5.1 Nutrition

Nutrients are chemical components of food that are required by living organisms for growth, maintenance, disease prevention, and energy source. Nutrients cannot be synthesized by our body and thus must be obtained from the diets that are considered essential.

5.1.1 Types and functions of nutrients

There are six classes of essential nutrients namely carbohydrates, protein, fat, vitamins, minerals and water. Nutrients are referred to as essential because our body cannot synthesize them and as such, we must obtain them from our diet. The best way to get all six types of nutrients is to eat a variety of different foods each day. Each type of nutrient has a specific purpose and meets a specific function that our body requires.

The six essential classes of nutrients include:

5.1.1.1 Carbohydrates

Carbohydrates are the major source of energy for both plants and animals. They are composed mostly of the elements such as carbon (C), hydrogen (H), and oxygen (O). Through the bonding of these elements, carbohydrates provide energy for the body in the form of kilocalories (kcal). The other biological functions include source of carbon in metabolic processes, structural elements of cells and tissues and storage of energy. Plants use starch and animals use glycogen to store energy; when the energy is needed, the carbohydrates are broken down by enzymes. Carbohydrates are also used in the manufacture of fabrics, photographic film and plastics.

Carbohydrates may be classified as monosaccharides, disaccharides, or polysaccharides by the number of sugar units they contain. Monosaccharides contain 1 sugar unit and the best examples include glucose and fructose, which are found in fruits. Disaccharides contain 2 sugar units, e.g. sucrose (table sugar), lactose (found in

milk) and maltose in beer. Monosaccharides and disaccharides are called simple carbohydrates. Polysaccharides contain 3 or more sugar units. They are usually made up of many linked glucose molecules, unlike simple carbohydrates, hence they do not have a sweet taste. Examples include potatoes, beans, and vegetables. Polysaccharides are often referred to as complex carbohydrates (e.g. whole grain) (Clark, & Blackburn, 1983).

5.1.1.1 Protein

Protein is like the brick and mortar of our body. It is the building blocks that provide the structure for the tissues of the body.

Proteins are made up of chains of amino acids which in turn are composed of the elements such as carbon (C), oxygen (O), hydrogen (H), nitrogen (N) and sometimes sulfur (S) and phosphorus (P). Nitrogen is the most essential element in proteins. Proteins are the primary component of numerous body tissues. There are 20 different amino acids. The body requires amino acids to produce new body proteins for protein retention and to replace damage proteins (maintenance) that are lost in the urine. Our body can be able to produce 14 of the 20 amino acids. The remaining amino acids, we have to get from the foods we eat. The amino acids that our body is able to produce are called *Non-Essential Amino Acids* and that of our body unable to produce are called *Essential Amino Acids* (Dunne, 1990). *Functions:* Proteins have a variety of functions in the body, including as a source of energy for tissue growth and maintenance, and for certain biological functions such as they are needed in body metabolism, antibody and DNA production, enzyme molecules and hormone receptors. When used for energy, protein supplies an average of 4 kcal/g. Proteins are also the major component in bone, muscle, and other tissues and fluids. *Sources:* Protein may be found in a variety of food sources. Proteins from animal sources include meat, eggs, milk, fish etc. and are basically considered to be of high biological value because they contain all of the essential amino acids. Proteins from plant sources include wheat, corn, rice, beans apricots, avocados, bananas, cherries, dates, figs, nuts, and grapes and are considered to be of low biological value because an

individual plant source does not contain all of the essential amino acids (Dunne, 1990).

Protein deficiency diseases: When protein intake is inadequate, but total caloric intake is sufficient, a condition known as **kwashiorkor** may occur. Symptoms of kwashiorkor include an enlarged stomach, loss of hair and hair colour, and an enlarged liver. Conversely, if protein and caloric intake are both inadequate, a condition known as **marasmus** occurs. Marasmus presents with a stoppage of growth, extreme muscle loss, and weakness (Dunne, 1990).

5.1.1.1 Lipids (Fats)

Although fat is often shunned, it is actually a macronutrient that our body needs in large amounts. Lipids, which consist of fats and oils, are high-energy yielding molecules composed mostly of carbon (C), hydrogen (H), and oxygen (O). They are found in all living organisms. Lipids have a smaller number of oxygen molecules than carbohydrates have. This small number of oxygen molecules makes lipids **insoluble** in water, but soluble in certain organic solvents.

According to Balch (1997), lipids are the major form of energy storage in the body (whereas carbohydrates are the body's major source of energy), and are also the major form of fat in foods. The energy contained in a gram of lipids is more than twice the amount in carbohydrates and protein, with an average of 9 kcal/g. Lipids can be classified into two types, saturated and unsaturated, based on the chemical structure. Whether a lipid is solid or liquid at room temperature largely depends on its property of being saturated or unsaturated. *Sources:* Lipids from plant sources include castor, coconut, corn, cottonseed, palm, peanut, soybean, wheat germ and olive. They are largely unsaturated, and therefore liquid at room temperature. Lipids that are derived from animals contain a higher amount of saturated fats, and they are therefore solid at room temperature. The important difference between saturated and unsaturated fatty acids is that saturated fatty acids are the most important factor that can increase a person's cholesterol level. An increased cholesterol level may eventually result in the clogging of blood arteries and, ultimately, a heart disease (Balch, 1997).

