



Macronutrients and Micronutrients in Nutrition

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HIGHLIGHTS

Different types of food have different nutritional content, quantity and quality. There is not a single nutrient that contains all nutrients at a level that meets body needs. For this reason, all nutrients are needed and we need to know these nutrients very well. For this purpose, in this study, it is aimed to explain the structure of all nutrients and their place and importance in adequate and balanced nutrition.

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ABSTRACT

Nutrition is not to suppress feelings of hunger, to feed your stomach, or to eat what you eat. Nutrition; is to be able to receive adequate amounts of nutrients that are needed by the body to maintain and improve quality of life. Adequate and balanced nutrition is healthy nutrition. Nourishment requires a large number of food items for human life. The functions of each food item found in foods are different from each other. When any of these items are not taken, are taken less or more than necessary, malnutrition occurs and as a result, growth and development are prevented and health deteriorates. For this reason, it has been determined how much food should be taken daily from each of the food items. In fact, we need to know very well the nutrients found in their structures and their functions in our metabolism as they consume nutrients. In this review, macronutrients and micronutrients, their properties and their metabolic significance are explained.

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1. Introduction

From past to present, people have exhausted what they could find first, then the ones that they produced. In this process, they wondered what and why they consumed and their components. Nowadays people realize that it is necessary to have adequate and balanced nutrition to live well and to live long

and to improve quality of life. Experiences, accumulations, experiments, researches and analyzes that have been going on for thousands of years have created science of nutrition with the support of science and technology. Nutritional science is exploring how an organism feeds. Nutritional science covers a wide spectrum of disciplines. As a result, nutritional scientists can interest in particular aspects of nutritional such

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as biology, physiology, immunology, biochemistry, education, psychology and sociology. Nutrition is the ability to take essential nutrients at adequate rates and use them in the body in order to fulfill basic functions such as energy generation, growth, reproduction, development and to maintain a healthy life. Nutrients affect the function of the body, protect it against disease, and respond to changes in people's environment. The chemical components in the composition of foods are called nutrients. Adequate and balanced nutrition, consume different food types and avoid harmful foodstuffs are essential in healthy and right nutrition. Sufficient consumption of nutrients to maintain healthy life is defined as adequate and balanced nutrition. Inadequate nutrition is that sufficient energy cannot be for the formation of body tissues and the body functions. Every nutrient group should be found in an adequate and balanced diet [1, 2].

All living beings need energy to live. However, the use of nutrients for energy production is common. As long as the metabolic events continue, vitality continues. For this reason, they need nutrients and the energy they provide. The foods we consume are absorbed from the intestines in the digestive system and transported to tissues and organs for the production of intermediates necessary for energy or metabolism through blood. Energy is spent every day during physical activity and at rest (basal metabolism). Basal metabolism refers to the metabolic pathways required to restore the basic functions of the body (such as respiration, heartbeat, liver and kidney functions) while resting. Basal metabolism refers to the metabolic pathways required to restore the basic functions of the body (such as respiration, heartbeat, liver and kidney functions) while resting. Regular and controlled occurrence of all these events is provided by vitamins, minerals, enzymes and hormones [3]. There are more than 50 nutrients or chemical compounds that carry out similar functions in the human organism that ensure the continuity of life [2].

Nutrition items in nutrition science; macronutrients and micronutrients. Macronutrients are proteins, fats, carbohydrates and water. Micronutrients are items found in small quantities in the diet, such as vitamins, minerals and trace elements (iron, fluorine, etc.). Nutrients that are taken in quite a lot quantities during daily feeding are referred to as macronutrients, but micro nutrients are nutrients that the body needs in lesser quantities. Both macronutrients and micronutrients are equally important for good health. Every nutrient plays an important role in the body. Water is a polar solvent which is quite necessary for life. It is necessary for all chemical reactions in the body to take place and to regulate body heat. For this reason, water is considered to be a very important food item [1].

1.1. Macronutrients

here are three classes of macronutrients; carbohydrates, proteins, fats. While macronutrients are used in metabolism, they are separated into their building blocks. The building blocks of macronutrients are monosaccharides, amino acids and fats acids.

It is that building blocks of the carbohydrates, proteins and fats are monosaccharides, amino acids and fatty acids (Figure 1).

