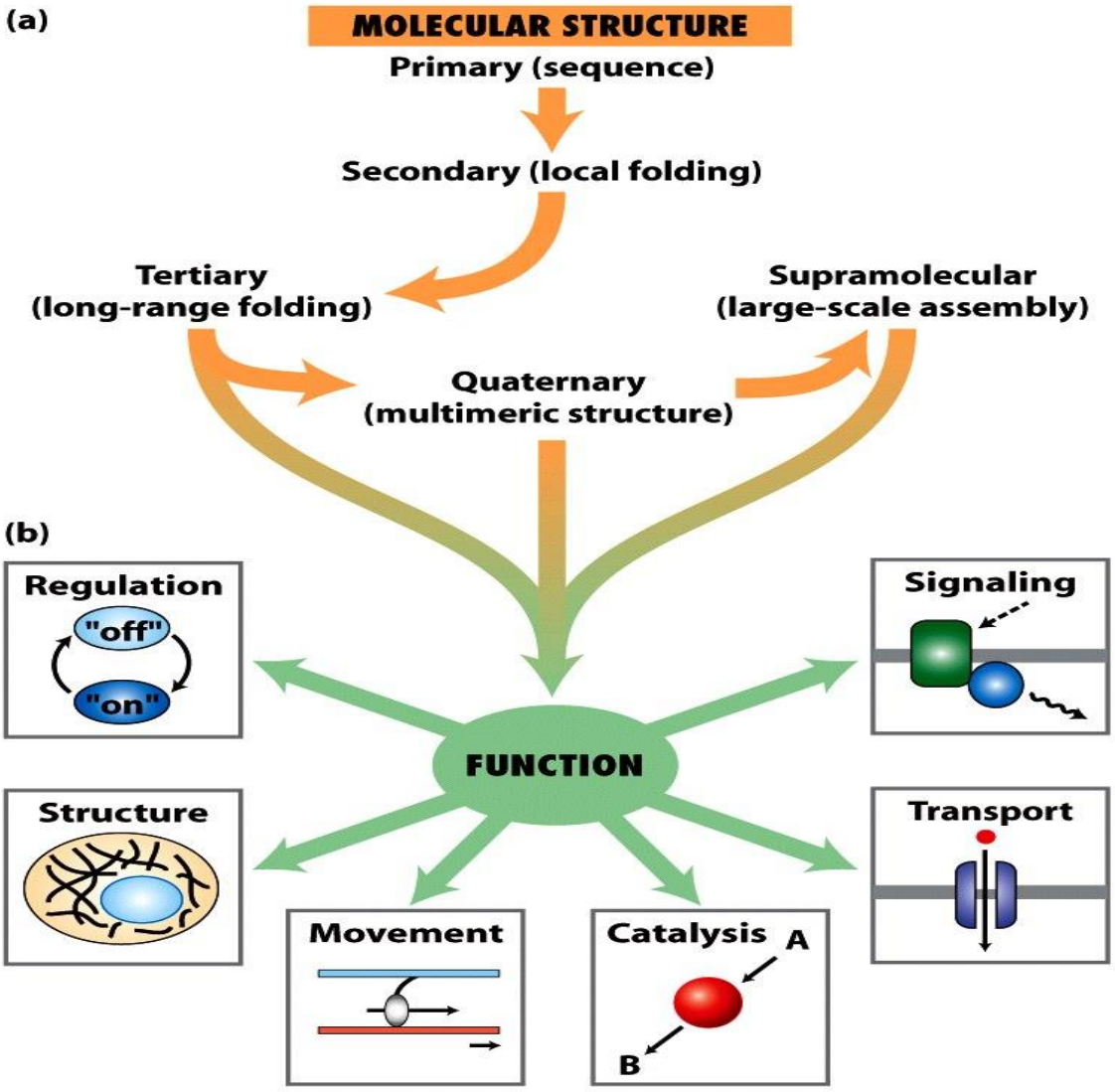

Figure 3-1
Molecular Cell Biology, Sixth Edition

CLASSIFICATION OF PROTEINS

Classification Based on Functions

1. Catalytic proteins, e.g. enzymes
2. Structural proteins, e.g. collagen, elastin
3. Contractile proteins, e.g. myosin, actin.
4. Transport proteins, e.g. hemoglobin, myoglobin, albumin, transferrin
5. Regulatory proteins or hormones, e.g. ACTH, insulin, growth hormone

6. Genetic proteins, e.g. histones
7. Protective proteins, e.g. immunoglobulins, interferons, clotting factors.

Classification based on Composition and Solubility

According to this classification, proteins are divided into three main groups as simple, conjugated and derived proteins.

