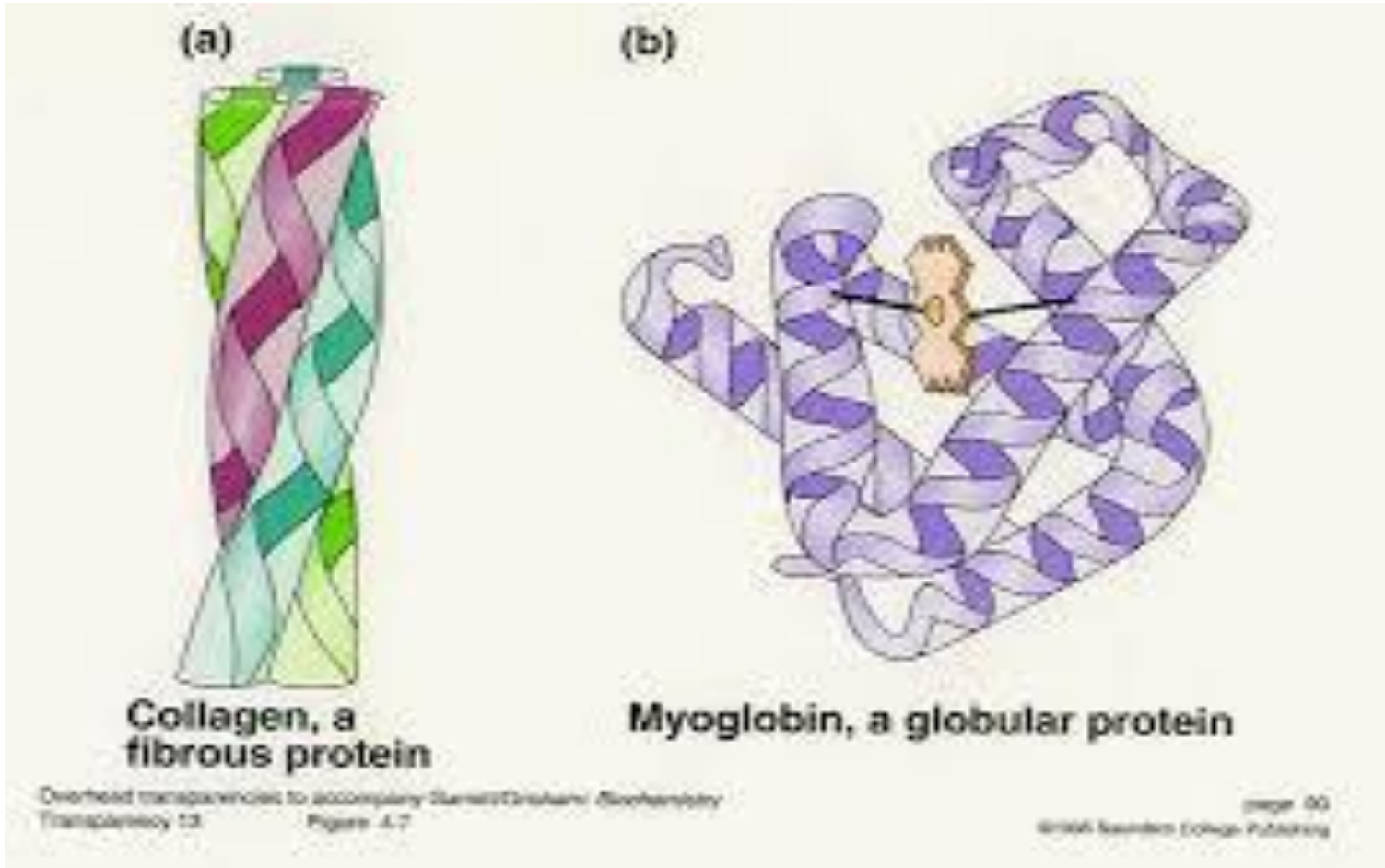

β Pleated sheet
Val – Gly – Ser – Leu –
(a) Primary structure
α Helix
(b) Secondary structure
(c) Tertiary structure
(d) Quaternary structure