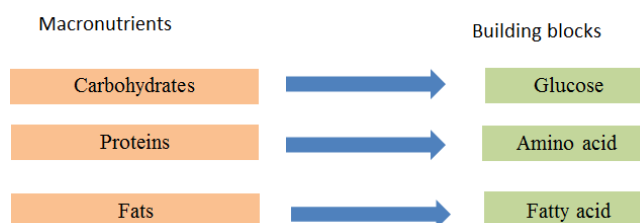


Figure 1 The building blocks of macronutrients

The main functions of carbohydrates and fats, which are macro nutrients, are energy. Proteins, on the other hand, are essential for body cells and tissues to be constructed. However, they are used to get energy during very long hunger. The energy of macro nutrients comes from chemical bonds. This chemical energy is converted to cellular energy and then used to fulfill the basic functions of your body [1, 4].

1.1.1. Carbohydrates

Structure and properties

Carbohydrates are the most abundant organic compounds in the biosphere and the main source of energy in your body. Among the foods we consume is the most common nutrient. For normal-fed adults, 55 to 60 percent of their daily energy needs are derived from carbohydrates. Grains (wheat, rice corn, etc.), legumes (beans, peas, etc.), roots and tubers (potatoes, beets, etc.), vegetables and fruits are abundant. White and solid are easily soluble in water except some polysaccharides. Basically, the hydrated carbons are [1, 2].

The most important task of carbohydrates is to provide energy. Also; they are involved in biosynthesis of the amino acids, nucleic acids, porphyrins, cholesterol, mucopolysaccharides, glycoproteins. On the other hand, they are found in the cell walls of plants and microorganisms.

Carbohydrates have a general form of $C_n(H_2O)_n$ and form from the carbon, hydrogen and oxygen atoms. The smallest units of carbohydrates are called monosaccharides. Monosaccharides combine with a special covalent bond called glycosidic linkage and form disaccharides and polysaccharides. By linking two monosaccharide units, disaccharides and 2-10 monosaccharide units are linked together to form oligosaccharides. Polysaccharides are linear or branched long chain carbohydrates formed by more than 10 monosaccharide units. The most common monosaccharides that appear as parts of polysaccharides are glucose, fructose, galactose and mannose [5].

1.1.1.1. Monosaccharides

Monosaccharides are carbohydrates that are not separated from their smaller constituents and are also known as simple sugars. Their digestion is easy and they get into the blood. If the carbonyl group ($C=O$) in the structure is in the form of an aldehyde in the first carbon, aldose is called any other carbon in the structure, that is ketose in ketone form. The simplest monosaccharide units are 3 carbons. Examples of monosaccharides in foods are glucose, fructose and galactose [5].

Glucose: One of the most important carbohydrates for life. Glucose is the most abundant in the composition of disaccharides and polysaccharides, and their hydrolysis also results in glucose. It forms the basic units of polysaccharides such as starch, glycogen and cellulose. Cells use it as an energy source and an intermediate in metabolic reactions. This

monosaccharide with six carbons is also known as blood sugar.

Glucose is the preferred fuel for all organisms, from bacteria to plants and animals. The brain is totally dependent on glucose as an energy source (except in extreme hunger conditions). In the liver, all monosaccharides are converted to glucose and used for energy metabolism. The normal glucose level is 65-110 mg/dL, while hypoglycemia below this level is expressed as hyperglycemia. Blood sugar falls in the case of fasting, and after eating, it increases [5].

Fructose: It is found in various fruits such as grapes, figs, mulberries and in foods such as molasses. Also known as fruit sugar. It also combines with glucose to form saccharose. It is the sweetest sugar in the monosaccharides. It is used to convert glycoside in the body.

Galactose: Combines with glucose to form a disaccharide, lactose (milk sugar). It is a less sweet monosaccharide than fructose and glucose. Not available freely. Monosaccharides are an energy source; most of them provide about 4 kcal (kilocalories) per gram, just like other carbohydrates [1, 5].

Monosaccharides and disaccharides are sweet and are separated from polysaccharides by these properties. Because polysaccharides are not sweet. While sugars determine the sweetness grades, sucrose sweetness grade is accepted as 100 in standard. Accordingly, the sweetness ratings of the others are shown in Table 1.

