BIOCHEMISTRY 1

2ND CLASS

UNIVERSITY OF ANBAR

COLLOGE OF SCIENCE

BIOLOGY DEPARTMENT

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Proteins

Lecture three(3)

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References:

Harper's Illustrated Biochemistry

Lippincott Biochemistry

Lehninger Principles of Biochemistry

Stryer Biochemistry

Learning Objectives

- To understand:
- The functions of protein as an important biomolecule
- Different structures of proteins
- Structures of two peptide chains conformations: alpha helix and beta pleated sheet
- The concept of folding, unfolding and misfolding of protein
- The deficiency and excess of proteins in human nutrition

Protein Nomenclature

- Peptides 2 – 50 amino acids
- Polypeptide 50-100
- Proteins >100 amino acids
- Amino acid with free α-amino group is the amino-terminal or N-terminal residue
- Amino acid with free α-carboxyl group is the carboxyl-terminal or C-terminal residue
- Three letter code – Met-Gly-Glu-Thr-Arg-His
- Single letter code – M-G-E-T-R-H

Proteins

- Proteins are polymers of amino acids
- Proteins range in size from small peptides to very large polypeptides chains of 100 to several thousand amino acid residues
- Proteins are the most abundant biological macromolecules occurring in all cells.

Classification of Proteins

Proteins can be classified according to

- **Protein Function**
- **Shape**
- **Chemical Composition**

Protein Function

Physiological functions

- Enzymes---- **Catalysis**
- Nutrient and Storage proteins----- **seeds and eggs**
- Contractile or Motile proteins---- **actin, myosin**
- Structural proteins-----**keratin**
- Defense proteins-----**antibodies**
- Regulatory proteins--- **Insulin**
- Transport proteins-----**hemoglobin**
- Other proteins

- Enzymes: The most valid and the most highly specialized proteins are those with catalytic activity – the enzymes. All the chemical reactions of organic biomolecules in cells are catalyzed by enzymes.

- Transport proteins: These proteins in blood bind and carry specific molecules or ions from one organ to another, e.g. Hemoglobin, lipoprotein

- Nutrient and storage proteins: The seeds of many plants store nutrient proteins required for the growth of germinating seedling, e.g. seed protein of corn, rice and wheat. Ovalbumin, the protein of egg white and casein the protein of milk are other examples of nutrient proteins. The ferritin found in some bacteria and in plant and animal tissues stores iron.

- **Contractile or motile proteins**: Some proteins endow cells and organisms with the ability to contract, change shape, or move about. Actin and myosin function in the contractile system of skeletal muscle and in many other cells.

- **Structural proteins**: Many proteins serve as supporting filaments, cables, or sheets to give biological structures, strength or protections. The major component of tendons and cartilage is the fibrous protein of collagen, which has very high tensile strength. Leather is almost pure collagen. Hairs, fingernails and feathers consist of the tough, insoluble protein keratin. The major component of silk fibers and spider webs is fibroin.

- **Defense proteins**: Many proteins defend organism against invasion by other species or protect them from injury. The immunoglobulins or antibodies, the specialized proteins made by the lymphocytes of vertebrates can recognize and precipitate or neutralize invading bacteria, viruses or foreign proteins of another species. Fibrinogen and thrombin are blood-clotting factors that prevent loss of blood when the vascular system is injured.

Regulatory proteins: Some proteins help regulate cellular or physiological activities, e.g. Insulin, a hormone regulates the metabolism of sugars. Other regulatory proteins bind to DNA and regulates the biosynthesis of enzymes and RNA molecules, involved in cell division in both prokaryotes and eucaryotes.

Other proteins: There are numerous other proteins whose functions are rather exotic and not easily classified, e.g., monellin, a protein of an African Plant, has an intensely sweet taste. It is being studied as a nontoxic food sweetener for human use

All these proteins with their very different properties and functions are made from the same group of 20 amino acids.

