



NUTRITIONAL BIOCHEMISTRY (BCH 412)

MODULE 1 – FOOD NUTRIENTS

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NUTRITION

- Nutrition is the science of food and its relationship to health.
- Nutrition refers to nourishment that sustains life.
- Pike and Brown, 1984 defined it as “the science that interprets the relationship of food to the functioning of living organism.

FOOD NUTRIENTS

- **Food nutrients** are chemical constituents in the food we eat that are essential for life and must be supplied to the body in suitable amount. They provide the energy needed for the metabolic processes in the body.
- The six essential food nutrients are: **proteins, fats, carbohydrate, vitamins, minerals and water.**
- The essential food nutrients may be further classified into **macronutrients** and **micronutrients.**

MACRONUTRIENTS

- **Macronutrients** are required in relatively large amounts to fuel the body and are also required for growth and maintenance of the body.
- carbohydrates
- proteins
- fats

MICRONUTRIENTS

- **Micronutrients**, as opposed to macronutrients are made up of vitamins and minerals which are required in small quantities to ensure normal metabolism, growth and physical well-being.
- **Minerals:** these comprise **microminerals** or **trace elements** (Fe, Cu, F, Zn, I, Se, Mn, Mo, Cr, Co and B) and **macrominerals** (Na, Mg, K, Ca, P, S and Cl)
- **vitamins** (A, B, C, D, E, K)

CARBOHYDRATES

- Carbohydrates $C_x(H_2O)_y / (CH_2O)_n$ are made up of carbon, hydrogen and oxygen and are burned during metabolism to produce energy. This group is a major energy source to the body.
- Carbohydrates are present in the form of **sugars**, **starch** (polymers of sugars) and **fiber** (Non-Starch Polysaccharide- NSP).
- In the diet of poor people, especially in the tropics, up to 85% of the energy may come from this source. On the other hand, in the diet of the rich people in many countries the proportion may be as low as 40%.

CARBOHYDRATES

- Carbohydrates are components of body substances needed for the regulation of body processes.
- Heparin, which prevents blood from clotting, contains carbohydrate.
- Ribose, another carbohydrate is part of Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA), the substances that carry the hereditary factors in the cell.

CARBOHYDRATES

- Other naturally occurring carbohydrates of interest in foods include –
- **glucose, fructose** (monosaccharides- are simplest form of carbohydrate and cannot be hydrolyzed further.)
- **sucrose, maltose and lactose** (disaccharides) and
- **starch** (polysaccharide).

DIGESTION AND ABSORPTION OF CARBOHYDRATES

- The digestion of carbohydrates begins in the mouth by amylase produced by the salivary glands. No carbohydrate digestion takes place in the stomach. Digestion occurs mainly in the small intestine through the action of pancreatic and intestinal juices:
 - Amylase
 - Lactase
 - Sucrase
 - Maltase

- The two hormones, which control the metabolism of carbohydrates, are insulin and glucagon
- Insulin is secreted by the beta cells of the islets of Langerhans
- glucagon is secreted by the alpha cells of the islets of langerhans

FUNCTIONS OF CARBOHYDRATES

- Major energy providing nutrient in the diet. It provides 4kcal/g
- The dietary fiber/non-digestible carbohydrate help in various ways.
- Different starches are used as thickening agents e.g. corn flour
- Pentoses are components of DNA and RNA.

FOOD SOURCES

- **Sugars** are found naturally in fruits, milk, honey and the sap of certain trees.
- **Starch is found in:** grains (rice, corn/maize, wheat, millet, oats), roots and tubers (potatoes, cassava, yams and certain fruits (breadfruit, banana/plantain, water chestnut)).
- **Foods containing fiber are:** wholegrain cereals, starchy roots, fruits, most vegetables, beans, peas and other legumes

LIPIDS

- Lipids consist of a broad group of compounds that are generally soluble in organic solvents but insoluble in water.
- They are major components of adipose tissue, and together with proteins and carbohydrates, they constitute the principal structural components of all living cells.
- Fatty acids in lipids can be grouped into **unsaturated fatty acids** (including monounsaturated and polyunsaturated) and **saturated fatty acids**.

LIPIDS

- ***Sources of monounsaturated fats are:*** canola oil; peanut oil; olive oil; avocados; nuts, such as almonds, hazelnuts and pecans; and seeds such as pumpkin and sesame seeds.
- ***Sources of polyunsaturated fats are:*** sunflower oil; corn oil; soybean oil; flaxseed oil; walnuts, flaxseeds; and fish. Fatty fishes, including salmon, trout, mackerel, herring, sardines,

DIGESTION OF LIPIDS

In the mouth

- Enzyme – lingual lipase
- End products – diglycerides

In the stomach

- Enzyme – Gastric lipase
- End products – Fatty acids, glycerol, diglycerides and monoglycerides

In small intestine

- Enzyme – Pancreatic lipase
- End products – monoglycerides, fatty acids, glycerol

FUNCTIONS OF LIPIDS

- Help in absorption of fat-soluble vitamins.
- Essential fatty acids (EFA) are important for the function and structure of body cell membranes.
- MUFAs and PUFAs have beneficial effects such as lowering risk of coronary heart disease, cancer, cataract, and other inflammatory disorders.
- act as an insulator and padding for vital organs.

PROTEINS

- **PROTEINS** are made up of 'building blocks' called *amino acids*, composed basically of carbon, hydrogen, oxygen and nitrogen (amino group).