Table 1 Some carbohydrates degree of sweetness [5].

Sugar	Degree of Sweetness
Lactose	16
Galactose	32
Maltose	32
Glucose	74
Sucrose	100
Fructose	173
Saccharin (artificial)	55.000

1.1.1.2. Disaccharides

The two monosaccharides combine with the glycosidic bond to form disaccharides. Easily soluble in water. The most important disaccharides are maltose, lactose and sucrose [5]. Maltose is the result of binding of two glucose units by glycosidic linkage. It is also called malt sugar and is rarely found in free form. Lactose is naturally found only in milk. There are no other types of carbohydrates in the milk. It is composed of galactose and glucose units. It is 7-8% in mother's milk and 4-5% in cow's milk. Sucrose is the sugar obtained from sugar beet or sugar cane we use every day. The binding of D-glucose and D-fructose units to the glycoside bond results. Disaccharides need to be separated into basic molecules to be used by the body and absorbed from the intestine. In the digestion phase, they are broken down by the enzymes into their constituent monosaccharides (Table 2) [5].

Structure	Disaccharide	Enzyme required for digestion
Glucose +fructose	Sucrose	Sucrase
Glucose + galactose	Lactose	Lactase
Glucose + glucose	Maltose	Maltase

Figure 2 Structure of disaccharides and enzyme required for digestion

Polysaccharides are polymers formed by the combination of a large number of monosaccharide monomers. The polysaccharides may be in a straight chain structure or in a branched structure. Their solubility in water is very low. Polysaccharides are also classified among themselves according to their chemical structure and properties. Polysaccharides derived from the same monosaccharide units are referred to as homopolysaccharide, heteropolysaccharide containing two or more varieties. The human nutrition includes three main polysaccharides: starch, cellulose, and glycogen.

Polymer	Monomer
Starch	Glucose
Glycogen	Glucose
Cellulose	Glucose
Inulin	Fructose
Pectin	Galactronic acid

Figure 3 Some polysaccharides and their monomers.

The repository polysaccharide found in animals and in humans is glycogen, while starch and inulin are plant storage polysaccharides. Cellulose and pectin are found as structure polysaccharides in plants. Starch, glycogen and cellulose glucose polymers are inulin fructose polymer and galacturonic acid is pectin polymer (Figure 3) [5].

Carbohydrates provide daily energy needs. The unavailable part is stored as glycogen in very small quantities such as several hundred grams in the liver or muscles. The glycogen can only meet the 12-hour energy requirement of the body. Starch is an energy source obtained from plants, cellulose is a structural polysaccharide in plants; when consumed, it acts as a dietary fiber [4, 6]. Polysaccharides can also be classified into two types according to their digestible properties:

Digestible polysaccharides are broken down and digested in the mouth and small intestine in several steps that eventually yield glucose, which is absorbed. Starch is the most important of digestible polysaccharide. Non-digestible polysaccharides are known also as dietary fiber-such as cellulose arrange the transition of food through bowel. Some building polysaccharides such as cellulose, hemi-cellulose, pectin, inulin, oligofructose, and oligosaccharides are described as dietary fiber [4]. Dietary fiber that is in the small intestine cannot be digested because there is not digestion enzymes for cellulose, but in the large intestine is fermented plays a very important role for health. Along with being a protective effect against bowel cancer and cardiovascular diseases, it also regulates the level of blood sugar and cholesterol. Some non-digestible polysaccharides, such as inulin, may also promote the growth of beneficial intestinal bacteria.

Monosaccharides, like most nutrients are absorbed in the small intestine. They can be absorbed without previously being broken down by the intestinal enzymes. Glucose absorption occurs in the small intestine via the SGLT-1 transporter (sodium glucose co-transporter). Fructose absorption is done with GLUT5 transporter [5]. Glucose and galactose are ab-

sorbed easily, completely and faster than other carbohydrates, while fructose can be absorbed slowly and incompletely. After ingestion, glucose and galactose quickly raise the blood sugar (they have high glycemic index), while fructose raises blood sugar only mildly and slowly (it has low glycemic index). During digestion, all carbohydrates have to be broken down into monosaccharides in order to be absorbed [7].

