

CHAPTER 10 HUMAN NUTRITION

Nutrition

The food supply for humans can be divided into five groups: carbohydrates, proteins, fats, minerals and vitamins. The first three are required in large quantities and are referred to as macronutrients, while the last two are needed in micro amount so are referred to as micronutrients. One gram of protein or carbohydrate when completely burned produces 4 Calories of energy, while one gram of fat produces 9 Calories.

Carbohydrates can be classified into three groups: monosaccharides, disaccharides, and polysaccharides.

Monosaccharides are consists of just one unit of carbohydrates, examples include glucose, fructose and galactose. These three are isomers in that they all have the same chemical formula ($C_6H_{12}O_6$) but different structures. The human body can only use the carbohydrates only when in the form of glucose; so all carbohydrates must be digested and converted into glucose. Many fruits have fructose that makes them very sweet. Plants can store glucose, but galactose always exists in a combined form with other molecules to form structural components of the plant tissue.

Disaccharides compose of two units of sugar, examples are sucrose, lactose, and maltose. For example: Glucose + fructose \rightarrow sucrose (stored in sugar cane and sugar beet); Glucose + galactose \rightarrow Lactose (milk sugar); or Glucose + glucose \rightarrow maltose (in germinating seeds).

Polysaccharides are complex sugar, contain several units of sugar, examples are starch found in all parts of plants. **Starch** is the storage form of glucose in plants. Starch is stored in many forms, examples include potato, rice, bean, peas, wheat, and corn in plants. Sugar is stored as **glycogen** in the human body, plants do not store sugar as glycogen, just like humans do not store sugar as starch. **Cellulose, lignin, hemicellulose, pectin, gums, mucilages, are polysaccharides found in plants.** Cellulose is of high amount in plants, humans cannot digest it; so when consumed in fruits and vegetables, they form roughage and pass through the digestive tracts undigested. All carbohydrates of this form are considered dietary fibers. Some dietary fibers are soluble fibers; an example is **pectin** in apples is known to lower cholesterol.

Proteins are made up of amino acids. There are altogether 20 amino acids, during digestion, proteins are broken down into these amino acids. These amino acids are used for the building of structural components of the human body. The human body can synthesize 11 amino acids (non-essential), while 9 others cannot be synthesized by the body (essential), must have to be present in the diet.

Essential	Non-essential	Essential	Non-essential
Histidine	Alanine	Methionine	Cysteine
Isoleucine	Asparagine	Phenylalanine	Glutamic acid
Leucine	Aspartic acid	Threonine	Glutamic acid
Lysine	Arginine	Tryptophan	glycine
Valine	Proline	-----	Serine, tyrosine

Table 1. Essential and Non- essential amino acids.

Animal proteins are classified as complete proteins, while plant proteins are incomplete proteins, because they may lack one or more of the 9 essential amino acids.

Lipids

Lipids include **fats (triglycerides), wax and steroid and cholesterol.**

Triglycerides include **fats and oils formed from glycerol and fatty acids.** Fatty acids are classified into two: **saturated and unsaturated** fatty acids. Fats formed from these fatty acids are saturated and unsaturated respectively. **Saturated fatty acids have no double bonds, while unsaturated fatty acids have one (monounsaturated) or more double bonds (polyunsaturated).** Most animal fats are usually saturated (except fish oil), while plant fats are usually unsaturated. **Most vegetable oils are unsaturated fats except palm oil, cocoa butter oil and coconut oil (saturated fat).** Some are monounsaturated, examples include olive oil, peanut oil, and canola oil, while others like corn oil, soybean, safflower oil are polyunsaturated. Saturated fats increase cholesterol level and increase the risk of heart disease. Cholesterol are steroids, they are transported by lipoprotein. There are two main lipoproteins, the low-density lipoproteins (LDL) and the high-density lipoproteins (HDL). The LDL transports cholesterol to body tissues for storage while HDL transports them to liver for degradation.