Functions: Not all fatty acids are considered harmful. In fact, certain unsaturated fatty acids are considered essential nutrients. Like the essential amino acids, these fatty acids are essential to a person's diet because the body cannot produce them. The essential fatty acids serve many important functions in the body, including *regulating blood pressure* and helping to *synthesize and repair vital cell parts*. Lipids also serve as a source of heat, insulation, and body protection. Lipids are also required for the absorption of fat-soluble vitamins, and they are generally thought to increase the taste and flavor of foods and to give an individual a feeling of satisfaction.

5.1.1.1 Vitamins

Vitamins are organic compounds, meaning they are made from other living organisms such as animals and plants. They are required for our normal growth and body metabolism. Some vitamins are essential for a number of metabolic reactions that result in the release of energy from carbohydrates, fats, and proteins. In humans, there are thirteen vitamins, which may be divided into two groups:

(i) Four fat-soluble vitamins (i.e. vitamins A, D, E, and K). The body can manufacture only vitamin D and rest all others must be derived from the diet.

(ii) Nine water-soluble vitamins (i.e. B vitamins and vitamin C).

These two groups are different from each other in many ways. First of all, cooking or heating destroys the water-soluble vitamins much more easily than the fat-soluble vitamins. On the other hand, fat-soluble vitamins are much less readily excreted from the body, compared to water-soluble vitamins, and can therefore accumulate to excessive, and possibly toxic, levels. This means, the level of water-soluble vitamins in the body can become depleted more quickly, leading to a vitamin deficiency if those nutrients are not replaced regularly.

Vitamins deficiency diseases: Deficiencies of vitamins cause a wide range of metabolic and other dysfunctions. Diseases such as beriberi, pellagra, ariboflavinosis, paresthesia, anemia, scurvy, bleeding diathesis and rickets and ostermalacia are the most common vitamin deficiency diseases (Dunne, 1990).

5.1.1.1 Minerals

Minerals are elements that originate naturally in the Earth and cannot be made by living organisms. Plants obtain minerals from the soil, and most of the minerals in our diets come directly from plants or indirectly from animal sources. Minerals may also be present in the water we drink, but this varies with geographical locations. Minerals from plant sources may also vary from place to place, because soil mineral content varies geographically (United States Department of Agriculture, 2002).

Minerals play major roles in many metabolic functions. Many minerals are components of enzymes, which are catalysts of chemical reactions in the body. The functions of minerals do not include participation in the yielding of energy, but they do play vital roles in several physiological functions such as to regulate the body's water balance, fluid and acid-base balance and provide structure such as the skeletal system and functioning in cellular reactions such as a part of hormones, enzymes, vitamins and also oxygen transportation. For instance, sodium and potassium play a vital role in maintaining proper fluid balance. Mineral calcium and phosphorus act as a major structural component of bones and teeth. These minerals are especially important for women because it helps prevent osteoporosis after menopause. Good sources include milk, cheese, meat, eggs fishes, pulses and vegetables. Iron for the formation of haemoglobin. it carries oxygen in blood throughout the body (Schauss, 1995).

Mineral nutrients are divided among two classes - major minerals and trace/minor minerals based on the intake level. If more than 100mg of a mineral is required per day, the mineral is classified as a major mineral. Animals and humans need major minerals and these include sodium, calcium, potassium, magnesium, phosphorus and sulfur in large amounts. Trace minerals, also called trace elements/minor minerals which are needed in small amounts. Some of the most essential trace minerals include iron, zinc, copper, manganese, selenium, chromium, and iodine (Wardlaw, 1999; The American Dietetic Association; 2002).

Minerals are not readily destroyed in the heating or cooking process of food preparation because they have a very simple structure of usually one or more molecules of an element. However, they can leak out of the food substance that

contains them and seep into the water or liquid the food is being cooked in. This may result in a decreased level of minerals being consumed if the liquid is discarded. Eating a variety of foods is the best way to get all the necessary minerals (Whitney, *et al*. 1996; Wardlaw, 1999). *Minerals deficiency diseases*: Lack of minerals in the body causes serious health conditions such as energy loss, premature aging, diminished senses, and degenerative diseases like osteoporosis, heart disease, and cancer. For instance, a deficiency in *iron* may lead to anemia. Iron-deficiency anaemia is the commonest nutritional disorder in the world and affects around 3.5 billion people (Regilda, *et al*., 2007). Calcium and phosphorus deficiency leads to osteoporosis. Goiter, an enlargement of the thyroid gland (located in the neck), is lack of *iodine*. Iodine deficiency during pregnancy results in cretinism (mental retardation, a large tongue, and sometimes deafness, muteness) in the newborn baby.