1.1.2. *Proteins*

Structure and properties

Proteins are macromolecules that are important in biological processes and are composed of amino acids. Growth, proliferation and self-repair processes, which are the basic characteristics of life, are realized by proteins. Proteins contain carbon, hydrogen, nitrogen and oxygen. Unlike carbohydrates and lipids, it is the only macro-nutrient containing nitrogen.

Proteins are the main building blocks of cells for growth and development and for the continuity of cells. Therefore, it is its task the construction of the tissues, the survival of the cells and repair of the damaged cells. Proteins constitute an average of 16% of the adult human body. Proteins form working cells, not stored in the body. Proteins are separated into amino acids, which are building blocks in the digestive tract, and transported to the liver by blood. Here they recombine in a specific order to make body proteins. There is no way to store amino acids in large quantities in the human body, so if more proteins are needed, they must be broken up and removed from the body. This very important function occurs in the liver. The amino moiety of the amino acid is converted to urea. The urea is then transported to the kidneys by blood circulation and then thrown out of the body. The remaining (carbon containing) portion of the amino acid can be stored by converting it into carbohydrate or oil depending on the identity of the R group [5, 8].

It assigns the genetic code to each amino acid sequence. The amino acid sequence of each protein is proprietary. Proteins are also used as energy sources in the body. 1 g of protein provides 4 kcal of energy. Proteins have a wide variety of functions;

1-As enzymes they catalyze the reactions necessary for survival. Enzymes require cofactors in catalysis reactions. Cofactors are organic molecules called coenzymes and metal ions.

2-Structural proteins are structural elements of tissues such as muscle, skin, bone, tendon, cartilage. for example, such as collagen, elastin.

3-Many small molecules and ions are transported and stored by specific proteins. While the O₂ molecule is carried by the hemoglobin in the protein structure, it is stored by the myoglobin in the muscles. While iron is transported by the transferrin protein in the bloodstream, it is complexed with another protein called ferritin in the liver and stored.

4-Protective proteins are involved in the defense mechanism of the body, e.g. antibodies.

5-Many hormones are in protein structure. Growth hormone, insulin and so on.

6- They take part in blood coagulation [5, 8, 9].

The structure of the proteins contains 20 standard amino acids and some amino acid derivatives. Valine, leucine, isoleucine, threonine, methionine, phenylalanine, tryptophan, and lysine are exogenously originated amino acids that the body itself cannot produce. It is absolutely necessary to be taken from outside diet. These amino acids, which cannot be synthesized in organism, are called essential amino acids. There are also two amino acids considered essential for children and those in the growing age; one is histidine and the other is arginine.

1.1.3. *Fats*

Structure and Properties

Fats are organic compounds that are insoluble in water but are soluble in apolar solvents such as ether, benzene, chloroform. Among the most important of the lipids are fats which give high energy and contain the chemical composition of carbon, hydrogen and oxygen [5, 9]. Fatty acids form the building blocks of fats. Fats are compounds resulting from esterification of the three hydroxyl groups of glycerol with the free fatty acids. Also known as triacylglycerol or triglycerides.

When we ate, the fat from the food is stored primarily in the fat tissue (adipose tissue). Approximately 95% of the lipids in the body are stored as triglycerides. Other lipid groups outside of the fats are either found in the cell membrane structure (phospholipids and glycolipids) and are involved in the biosynthesis of many molecules required for metabolism. Lipids are molecules that show great differences in structure and function and have important roles in metabolism. The most important functions of lipids are the intracellular deposition of metabolic fuels and structural components of cell membranes. It is also predisposed in the synthesis of bile acids (colic acid), adrenal cortex hormones (cortisone, cortisol and aldosterone), sex hormones (estrogen, progesterone, testosterone) and fat soluble vitamins such as A, D, E and K [5].

The fatty acids indicated by the R-COOH formula have different types depending on the number of carbons contained and the presence of double bonds in the structure. When there are one or more double bonds (C = C) between the carbon atoms, this is called acid unsaturated fatty acid. As the number of double bonds increases, the melting points decrease. They are therefore liquid at room temperature. Unsaturated fatty acids are more common in vegetable oils. In higher organisms the most abundant unsaturated fatty acids are oleate, linoleate, linolenate and arachidonate. Double bonds found in unsaturated fatty acids; heat, light, etc. may be degraded by agents or by the action of free radical molecules. Vitamin E, which is soluble in fats and is an important antioxidant, protects fats (especially phospholipids from the membrane structure) from these harmful effects.

