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LECTURE No. 40
Nutrition:
Classification of foods and Proximate principles and role of various nutrients

Introduction

Nutrition may be defined as the science of food and its relationship to health. It is concerned primarily with the part played by nutrients in body growth, development and maintenance. The word Nutrient or "food factor" is used for specific dietary constituents such as proteins, vitamins and minerals. Dietetics is the practical application of the principles of nutrition; it includes the planning of meals for the well and the sick. Good nutrition means "maintaining a nutritional status that enables us to grow well and enjoy good health".

For the average person, a **recommended dietary allowance** (RDA) has been established to provide standards for promoting and maintaining good health. However, nutritional requirements are much greater for athletes than the average population. Depending on the needs of the athletes (e.g., size, gender, requirements of the sport), energy intake may be three to four fold higher than that recommended for the average individual. The nutritional needs of the athlete have been the focus of much research concerning what to eat, when to eat, and which nutritional supplements to take in order to

maximize athletic performance. For example, a recommended balance of 55-60 % carbohydrates, 30% fat, and 10-15% protein appears to provide a sufficient dietary composition for most people. However, many athletes are concerned that their specific nutritional needs may not be met without altering the recommended balance of protein or carbohydrate intake.

Sports nutrition covers a broad range of topics that may be specific to the individual athlete (e.g., the needs of a marathon runner may be different from the needs of a wrestler). To thoroughly review each topic area would be beyond the scope of this unit. Thus, this unit provides a brief review of the nutritional classes, with additional focus on topics considered to be common areas of concern for the general athletic population.

Classification of food: -

There are many ways of classifying foods:

1. Classification by origin:
    i. Foods of animal origin.
    ii. Foods of vegetable origin.
2. Classification by chemical composition:
    i. Proteins
    ii. Fats
    iii. Carbohydrates
    iv. Vitamins
    v. Minerals
3. Classification by predominant function:
    i. Body-building foods, e.g., milk, meat, poultry, fish, eggs, pulses, groundnuts etc.
    ii. Energy giving food, e.g., cereals, sugars, roots and tubers, fats and oils.
    iii. Protective food. e.g., vegetables, fruit, milk.
4. Classification by nutritive value:
    i. Cereals and millets.
    ii. Pulses (legumes).
    iii. Vegetables.
    iv. Nuts and oilseeds.
    v. Fruits.
    vi. Animal foods.
    vii. Fats and oils.
    viii. Sugar and jaggery.
    ix. Condiments and spices.
    x. Miscellaneous foods.

PROXIMATE PRINCIPLES AND ROLE OF VARIOUS NUTRIENTS:

Nutrients are organic and inorganic complexes contained in food. There are about 50 different nutrients which are normally supplied through the food we eat. Each nutrient has specific functions in the body. Carbohydrates, fats, proteins, vitamins, minerals, and water are the six classes of nutrients which required for the energy and health needs of an individual. Carbohydrates, fats, and proteins are the principal compounds that make up our food and provide energy for our bodies. Vitamins and mineral play an important role in energy production and are also involved in bone health and immune function. However they provide no direct source of energy. Water may be the most important nutrient available. It is needed for nutrient transport, waste removal, body cooling, and most other body reactions. Most natural foods contain more than one nutrient. These may be divided into:

Macronutrients: These are Proteins, fats and carbohydrates which are often called "proximate principles" because they form the main bulk of food. In the Indian dietary, they contribute to the total energy intake in the following proportions.

Proteins	7 to 15 per cent
Fats	10 to 30 per cent
Carbohydrates	65 to 80 per cent

Micronutrients: These are vitamins and minerals. They are called micronutrients because they are required in small amounts which may vary from a fraction of a milligram to several grams. A short review of basic facts about these nutrients is given below.

CARBOHYDRATES (our main source of energy): - Carbohydrate provides quick energy to the body and is not stored in the body for long. The ratio of carbohydrates is increased in endurance events/activities. The basic unit of carbohydrates is monosaccharide.

Carbohydrates are compounds of Carbon, hydrogen, and oxygen. Carbohydrates are of two type; 1.Simple carbohydrates and 2.Complex carbohydrates.

Simple Carbohydrates:

Sugars are simple carbohydrates, which are use to provide energy immediately. **Monosaccharides** are the simplest form of carbohydrate. They consist of a one-unit sugar molecule such as glucose, fructose and galactose. **Disaccharides** are composed of two-unit sugar molecules such as sucrose (table sugar), maltose (grain sugar), and lactose (milk sugar). Each of these carbohydrates can be broken down to its simpler form through the process of digestion. Both mono- and disaccharides are considered simple sugars and are a good source of quick energy. Sucrose consists of a glucose and fructose molecule, maltose consists of two glucose molecules, and lactose consists of a glucose

and galactose molecule. However, for galactose to be used as energy, it must undergo a secondary conversion to glucose. So, to increase blood glucose levels quickly, a glass of milk may not be ideal. Simple carbohydrates are found in natural foods such as fruits (fresh, dried, and juices) and vegetables, as well as in processed foods such as candies and soft drinks.

Structural classification of carbohydrates

Monosaccharides "Simple carbohydrates"
Glucose
Fructose
Galactose
Disaccharides "Simple Carbohydrates"
Sucrose (glucose + fructose)
Lactose (glucose + galactose)
Maltose (glucose + glucose)
Polysaccharides "Complex Carbohydrates"
Starch
Cellulose

Source of simple carbohydrates: - they naturally occur in fruits, milk and milk products and vegetable (potatoes, carrots). They are also found in processed and refined sugars such as honey, jam, cake, pastries, ice cream, table sugar, candy, syrups and regular carbonates beverages (drinks), jaggery (gurh).