Vitamins

Vitamins are important in the formation of coenzymes (coenzymes assist enzymes in the catalyses of metabolic reactions). There are 6 groups of vitamins: Vitamin A, B, C, D, E and K. Vitamins A, D, E, and K are fat soluble while Vitamins A and B are water soluble.

Vitamin A is important in the formation of retinol in the rhodopsin (visual pigment) of retina in the eye. Deficiency causes night blindness. Retinol pre-cursor is beta-carotene found in carrots. **Beta-carotene** is regarded as an anti-oxidant, this means that beta-carotene can react with free radicals.

Vitamin D regulates calcium and phosphorus levels. It is important for normal bone development. Vitamin D promotes the absorption of calcium and phosphorus from food in the gastrointestinal tract. The sunlight promotes its synthesis in the body. Vitamin D can be obtained from milk, egg yolk, and liver fish. Deficiency causes **rickets**, osteoporosis and **osteomalacia**. Excess calcium can cause calcium deposits in the blood causing damage to the cardiovascular system, kidney failure and death.

Vitamin C (Ascorbic Acid)

Vitamin C is important for the **synthesis of collagen**. It also functions as an **antioxidant**. It promotes the **absorption of iron**. Deficiency causes **scurvy**. **High doses of vitamin C are known to prevent cold.**

Vitamin B occurs in many forms, so it is usually referred to as a complex. They are important in the **synthesis of coenzymes**. Coenzymes are important in catalyses of metabolic reactions involved in energy productions. **Deficiency can lead to fatigue, cramping, numbness, and cardiac failure. Both vitamins C and B may be destroyed by heat. Deficiency of B1 or thiamine causes beri-beri; deficiency of Niacin causes Pellagra (skin disorder); deficiency of B12 (cobalamine) causes pernicious anemia. B12 interacts with folic acid for red blood cell synthesis.**

Minerals

Minerals are in two groups: the ones required in high amount, and the ones required in trace amount.

Major Minerals	Trace Minerals
calcium	iron
sodium	iodine
potassium	copper
phosphorus	fluorine
magnesium	manganese
chlorine	cobalt
chromium	
molybdenum	
selenium	
zinc	

Functions of the minerals in the human body

Calcium is important for bone and tooth formation, muscle contraction, blood clotting.

Phosphorus is important in bone and tooth formation, cell membrane formation and energy production. **Iron** important in hemoglobin formation. **Iodine** is important in the synthesis of thyroid hormones. **Selenium** is an antioxidant. **Sodium** is important for water balance and blood pressure regulation. Sodium and potassium are important for nerve impulse transmission. **Fluorine** is important for bone and tooth formation.

**These minerals act as cofactors or coenzymes.*

Study Questions

1. Give 2 examples each, of monosaccharides, disaccharides, and polysaccharides.
2. There are 20 amino acids in the body, 11 are non- essential and 9 are essential, and name any five amino acids from each group.
3. Why is it not recommended that man should only eat plant proteins?
4. Name the two kinds of lipids common in plants.
5. Fatty acids are classified as either saturated or unsaturated, give 4 examples of unsaturated fats that are being sold as vegetable oils. Give one example of a saturated fat that is sold as a vegetable oil.
6. What are vitamins? Why are vitamins important in metabolism?
7. State any one source of each of these vitamins: A, B, C, and D.
8. State any disorder associated with the deficiencies of each of these vitamins: A, B, C, and D.
9. Give one function of each of the following minerals: Calcium, Phosphorus, iron, sodium, and fluorine
10. Give five examples of plants that store fructose or starch.
11. Name three vitamins, their importance, and disorders associated with their deficiencies.

12. Name three major minerals and three micro minerals, their functions, and disorders associated with their deficiencies.
13. List the 2 names of vegetable oils that are polyunsaturated, those that are monounsaturated, and any that is saturated.