Protein Digestion

- Digestion of protein starts from the stomach and finally completes in the small intestine.
- The proteolytic enzymes have the power to attack native proteins and must be secreted in an inactive form to prevent damage to the tissues where they are formed.
- Proteins on hydrolysis break down to polypeptides and finally into amino acids.

PROTEINS

Proteolytic enzymes

- Pepsinogen
- Trypsinogen
- Chemotrypsinogen

Functions of proteins

1. Required for general growth, maintenance & repair of body tissues.
2. It serves as an energy source, It provides 4kcal/g
3. Required for the supply of the essential amino acids which cannot be synthesized by the body
4. Required to build new tissue, particularly during the rapid growth period of infancy and early childhood, during pregnancy and nursing, and after infections or injuries.

WATER

- Water is the most abundant and surely the most frequently overlooked component in food.
- It is estimated that over 35% of our total water intake comes from the moisture in the food we consume.
- The water content of food varies, it may be as low as 0% in vegetable oils and as high as 99% in some vegetables and fruit.
- Water by itself is free of calories and plain water does not contain nutritive substance, but it may be an ingredient itself in food.

MICRONUTRIENTS

- ***Vitamins:*** are defined as organic compounds, other than any of the amino acids, fatty acids and carbohydrates that are necessary in small amounts in the diet of higher animals for growth, maintenance of health and reproduction.

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13 essential vitamins:

- Vitamin A (Retinol)
- Vitamin B1 (Thiamine)
- Vitamin B2 (Riboflavin)
- Vitamin B6 (pyridoxine)

MICRONUTRIENTS (CONTD)

- Vitamin B12 (Cyanocobalamine)
- Niacin
- Panthotenic Acid
- Folate
- Biotin
- Vitamin C (Ascorbic acid)
- Vitamin D (Cholecalciferol)
- Vitamin E (Tocopherol)
- Vitamin K

FUNCTIONS OF VITAMINS:

- promote growth
- promote reproduction
- promote health & vigor
- promote nervous activity
- promote normal appetite
- promote resistance to infection.
- promote digestion

WATER SOLUBLE	FAT SOLUBLE
B, C	A, D, E, K (All Dogs Eat Kibbles)
highly polar with many hydroxyl (-OH) groups	non-polar with long hydrocarbon chains

Vitamin A	
Function	Vitamin A is a fat-soluble vitamin required for the normal functioning of the eyes, the immune system, growth and development, maintenance of healthy skin, and reproduction.
Forms	Vitamin A is present in food in two forms: as preformed vitamin A (retinol) contained in foods of animal origin and easily absorbed; as carotenoids (largely β -carotene) contained in plant foods, these can be biologically transformed to vitamin A but are less easily absorbed
Sources	Retinol is chiefly found in dairy products, liver and some fatty fish. Carotenoids are found in yellow and red fruits and vegetables, and in green leafy vegetables, especially the green outer leaves. Vitamin A is absent in vegetable oils with the exception of red palm oil and fortified vegetable oils or margarine.
Vitamin C	
Function	Vitamin C is a water soluble vitamin and serves a number of essential metabolic functions. It also assists in absorption of non-haem iron and is an important anti-oxidant.
Sources	Fresh fruit and fruit juices are the richest sources of vitamin C, but amounts vary greatly in different fruits.
Niacin	
Function	Niacin is water-soluble and plays a central role in the utilization of food energy.
Sources	Niacin is widely distributed in plant and animal foods, but only in small amounts. Meat (especially offal), fish, milk and groundnuts are rich sources of niacin. Dried fruits, nuts and pulses contain smaller amounts.
Thiamin	
Function	Thiamin is water-soluble and is required mainly for the metabolism of carbohydrate, fat and alcohol. It is also necessary for the proper function of the nervous system and the heart.
Sources	Unrefined cereals, yeast, nuts, legumes, organ meats (e.g., liver and kidney).
Riboflavin	
Function	Riboflavin is water-soluble and is a component of enzymes, which play a role in the utilization of food energy.
Sources	Riboflavin is plentiful in animal foods, green vegetables, and whole wheat. Poor sources are maize, rice and highly refined flour.
Iodine	

MINERALS

- **Minerals** – are inorganic elements occurring in nature. They are inorganic because they do not originate in animal or plant life but rather from the earth's crust.
- Although minerals make up only a small portion of body tissues, they are essential for growth and normal functioning of the body.
- They include the trace elements copper, iodine, iron, manganese, selenium and zinc together with the macro elements calcium, magnesium, potassium and sodium.

FUNCTIONS OF MINERALS

- Some minerals form hard tissues such as bones and teeth
- Electrolytes, sodium and potassium are the most important factors in the osmotic control of water metabolism
- Some minerals may act as catalysts in the enzyme system, or as integral parts of organic compounds in the body such as:
 - Iron in hemoglobin
 - Iodine in thyroxin
 - Cobalt in vitamin B12.
 - Zinc in insulin and
 - Sulfur in thiamine.

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Iodine	
Function	Iodine is an essential constituent of hormones produced by the thyroid gland in the neck. In the foetus, iodine is necessary for the development of the brain and nervous system during the first three months of gestation.
Sources	The level of iodine in the soil determines its content in plants and animals. As most soils contain little iodine, most foods are poor sources. The only rich source of iodine is seafood.
Iron	
Function	Most of the iron in the body is present in red blood cells. The main function of iron is the transfer of oxygen to various sites in the body. Lack of iron eventually results in anaemia.
Sources	Meat, fish, eggs, pulses, green leafy vegetables and fortified blended foods are good iron sources. Cereals contain moderate amounts. Milk is a poorer source.



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