**Proteins**

**INTRODUCTION**

* The name ‘Protein’ was suggested by Mulder in 1938 to the complex organic nitrogenous substances found in animal and plant tissue.
* Protein constitute about one-fifth of the animal body on the fresh weight basis
* The basic units of proteins are the amino acids. Each amino acid contains an acidic group and an amino group.
* Proteins consist of chains of amino acid that are linked to each other by peptide linkage.

**DEFINITION**

Proteins are large, complex, organic compounds made-up of carbon, oxygen and nitrogen.

The presence of nitrogen distinguishes proteins from carbohydrates and fats.

**PROPERTIES**

* Proteins are colloids.
* They act both as weak acids and bases
* They are, in general, soluble in sodium hydroxide and when the alkaline solutions of proteins are acidified, the proteins are precipitated
* When proteins are heated, a decrease in their solubility is observed . This is known as ‘denaturation.’

**Amino acids**

Amino acids are biologically important organic compounds composed of amine (-NH2) and carboxylic acid (-COOH) functional groups, along with a side-chain specific to each amino acid.

**Amino Acid**

* These are nitrogen containing compound of which protein is composed.
* There are twenty amino acids out of which nine are considered essential and are known as EAA (Essential Amino Acids).
* A protein is said to be biologically complete if it contains all essential amino acids in required amount.
* When one or more EAA(essential amino acid) is lacking that is called “biologically incomplete”

**ESSENTIAL Amino Acids**

* + Histidine
	+ Isoleucine
	+ Leucine
	+ Lysine
	+ Methionine
	+ Phenylalanine
	+ Treonine
	+ Tryptophan
	+ Valine

**NON ESSENTIAL Amino Acids**

* + Alanine
	+ Arginine
	+ Asparagine
	+ Aspartic acid
	+ Cysteine
	+ Glutamic acid
	+ Glutamine
	+ Glycine
	+ Hydroxyproline
	+ Proline
	+ Serine
	+ Tyrosine

**Classification**

* **Classification by** **structure**
* Simple proteins
* Conjugated proteins
* Derived proteins
* **Classification by** **quality**
* Complete proteins
* Partially complete proteins
* Incomplete proteins

**SIMPLE PROTEINS**

 These proteins are made –up of amino acids only e.g. zein in corn, albumin in egg and globin in haemoglobin etc.

**CONJUGATED PROTEINS**

 These are the proteins which are combined with a non protein molecules e.g. Haemoglobin (protein+haem) Mucin (protein + carbohydrates), Lipoprotein ( lipid+protein).

**DERIVED PROTEINS**

These are produced by actions of acids, alkalise, heat and enzymes on native proteins. E.g. peptones and polypeptides are formed when digestive enzymes begin their action on proteins.

**CLASSIFICATION BY QUALITY**

**Complete or First Class Proteins**

* + High quality.
	+ Contains all essential amino acids in sufficent proportions and amounts to meet the body’s need.
	+ This protein is also called biologically complete proteins.
	+ Found in animal foods e.g. eggs,milk,meat,fish etc.

**Partially complete proteins:**

* They do not contain all the essential amino acid in required amount .
* They are found in plant foods.
* Cereals, pulses, nuts and oil seeds.
* Cereals contain inadequate amounts of essential amino acid lysine and pulses are deficient in methionine.

**Incomplete proteins:**

* Low quality.
* Lacks one or more amino acid.
* Cannot build tissue without help.

 e.g. Gelatin lacks three essential amino acids.

**COMPLEMENTORY PROTEINS**

* Occurs when a combination of incomplete proteins are eaten in the same day to make a complete protein.
* **Examples**: Corn and beans, rice and beans, bread and peanut butter, bread and split pea soup, bread and cheese, bread and baked beans, macaroni and cheese, cereal and milk.

**Food Sources**

**Animal food sources:**

* + Complete proteins
	+ Meats, fish, poultry, eggs, milk, cheese

**Plant food sources:**

* + Incomplete proteins
	+ Corn, grain, nuts, sunflower seeds, cereals, sesame seeds, and legumes

**Food Sources**

**Analogues :**

* + Meat alternatives made from soya protein and other ingredients to simulate various kinds of meat.
	+ Tofu is a soft cheese like food made from soya milk.

**PROTEIN CONTENT OF FOODS**

**Stop and Share**

Your client is concerned because her daughter is a vegetarian and does not eat meat. Your client states, “My daughter does not eat meat, so I know she doesn’t get any protein. She is ruining her body.”

How do you respond?

* Although animal foods are the best sources of complete proteins, foods that provide incomplete proteins can be combined to make complete proteins. The best sources of incomplete proteins are legumes, corn, grains, and nuts. Soya protein and tofu are nutritious meat replacements.

**FUNCTIONS**

* **Building and repairing body tissue:**

 The primary function of proteins is the synthesis of body cells.

* Proteins are the major constituent of muscles

 organs, endocrine gland and collagen.