5.1.1.1 Water

Water makes up the last class of nutrients, though the fact that it is considered a nutrient is surprising to many people. Water, however, has many necessary functions in the human body. Some of its actions include its use as a solvent (a substance that other substances dissolve in), as a lubricant, as a conduction system for transportation of vital nutrients and unnecessary waste, and as a mode of temperature regulation. About 70% of the non-fat mass of the human body is made of water. To function properly, the body requires between one and seven litres of water per day to avoid dehydration. The precise amount depends on the level of activity, temperature, humidity, and other factors. With physical exertion and heat exposure, water loss will increase and daily fluid needs may increase as well (Wardlaw, 1999).

There are many available sources of water other than tap water and bottled water. Some foods have high water content, including many fruits and vegetables. In addition, the body can make small amounts of water from various metabolic processes that result in molecules of water as a by-product. This, however, is by no means sufficient for the body's needs of water. It is generally recommended that people drink eight cups (or nearly 2 liters) of water a day to maintain an adequate supply (Wardlaw, 1999).

Table 5.1 Summary of the classes of nutrition, their facts and sources

Nutrients	Facts	Rich sources	Deficiency diseases
Carbohydrates	• Provide energy • Simple carbohydrates (i.e. simple sugar) such as fruit, enter the bloodstream rapidly for quick energy ✓ Monosachharide – contain only one molecule of sugar ✓ Disaccharide – contains two molecules (sucrose, lactose, maltose) • Complex carbohydrates (polysaccharides) such as rice, provide long lasting energy ✓ Two major forms: starches and fiber (cellulose)	Bread, wheat, rice, pasta, cereal.	
Lipids (Fats)	• A source of concentrated energy • Essential for making certain vitamins available; essential in healthy cell function • Stored as fat tissue which surrounds and protects organs; also helps maintain healthy skin and body temperature • Saturated fats such as those in meat or dairy products, raise cholesterol levels • Unsaturated fats are found in plant products.	Ice cream, milk, cheese, butter, meat, egg yolks, corn oil.	
Proteins	• Most abundant substances in the human body • Essential for the growth, development and repair of all body tissues • Form parts of muscle, bone, blood and cell membranes • Form hormones and enzymes • Made of amino acids	Meat, chicken, fishes, dried bean, eggs, nuts	Kwashiorkor

Vitamins: Facilitate chemical reactions: promote growth and reproduction of cells. The following are all vitamins:			
Vitamin A *(Retinol)*	• Night vision • Bone formation	Carrots, sweet, butter, eggs, milk, green vegetables, yellow fruits, fish liver oils.	*Xerophthalmia* – Night blindness due to dryness of epithelium and cornea.
B_1 *(Thiamine)*	• Increases growth & appetite • Helps in digestion • Regulates oxidation of food	Nuts, peas, beans, eggs, meats.	Beriberi
B_2 *(Riboflavin)*	• Metabolism • Energy production • Eyes and skin	Milk, cheese, eggs, liver, yeast, green vegetable.	Irritation of eye, skin and intestinal disorder, inflammation of tongue
(Niacin)	• Normal digestion • Appetite • Nervous system	Cereal, fish, peanuts, lean meat, liver.	Pellagra
B_{11} *(Folic acid)*	• Blood formation (synthesis if haemoglobin) • Enzyme function	Grain bread, liver, broccoli	Anaemia
C *(Ascorbic acid)*	• Helps in body resist infection • Strengthens blood vessels	Oranges, limes, tomatoes	Scurvy – spongy & bleeding gum & loosening teeth.
D *(Calciferol)*	• Helps the body to use calcium & phosphorus for bones & teeth formation.	Fish liver oils, milk, eggs, produced by untraviolet rays in skin.	Rickets
E *(Tocopherol)*	• Prevents oxidation of vitamin A	Meat, milk, wheat.	Sterility in rats
K *(Phylloquinone)*	• Helps in normal clotting of the blood.	Leafy green vegetable such as cabbage and spinach.	Haemorrhage
Minerals: Assist in the regulation of chemical reactions. The following are all minerals:			
Calcium	• Strong bones and teeth • Heartbeat • Phosphoric acid (phosphate) can cause you to excrete extra	Milk, cheese/cottage cheese	Osteoporosis

	calcium; can lead to calcium loss from bones		
Chlorine	• Aids in digestion • Keeps body limber	table salt	-
Iodine	• Energy • Growth • Manufacture thyroid • Mental alertness	table salt, seafood	Goiter
Iron	• Most common deficiency (anemia vs. hemochromatosis) • Forms red blood cells • Prevents fatigue	Red meat, liver	Anaemia
Magnesium	• Fights depression • Insomnia • Nervousness	Dark green vegetables, apples	-
Phosphorus	• Healthy gums and teeth • Growth and repair cells	Grains, fish, chicken	Osteoporosis
Water	• Makes up blood • Helps the process of digestion • Helps remove the body wastes • Helps regulate body temperature • Not a vitamin or minerals	Drinking water Juices, soups, fruits, vegetables	Dehydration