A gallery of protein structure and function…

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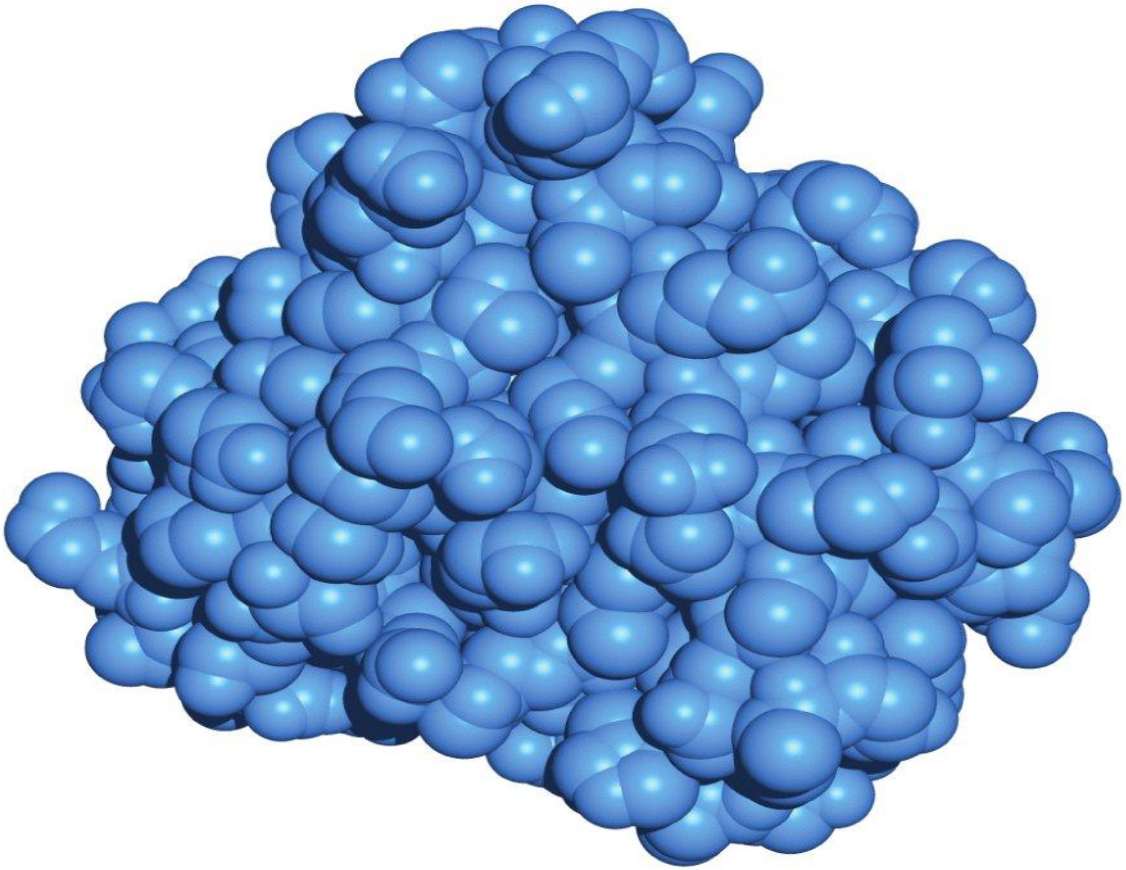
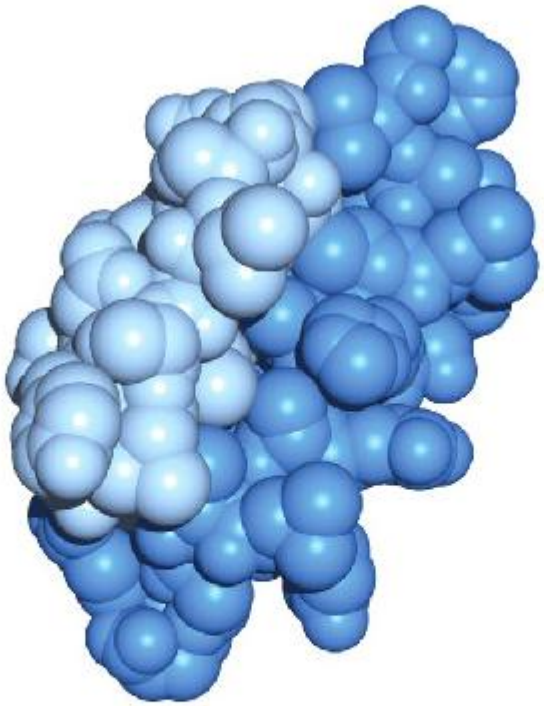