* Collagen is the main structural protein of bones,tendons,ligaments,skin etc.
* Metabolism and digestion.
* Fluid and electrolyte balance.
* Development of antibodies.
* **Maintenance of wear and tear:** Protein is required by all age groups for continuous maintenance of all body cells

Cells have a varying life span and proteins is needed to replace the old and worn out cells

* **Regulatory functions**: Hemo-globulin ,an iron containing protein in the red blood cells ,carries the oxygen to the tissues
	+ Plasma protein maintains water balance and regulates the osmotic pressure in the body
	+ Antibodies are made-up of proteins which protect us by increasing the body’s resistance to disease
	+ All enzymes and some hormones i.e. insulin, regulate blood sugar level. Enzymes act as specific catalysts to metabolic processes in the body.
* **Providing energy**
* **Energy** : proteins are a potential source of energy. Each gram of protein yields on the average 4 kcal. If the diet does not supply adequate calories from fats & carbohydrates, the protein will be oxidized to meet the energy needs of the body.
* Synthesis of certain substances like antibodies, enzymes, hormones & coagulation factors in another important function of the protein.
* **Others:** protein provides amino acids for growth of fetus in pregnancy & for the production of milk during lactation; so extra proteins are advisable during pregnancy & lactation.

**DIGESTION & ABSORPTION**

**Mechanical digestion**

* Begins in mouth
* Teeth grind food into small pieces

**Chemical digestion**

* Begins in stomach
* Hydrochloric acid prepares stomach
* The proteolytic enzymes present in gastric juice is called pepsin
* Enzyme pepsin reduces proteins to polypeptides

**GASTRIC DIGESTION:**

The proteolytic enzyme present in gastric juice is called pepsin. It acts on proteins in an acid medium and hydrolyses them to simpler compounds known as polypeptides.

**INTESTINAL DIGESTION:**

* The digestion of proteins is further carried on in the intestines by the action of proteolytic enzymes present in the pancreatic and intestinal juices.
* The polypeptides produced by gastric digestion are hydrolyzed to free amino acids.
* The amino acids are absorbed in the small intestine and enter the blood circulation through portal vein.

**PROTEIN METABOLISM:**

It occurs by:

* Breakdown and synthesis of tissue proteins
* Nitrogen balance
* Oxidation of amino acids

**Breakdown and synthesis of tissue proteins**

* A part of the tissue proteins is broken down continuously and is replaced by the formation of new tissue protein from amino acids supplied by diet.
* The breakdown of tissue protein is called catabolism and the formation of the new protein is known as anabolism.

**Nitrogen balance**

* When nitrogen intake equals the nitrogen lost from body through urine and faeces the body is said to be in state of nitrogen equilibrium.
* When the nitrogen lost from the body is less than that of the nitrogen intake, the body is in positive nitrogen balance.
* If the nitrogen lost from the body is higher than the nitrogen intake, the body is said to be in negative nitrogen imbalance.

**Oxidation of amino acids**

* The amino acids not utilized for the formation of tissue proteins are oxidized by enzymes in the liver
* The ammonia thus formed is converted into urea in the liver and excreted in the urine.
* The keto acids are oxidized to yield energy.

**Dietary Requirements**

* Determined by size, age, sex, and physical and emotional conditions.
* The National Research Council of the National Academy of Sciences considers the average daily requirement to be **0.8 g** of protein for each kilogram of body weight.

 **To determine your requirement:**

* + Divide body weight by 2.2 (the number of pounds per kilogram)
	+ Multiply the answer obtained in the first step by 0.8 (grams of protein per kilogram of body weight)

**Protein Excess**

* Increased demand on kidneys
* National Research Council recommends that protein intake represent no more than 15-20% of one’s daily kcal intake and not exceed double the amount given in the table of Recommended Dietary Allowances.

**Protein Deficiency**

* Muscle wasting occurs.
* Albumin (protein in blood plasma) causes edema.
* Loss of appetite, strength, weight.
* Lethargy, depression, slow wound healing.

**PROTEIN ENERGY MALNUTRITION**

* It has been identified as major health and nutritional problem in India
* Lack protein and energy-rich foods.
* Found in developing countries with shortages of protein and energy-rich foods.
* Stunted growth and mental retardation may occur.
* PEM has its two clinical forms **- Kwashiorkor & Marasmus**

**MARASMUS**

* This is caused by severe deficiency of proteins & calories(both) in diet.
* Affects very young children.
* Results from severe malnutrition (lack of protein, vitamins, and minerals).
* Emaciated, no edema
* Hair is dull and dry; skin thin and wrinkled.

**Classification :**

* Gomez’s classification
* Water low's classification
* **Gomez's classification**: it is based on weight retardation.
* It locates the child on the basis of his/her weight in comparison with a normal child of same age.
* **Water loo's classification**: this is done with help of age (if known)
* Measurements of height assess the effect of nutritional status on long term growth

**Kwashiorkor**

* Sudden or recent lack of protein-containing food; affects children and adults.
* Fat accumulates in liver, and lack of protein and hormones results in edema, painful skin lesions, and changes in pigmentation of skin and hair.
* High mortality rate

**Causes of PEM**

* **An inadequate intake of food** in quality & quantity
* **Infections** like diarrhea ,measles, respiratory infections & intestinal worms which increase requirements for proteins.
* **Others** : poor environmental conditions, large family size, failure of lactation, premature termination of breast feeding etc.

**Conclusion**

* Proteins contain nitrogen.
* They build and repair body tissues, regulate body processes, and supply energy.
* Each gram of protein provides 4 kcal.
* Composed of amino acids.
* Nine of the amino acids are essential for growth and development.