I- Simple proteins:

On hydrolysis gives only amino acids , Examples:

1- Albumin and globulins: present in egg, milk and blood. They are proteins of high biological value i.e. contain all essential amino acids and easily digested.

Albumin is a protein made by the liver. It makes up about 60% of the total protein in the blood and plays many roles. Albumin keeps fluid from leaking out of blood vessels and transports hormones, vitamins, drugs, and substances like calcium throughout the body. Levels of albumin may decrease, to a greater or lesser degree, when conditions interfere with its production by the liver, increase protein breakdown, increase protein loss via the kidneys, and/or expand plasma volume (diluting the blood).

Two important causes of low blood albumin include:

- Severe liver disease—since albumin is produced by the liver, its level can decrease with loss of liver function; however, this typically occurs only when the liver has been severely affected.
- Kidney disease—one of the many functions of the kidneys is to conserve plasma proteins such as albumin so that they are not released along with waste products when urine is produced. However, if a person's kidneys become damaged or diseased, they begin to lose their ability to conserve albumin and

other proteins. This is frequently seen in chronic diseases, such as diabetes and hypertension. In nephrotic syndrome, very high amounts of albumin are lost through the kidneys.

Globulins

The globulins are a family of globular proteins that have higher molecular weights than albumins and are insoluble in pure water but dissolve in dilute salt solutions.

Types of globulins:

α1 globulin: e.g. antitrypsin

α2 globulin: e.g. hepatoglobin: protein that binds hemoglobin to prevent its excretion by the kidney

β-globulin: e.g. transferrin: protein that transport iron

γ-globulins = **Immunoglobulins** (antibodies) : responsible for immunity.

2- Globins (Histones): They are basic proteins rich in histidine amino acid.

They are present in:

a - combined with DNA

b - combined with heme to form hemoglobin of RBCs.

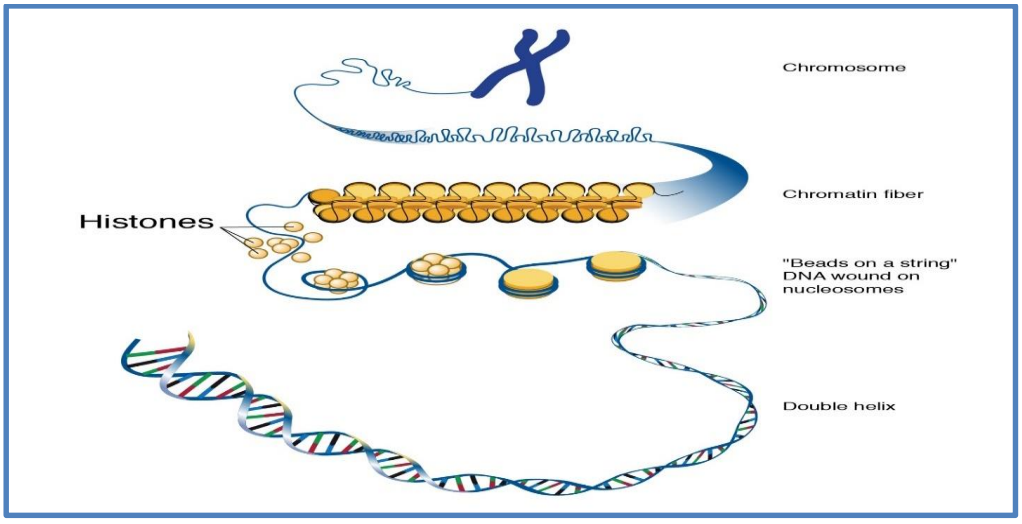

Figure: Histone combined with DNA

3- Gliadines They are **plant proteins** e.g., glutenin of wheat

4- Scleroproteins: They are structural proteins, not digested. include: keratin, collagen and elastin.

a- α-keratin: protein found in hair, nails, enamel of teeth and outer layer of skin. It is rich in cysteine and hydrophobic (non polar) amino acids so it is water insoluble.

b- Collagens: protein of connective tissues found in bone, teeth, cartilage, tendons, skin and blood vessels. Collagen may be present as gel e.g. in extracellular matrix or in vitreous humor of the eye. Collagens are the most important protein in mammals. They form about 30% of total body proteins.