Those that do not contain double bonds are saturated fatty acids. As the carbon numbers of saturated fatty acids increase, the melting points also increase. These fatty acids are solid at room temperature. Animal fats generally contain saturated fatty acids [5, 9]. Essential fatty acids are called fatty acids which cannot be synthesized in the body and must be taken from the outside. Polyunsaturated fatty acids containing two or more double bonds are essential and need to be taken on an external diet. Omega oil groups are formed according to the position of the double bond most distant to the carboxyl group [4, 5, 9].

The most important essential fatty acid that cannot be synthesized in the body is acid linoleic acid (omega-6). Both linolenic and arachidonic acid can be synthesized in the body with sufficient amount of linoleic acid in the diet. Some of the energy needed by the human body comes from the carbohydrates that provide the daily energy source, while the other part comes from the fat we know as the energy store. Particularly in the case of starvation, fats supply energy need.

Proteins normally contribute little to energy metabolism, but proteins are also used as energy sources in very long-term fasting conditions. Triacylglycerides are more suitable as storage fuel than starch and glycogen. 1 g of carbohydrate and 1 g of protein provide 4 kcal of energy, while 1 g of oil provides 9 kcal of energy. There are two reasons for this. The first is more reduced than fats, protein and carbohydrates. Second, they are stored anhydrous because they are in apolar formation [5, 9].

1.2. Micronutrients

1.2.1. Vitamins

Vitamins are organic substances that are necessary for the body to develop and fulfill many functions. They are essential for sustaining life and for growth. Taking only a small amount (on the order of milligrams or micrograms) on a daily basis is sufficient. Since vitamins cannot be produced by the body, they need to be supplied with nutrients from the outside. Vitamins are different from other organic nutrients because they do not enter the tissue structure and do not supply energy to the organism. However, most vitamins are able to bind to enzymes as coenzymes (especially the vitamins of group B) and be realized all metabolic reactions in the process of protein, carbohydrate and fat breakdown to take place [5, 10].

Vitamins are divided into two groups as water and fat soluble.

Water soluble vitamins

Group B vitamins and vitamin C are water-soluble vitamins. All water soluble vitamins -except vitamin C- have coenzyme functions. Water-soluble vitamins are soluble in water due to their polar structure and are not stored in the body, so they should be taken continuously with daily food. Group B vitamins; are the precursors of various coenzymes. They are involved in the body's energy metabolism and immune system. Group B vitamins; thiamine (vitamin B1), riboflavin (vitamin B2), nicotinic acid, pantothenic acid, pyridoxine (vitamin B6), biotin, folic acid, vitamin B12 (Table 2) [4, 5].

Table 2 Vitamins and their functions in fat soluble.

Name of Vitamin	Functions
Vitamin A (retinal)	<ul style="list-style-type: none"> • Provides sight power and prevents night blindness. • Helps to improve. • Delays aging. • Antioxidant properties. • Immune stimulant.
Vitamin D	<ul style="list-style-type: none"> • It plays a role in calcium and phosphate metabolism. Protects against diseases caused by impaired metabolism (Rachitism, osteomalacia).
Vitamin E	<ul style="list-style-type: none"> • It plays a role in calcium and phosphate metabolism. • Protects against diseases caused by impaired metabolism (Rachitism, osteomalacia).

	<ul style="list-style-type: none"> • Intracellular antioxidant. • Prevents oxidation of unsaturated fatty acids and helps to protect cell membranes. • Protect the cells from aging. • It is a protection against cancer.
Vitamin K	It is necessary for the formation of prothrombin which is involved in coagulation.