CHAPTER 12 THE GRASSES

GRASSES

The grasses are the largest members of plants. About 25% of the vegetation belongs to the grass family. Some grasses are **annuals**, while others are **perennials**. Most **cereal grasses are annuals, while pasture and lawn grasses are perennials**.

Stem and Root structure

A typical grass is **herbaceous** with linear leaves of **parallel venation** that is **typical of monocots**. The leaves are usually arranged alternately, the base of each leaf forms a sheath around the stem. The **stems are known as culms**, some stems are above the ground and horizontal, these are called **stolons**; other stems are horizontal but remain underground, these are called **rhizomes**. The primary **roots are fibrous and adventitious**. The flowers are in **inflorescence**, each individual flower is small, inconspicuous and incomplete with no sepals or petals. Each flower has about three stamens and one carpel. Each carpel has two styles and large stigmas to facilitate pollination. Two bracts surround each flower, the outer is called lemma, the inner is called Palea, together the three form a floret, several florets form a spikelet that is also suspended from the stem by two bracts called glumes.

Fruit / Seed or grain of grasses

The seed or grain is of single **seeded indehiscent fruits**. The fruit wall and the seed coat together form the **bran**, underneath the bran is the **aleurone layer** which is mainly protein. The aleurone layer encloses the **endosperm (which is stored starchy food for the embryo development)** and contains **enzymes** for digestion of the endosperm. The **embryo, the coleoptile and coleorhiza (sheaths) are collectively called the germ**. **White flour, corn starch, and white rice consist of only the endosperm, the germ and the bran are removed**. **Whole grain products (brown rice, whole wheat flour, popcorn) contain everything excluding the chaff, they contain proteins, vitamins and oil in addition to the starch**.

Wheat is the most widely cultivated cereal in the world. The wheat grows best in temperate grassland biomes, for example Ukraine, United States, Canada, China, India, Argentina, France, and South Africa. There are two common types of wheat that are widely cultivated: **Durum wheat and the bread wheat**. The durum wheat is used to make **spagetti, macaroni, noodles and semolina**. The bread wheat is the most common one, used to **make pastries and breakfast cereals**. Wheat lacks vitamins A, B12, C and iodine. Cereal grains have **low amount of lysine and tryptophan**. Cereal is the main source of bread flour. **Wheat and rye flour contain gluten (a protein), in the presence of yeast with water, the dough becomes elastic and the flour is fermented, releasing carbon-dioxide**. The carbon-dioxide makes the dough rise producing a leavened bread after baking.

Corn or Maize (*Zea mays*)

Corn grows best under **moderate conditions of temperature and moisture** of the summer season. The color of corn is as the result of the **pigment of the endosperm, aleurone layer, and the pericarp**. Corn plants self pollinate to produce inbred plants,

however to produce hybrid corn plants, the tassel inflorescences (staminate) of one plant is detasseled to allow cross pollination from another plant to occur. Sterilization of male corn plants to promote cross pollination is now currently done, using a fungal pathogen.

A Corn fruit is much larger than other cereals. The corn plant has **separate staminate and pistillate inflorescences**. The pistillate gives rise to the ear corn covered with bracts (or husks). The staminate produces the tassel inflorescence. Corns are of various forms: **popcorn, sweet, waxy, flour, flint, and pod**. The popcorn has hard kernels with hard starch surrounding a soft starch. The endosperm cell contains a lot of water, in the presence of heat, the water turns into steam and makes the corn explode. Flint and flour corns are not very common. Sweet corn has a high % of sugar instead of starch in the endosperms.

Corn is a source of carbohydrates, fats, and proteins, it is low in **lysine, and tryptophan**; also deficient in **niacin** (vitamin B6). Corn kernel is used to produce, **corn-starch, corn meal, corn oil, and corn syrup**. Corn is also used for animal feeds, industrial and pharmaceutical products; also corn can be fermented for alcohol beverages.