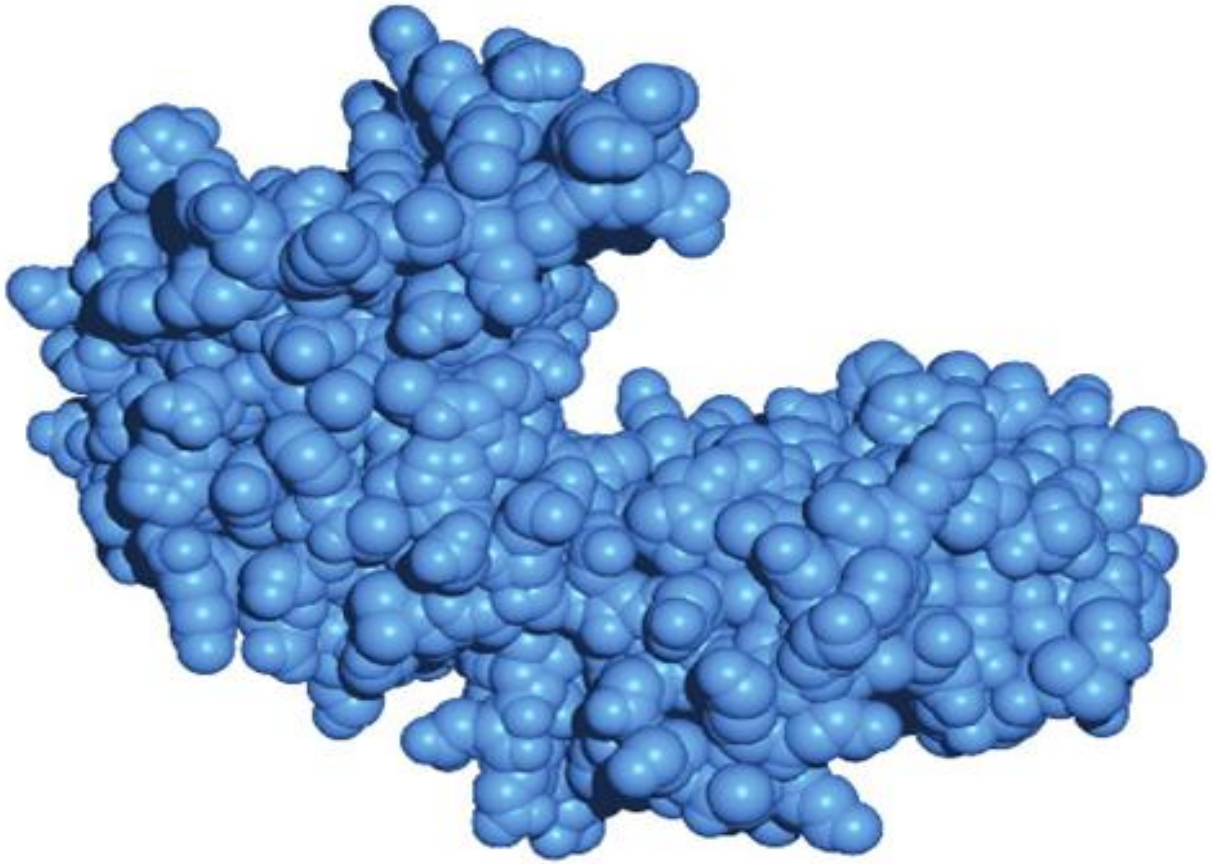
Myoglobin (sperm whale)
Facilitates oxygen diffusion in muscle