1.2.2. Minerals

Most of the elements found most commonly in nature are also found in the organism. An average of 6% of the adult human body is made up of minerals. The four most common elements in living cells are carbon (C), hydrogen (H), oxygen (O), and nitrogen (N). These four elements constitute about 99% of many cell masses. These elements are the basic elements of organic structure in living things. It forms proteins, carbohydrates, fats, vitamins and nucleic acids (DNA and RNA). Phosphorus (P) and sulfur (S) are present in smaller quantities but also in the organization of many organic molecules in the organism. Phosphorus is found in the structures of nucleic acids (DNA and RNA), high-energy nucleotides such as ATP, intracellular buffers, phospholipids, inorganic phosphates. Sulfur, methionine and cysteine are located in the building of some amino acids.

In living organisms, sodium (Na), potassium (K), chlorine (Cl), calcium (Ca) and magnesium (Mg) are present in the form of ions in larger quantities than the other elements (at the level of% mg) and known as macro elements (major elements). Copper (Cu), iron (Fe), cobalt (Co), iodine (I), selenium (Se), manganese (Mn), zinc (Zn) and fluorine (F) are known as trace elements and it is also present in trace amounts (blood at% µg level) in blood. Minerals such as calcium, phosphorus, magnesium are found in skeleton and tooth structure. Iron and cobalt are important for blood production, while zinc is important for the immune system [4, 5]. Some of the elements work by binding to the body's enzymes, hormones or vitamins, while others are found in the form of ions in the organism. These elements in the form of ions in intracellular or extracellular fluids are called electrolytes. Electrolytes in the organism are in the forms of Na⁺, K⁺, Ca²⁺, Mg²⁺ as a cation or Cl⁻, HCO³⁻, HPO₄²⁻ as anions.

Minerals, which are highly effective in metabolic events, have a wide variety of functions:

- They bind to enzymes as cofactors and take part in catalysis.
- They regulate the acid-base balance of the body.
- Osmotic pressure settings.
- They play a role in the regulation of heart and muscle functions.
- They contribute to the regulation of oxydoreduction events.

1.3. Water

The water polarity is due to the fact that the oxygen side is more negative (-) and the hydrogen side is more positive (+) and dipol (bipolar). Because of the H and O atoms in the structure, water can easily bind to H. For this reason, it is a very good polar solvent for intracellular and extracellular environments. There is a need for water for a healthy life. Inadequate intake of water or loss of water can lead to conditions that can last up to death [9]. Water in the organism differs at different rates in tissues [9]. Cornea 98%, Blood 79%, Muscle 72%, Skin 72%, Fat tissue 15%. Water is present in

the cell in two forms, free and bound. Free water forms 95% of all water in the cell and creates a solvent environment for ions and other substances. Free water is found at high levels in fluids such as blood, lymph, CSF (cerebrospinal fluid). The remaining 5% water is bound to hydrogen bonds and molecules such as protein, nucleic acid, carbohydrate [9]. Because water is needed in more quantities than the body produces, water is regarded as a basic nutrient. All biochemical reactions occur in water. It fills the gaps in and between cells and helps to create structures of large molecules such as proteins and glycogens. Apart from these, water is also required for digestion, absorption, transport, dissolution for dissolved nutrients, removal of waste products and thermoregulation [11].

2. Conclusion

Each food that we eat has a proportion of the macronutrients and micronutrients that it contains: the carbohydrates, fats, proteins, vitamins and minerals. Eating all of them is very important in metabolism. For example, beans, nuts, vegetables, meat and other foods have multiple macronutrients and micronutrients. Thus, even if we consume a single food group, we can get both macro and micro nutrients at the same time. But, since these foods are comprised of different proportions of carbs, fats, and proteins, all of them must be taken in balanced and sufficient quantities. The amount of micronutrients and macronutrients varies greatly depending on the food. Fresh foods always contain much more micronutrients (vitamins, minerals, etc.) than processed foods. Processed and "high-calorie" foods contain high amounts of macro nutrients (such as high amounts of sugar and fat due to high amounts of carbohydrate and fat), such as fried foods, sweet, refined grains and poor quality meat and dairy products) they contain micronutrients in low quantities. Controversy over the nutritional expression of consumed packaged foods is still ongoing [12]. The best thing we can do to get enough of both is to avoid processed and packaged foods and eat from all the food. When we eat fresh and real foods such as vegetables, fruits, beans, whole grains, good quality animal foods like seafood and eggs, we eat enough macronutrients and micronutrients.

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