Classification of Proteins

- 1) classification of proteins based on physical properties;
  - Fibrous Proteins,
  - Globular Proteins
- 2) classification of proteins based on function,
- 3) Conjugated proteins

1) classification of proteins based on physical properties

CLASSIFICATION OF PROTEINS BASED ON PHYSICAL PROPERTIES		
Class	**Properties**	**Examples**
I. FIBROUS PROTEINS	**Insoluble in aqueous solutions elongated molecules often consisting of several coiled polypeptide chains**	
1. Collagens	**Can be converted into soluble gelatins by boiling contain large amounts of hydroxy-proline and hydroxylysine but no cysteine or tryptophan**	**The major proteins of connective tissues**
2. Elastin	**Similar to collagens but cannot be converted to gelatins by boiling**	**Proteins of tendons and arteries**
3. Keratins	**Contain large amounts of cysteine**	**Hair, wool, nails (Hair is about 14% cysteine)**


(a)
(b)
Collagen, a fibrous protein
Myoglobin, a globular protein

CLASSIFICATION OF PROTEINS BASED ON PHYSICAL PROPERTIES		
Class	**Properties**	**Examples**
II GLOBULAR PROTEINS	**Soluble in aqueous solutions spherical or ellipsoidal in shape**	
1. Albumins	**Readily soluble in pure water coagulated by heat function as carriers for hydrophobic molecules**	**Serum albumin, egg albumin**
2. Globulins	**Insoluble or only slightly soluble in pure water very soluble in aqueous salt solutions can be coagulated by heat**	**Enzymes and antibodies**
3. Histones	**Basic proteins contain large amounts of arginine and lysine soluble in pure water**	**Histones in chromatin**
4. Protamines	**Very basic proteins contain large amounts of arginine but no tryptophan or tyrosine**	**Found in sperm cell chromosomes**

2) classification of proteins based on function

Classification of proteins based on function		
Class	Properties	Examples
CATALYTIC PROTEINS I. Enzymes	Catalyze chemical reactions	Lactate dehydrogenase (LDH) amylase pyruvate dehydrogenase
II. **NONCATALYTIC PROTEINS** 1. Carrier proteins	Carry molecules or ions through the bloodstream	Hemoglobin, albumin
2. Receptor proteins	Bind hormones and neurotrans mitters to cell membranes	The insulin receptor
3. Membrane transport proteins	Carry molecules across cell membranes	Na+ K+ Atpase, which transports K+ ions into cells and pumps Na+ ions out of cells
4. Structural proteins	Form extracellular structures such as hair and nails	Collagen keratin
5. Contractile proteins	Extend or contract to produce movement of muscles cells or subcellular parts	Myosin, tubulin

Classification of proteins based on function……. cont		
Class	Properties	Examples
6. Proteins hormones	**Messenger molecules that direct the activities of various cells and organs**	**Insulin, adreno corticotropic hormone (ACTH), growth hormones**
7. Antibodies	Bind to foreign substances and activate their elimination from the body	Anti-Rh, Anti –A (antibodies in Rh factor and to blood group A)

3) Conjugated Proteins

II CONGUGATED PROTEINS

Types	Prosthetic Group	Properties	Example
Nucleoproteins	Nucletic acid (DNA,RNA)	Large, compact complexes	Chromatin, ribosomes
Mucoproteins*	Carbohydrate	More than 4% carbohydrate by weight	Human chorionic gonadotrophin, a hormone used to test for pregnancy
Glycoproteins * Lipoproteins	Carbohydrate Lipid	Less than 4% carbohydrate Water soluble	Antibodies Serum lipoproteins
Proteolipids	Lipid	Not very water soluble, soluble in nonpolar solvents	Cell membranes
Hemoproteins	Heme group	Characteristic color	Hemoglobin, cytochrome c
Metalloproteins	Metal ion (Fe^{3+}, Zn^{2+} Mg^{2+}, Mn^{2+})	Require a metal ion to function	Carbonic anhydrase
*The distinction between mucoproteins and glycoproteins is somewhat arbitrary			