C- Elastin: present in walls of large blood vessels (such as aorta). It is very important in lungs, elastic ligaments, skin, cartilage, .It is elastic fiber that can be stretched to several times as its normal length.

Conjugated proteins

They are combinations of protein with a non-protein part, called **prosthetic group**

Conjugated proteins may be classified as follows

1-**Glycoproteins**: These are proteins combined with carbohydrates. Hydroxyl groups of serine or threonine and amide groups of asparagine and glutamine form linkages with carbohydrate residues. Blood group antigens and many serum proteins are glycoproteins.

2- **Lipoproteins:** These are proteins loosely combined with lipid components. They occur in blood and on cell membranes.

3- **Nucleoproteins:** These are proteins attached to nucleic acids, e.g. Histones. The DNA carries negative charges, which combines with positively charged proteins.

4- **Chromoproteins:** These are proteins with coloured prosthetic groups. Hemoglobin (Heme, red);Flavoproteins (Riboflavin, yellow) are some examples of chromoproteins.

5- **Phosphoproteins:** These contain phosphorus. **Casein** of milk and **vitellin** of egg yolk are examples. The phosphoric acid is esterified to the hydroxyl groups of serine and threonine residues of proteins.

6- **Metalloproteins:** They contain metal ions. Examples are Hemoglobin (Iron), Cytochrome (Iron), Tyrosinase (Copper) and Carbonic anhydrase (Zinc).

Classification Depending on the Shape

1- Fibrous

1) polypeptides arranged in long strands or sheets
2) water insoluble (lots of hydrophobic AA's)
3) strong but flexible
4) Structural (keratin, collagen)

2- Globular

1) polypeptide chains folded into spherical or globular form
2) water soluble
3) contain several types of secondary structure
4) diverse functions (enzymes, regulatory proteins)

Classification Based on Nutritional Value

Nutritionally Rich Proteins

They are also called as **complete proteins or first class proteins**. They contain all the essential amino acids in the required proportion. On supplying these proteins in the diet, children will grow satisfactorily. A good example is **casein** of milk.

Incomplete Proteins

They **lack one essential amino acid.** They cannot promote body growth in children; but may be able to sustain the body weight in adults. Proteins from **pulses are deficient in methionine**, while proteins of **cereals lack in lysine**. If both of them are combined in the diet, adequate growth may be obtained.

Poor Proteins

They **lack in many essential amino acids** and a diet based on these proteins will not even sustain the original body weight. Zein from corn lacks tryptophan and lysine.

Diseases caused by changes in protein structure

- Sickle Cell Anemia – single amino acid change in hemoglobin related to disease.
- Osteoarthritis – single amino acid change in collagen protein causes joint damage

Plasma Protein

A **protein** present in blood **plasma** (6 to 8 g/100 mL).The plasma proteins consist of albumin (3.5 to 5 g/dL), globulins (2.5 – 3.5 g/dL) and fibrinogen (200– 400 mg/dL). The albumin : globulin ratio is usually between 1.2:1 to 1.5:1.

Site of synthesis of Plasma Proteins

- Liver - 90% plasma proteins
- Plasma cell (B lymphocytes) - γ globulin
- Peptide hormones – Endocrine glands

Methods of plasma protein separation

Common methods of protein separation into: albumin, globulins (alpha, beta & gamma) and fibrinogen by:

- Electrophoresis
- Salting out
- Ultracentrifugation
- Affinity chromatography
- Fractional precipitation method
- Immune electrophoresis

Note

If blood is mixed with an anticoagulant and centrifuged, the cell components (RBC and WBC) are precipitated. The supernatant is called plasma. About 55–60% of blood is made up of plasma.

If blood is withdrawn without anticoagulant and allowed to clot, after about 2 hours liquid portion is separated from the clot. This defibrinated plasma is called serum, which lacks coagulation factors including prothrombin and fibrinogen.