Rice (*Oryza sativa*)

Oryza sativa is the most common rice plant that is currently being cultivated. It can grow to about 3 feet looking like a tall grass. **The rice stem has air chambers, which allow diffusion of air through to the roots**. This enables the rice to grow well in flooded areas. Young seedlings are transplanted into paddies (that have been irrigated with water or rain) for growth. When the rice grain is mature, the fields are drained to prepare for harvest.

Just like wheat, brown rice is nutritionally better than white rice that lacks the bran and the germ. There are varieties of *Oryza sativa*, the most common one is the long grains that do not stick together when cooked. The short grains are sticky when cooked; they are grown in subtropical to temperate regions. The stickiness is as a result of the starch composition in the endosperm.

Oats are highly nutritious; it is used as breakfast meal in the United States. It is believed that it has cholesterol-lowering ability.

Barley (*Hordeum vulgare*) looks like wheat. It can grow in a wide range of environmental conditions. It is used for animal feed and also for production of malt for brewing.

Sorghum and Millets are consumed in other parts of the world, but used for animal feed in United States. Millet can be eaten as rice; the nutritional value is like that of wheat.

Forage Grasses are consumed by herbivores. Grasses and legumes are considered forage plants. Lawn Grasses are mainly of two kinds: the **kentucky blue grass and the Bermuda grass**.

Key Points

1. Grasses are herbaceous monocots. Some are annuals (example: cereals), and others are perennials (example: lawn grasses).
2. The stems of grasses are known as culms, some stems are called stolons because they are above the ground, the stems that remain underground are called rhizomes.
3. Grasses have fibrous roots and adventitious roots.
4. The flowers are inflorescences (appear in clusters) and each flower is incomplete with no sepals or petals (naked flowers). The flowers bear large amount of pollen to allow wind pollination.
5. Examples of edible grasses include grains (wheat, rice, corn). Whole grain products contain the fruit, seeds and the seed coats. The seed coats of grains have another membrane underneath them called aleurone layer that contains mainly protein. For this reason whole grains are nutritious and highly recommended in place of white flour, white rice or corn.
6. Wheat is the most widely cultivated grass. There are different kinds of wheat: Durum (for spaghetti, macaroni & noodles); Bread wheat (bread & pastries). Wheat flour & rye flour contain gluten which makes the dough elastic in the presence of water & yeast.
7. Corn plants are of various forms: popcorn, sweet corn, waxy corn, flour corn, flint and pod corn. Corn can be used to produce corn starch, corn meal, corn oil, corn syrup, animal feeds, and fermented alcohol beverages.
8. Rice occurs in different forms: long grains (do not stick), short grain (sticky rice)
9. Oats, Barley, Sorghum and Millets are other forms of grasses consumed along with wheat.
10. Among the non – consumable grasses include forage grasses consumed by herbivores, lawn grasses (Kentucky bluegrass and the Bermuda grass)

Study Questions

1. Using 3 sentences, describe the group of plants classified as grasses.
2. Using 3 sentences, describe a grain. What is the difference between a whole grain and non-whole grain product?
3. Give 3 examples of grain products.
4. State the difference between Durum wheat and bread wheat.
5. Name any 3 products of durum wheat and bread wheat respectively.
6. Why do bakers use wheat flour to make a leavened-bread, but cannot use rice flour or corn flour to do the same?
7. Describe a corn plant in 3 sentences.
8. Name the 6 kinds of corn.
9. What is the difference between popcorn and a sweet corn?
10. Apart from popcorn, state other 4 uses of corn in general.
11. Briefly describe the structure of a rice plant and how it is cultivated.

12. State one use of each of the following: oats, barley, sorghum, mullets, forage grass, and lawn grasses.
13. What is the use of an endosperm in plant's seed?
14. Give examples of plants considered grasses, and state one economic importance of each.
15. Describe the structure of a typical plant, naming the male and the female parts of the plants.
16. What is an endosperm? What is its significance in a plant?