A gallery of protein structure and function…



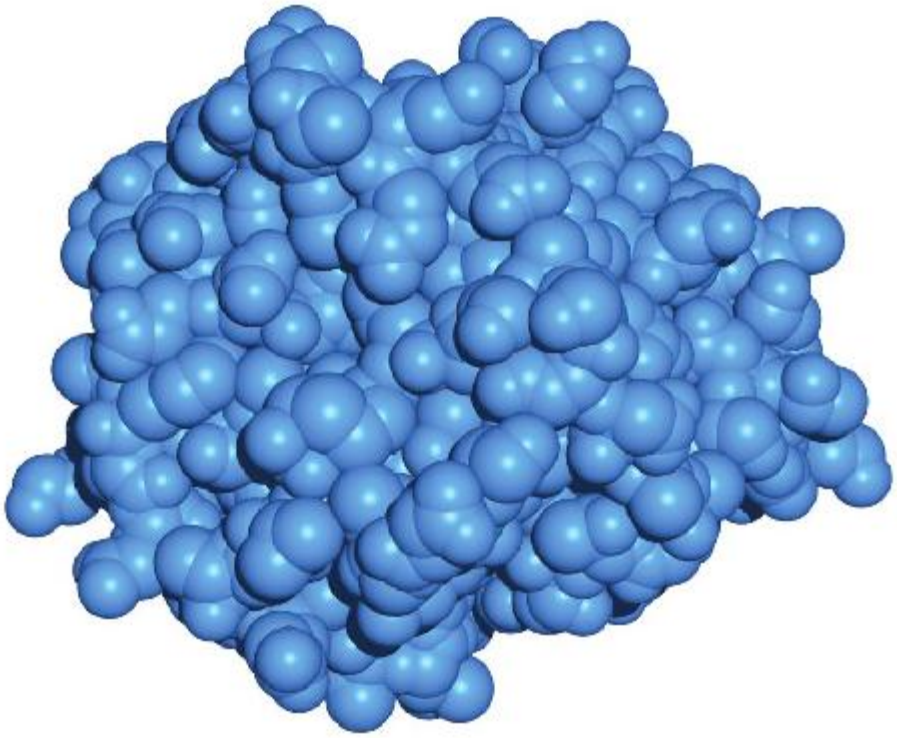
Insulin (pig)
Released from the pancreas to signal the availability of the metabolic fuel glucose

A gallery of protein structure and function…



Phosphoglycerate kinase (yeast)
Catalyzes one of the central reactions in metabolism

A gallery of protein structure and function



Chymotrypsin (cow)
Degrades dietary proteins in the small intestine

Properties of proteins

- Proteins are very large molecules
- Proteins have characteristics amino acid composition
- Some proteins contain chemical groups other than amino acids
- Protein can be separated and purified
- Individual proteins can be quantified
- The functions of a protein depend on its amino acids sequence
- The amino acid sequence of polypeptides chain can be determined
- Homologous proteins from different species have homologous sequences

Shape of Protein

- **Fibrous proteins**
  - Water insoluble
  - Have a role as structural elements, e.g. Collagen, elastin, α-keratin and silk fibroin

- **Globular proteins**
  - water soluble
  - biologically active, e.g. Insulin, albumin, globulins and many enzymes

Chemical Composition of Proteins

Proteins are classified according to their chemical composition into

- Simple Proteins.
- Conjugated Proteins.
- Derived Proteins

- Simple Proteins
  - Contain only amino acid residues and no other chemical constituents for example the enzymes ribonuclease A and chymotrypsinogen

Conjugated Proteins

- They are combinations of proteins with a non- protein part
- The non–amino acid part of a conjugated protein is usually called its prosthetic group
- Conjugated proteins are classified on the basis of the chemical nature of their prosthetic groups (table below)
- Usually the prosthetic group plays an important role in the protein's biological function

Class	*Prosthetic group*	*Example*
Lipoproteins	Lipids	β_1-Lipoprotein of blood
Glycoproteins	Carbohydrates	Immunoglobulin G
Phosphoproteins	Phosphate groups	Casein of milk
Hemoproteins	Heme (iron porphyrin)	Hemoglobin
Flavoproteins	Flavin nucleotides	Succinate dehydrogenase
Metalloproteins	Iron	Ferritin
	Zinc	Alcohol dehydrogenase
	Calcium	Calmodulin
	Molybdenum	Dinitrogenase
	Copper	Plastocyanin

- Derived proteins:

  - They are degradation products of native proteins as denatured proteins or hydrolytic products as peptones and peptide.

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