Complex carbohydrates are good source of fibres. Starch are complex carbohydrates that contain several sugar molecules combined together chemically. Carbohydrates that contain more than two monosaccharides are termed **polysaccharides** and are known as complex carbohydrates. Common polysaccharides include starch and glycogen, which is made up primarily of chain of glucose molecules, the bonds that bind the monosaccharides of the complex carbohydrate may be either digestible (such as those found in potatoes, pasta, bread, and beans) or indigestible. Indigestible polysaccharides are known as **fibre** and are common in some grains, fruits, and vegetables. Their energy content is higher than sugar but is released more slowly.

Source of complex carbohydrates: - they are found in breads, cereals (wheat, bajra, rice), starchy vegetables and whole pulses (chana, moong, rajma).

FUNCTIONS OF CARBOHYDRATES:

Primary function of carbohydrate is to provide energy, especially the brain and nervous system. The consumption of simple carbohydrates results in a relatively fast rise in blood glucose. This results in an insulin response to move the glucose from the blood into the muscles, where it can be used for immediate energy or stored for later use. Carbohydrates that are not used immediately are stored in the muscles and liver as **glycogen**. Having full

glycogen storage depots is critical for fueling athletic performance. However, if the body's glycogen stores are completely full, the excess carbohydrate is converted to fat and stored in adipose sites around the body. The benefit of consuming complex carbohydrates such as starchy foods is that the time required for complete digestion is slower, which results in a more gradual increase of blood glucose. The body breaks down starches and sugars into substance called glucose that is used for energy by the body.

Carbohydrates serve four important functions related to energy metabolism and exercise performance.

1. Energy source: - the main function of carbohydrate is to serve as an energy fuel, particularly during exercise.
2. Protein sparing: - adequate carbohydrate intake helps to preserve tissue proteins.
3. Metabolic primer: - carbohydrates serve as a "primer" for lipid metabolism.
4. Fuel for the CNS: - carbohydrate is essential for the proper functioning of the central nervous system.

RECOMMENDATION:

55 to 60 % of total calories from carbohydrate preferably from complex carbohydrates. To increase complex carbohydrate we should eat more fruits, vegetables, whole grain, rice, bread and cereals and also more beans, dried peas and low fat milk.

Excess of carbohydrates are converted into fat by the liver and stored in adipose tissue. The consumption of excess sugar prior to exercise reduces performance and endurance.

PROTEINS: - Proteins are the basic structure of living cells, essential growth and repair of muscles and other body tissues. It is nitrogen-containing substances that are formed by amino acids. The basic structure of proteins is a chain of amino acids that contain carbon, oxygen, hydrogen and nitrogen. In addition, they are used to produce certain hormones, enzymes, and hemoglobin. Proteins can also be used as energy; however, they are not the primary choice as an energy source. For protein to be used by the body, they must be broken down into their simplest form, amino acids. There are two types of amino acids; 1.Non-essential amino acids 2.Essential amino acids.

Non-essential amino acids: - The human body needs approximately 20 amino acids for the synthesis of its proteins. The body can make only 11 of the amino acids that are known as the non- essential proteins or amino acids. Nonessential meaning that our body can synthesize them, and they do not need to be consumed in the diet. They are essential but we do not have to get them from the food that we eat.

Essential amino acids: - Eight amino acids (nine in children and certain older adults) that cannot be synthesized by the body and therefore must be provided in foods. Thus they are called **essential proteins or amino acids**. Absence of any of these essential amino acids from our diet prevents the production of the proteins that are made up of those amino acids. As a result, the ability for tissue to grow, be repaired, or the maintained is compromised.

Table: Essential and Non-essential Amino acids

Essential	Nonessential
Histidine (in children only)	Alanine
Isoleucine	Arginine
Leucine	Asparagines
Lysine	Aspartic acid
Methionine	Cysteine
Phenylalanine	Glutamic acid
Threonine	Glutamine
Tryptophan	Glycine
Valine	Histidine (in adults only)
	Proline
	Serine
	Tyrosine

Histidine is not synthesized in children, making it an essential amino acid for that population group. However, in adults it is synthesized, making it a non-essential amino acid for the population.

Complete protein: - If the protein of a food supplied contain enough of the essential amino acids it is called a complete protein food.

Incomplete protein: - If the protein of a food does not contain all the essential amino acids, it is called an incomplete protein food.

Sources of complete protein: All meat and other animal products are sources of proteins. The best sources of complete protein are eggs, milk, meat, poultry, beef and milk products.

Sources of incomplete protein: Grains, fruits and vegetables are the sources of incomplete proteins as they lack one of the essential amino acids.

The plant protein can be combined to all of the essential amino acids and form a complete protein.

Protein is the main component of muscles, organs and glands. Every living cell and all body fluid except urine and bile contain protein.

Table: Quality of different protein sources

High-Quality	**Milk** **Eggs** **Meat (beef, chicken, fish)**	**Animal Sources**
Intermediate-Quality	Nuts/seeds Rice Soy Potatoes Oats	Plant Sources
Low-Quality	Peas Cornmeal White flour Gelatin	

Functions of proteins:

1. The cell of muscles, tendons and ligament are maintained with protein.
2. Needed for growth and developments of children.
3. Required for the formation of hormones, enzymes and haemoglobin.

Protein works as a source of energy in starvation (hunger) otherwise it is not a source of energy.

Special consideration: - High intake of proteins creates extra load on the body due to disposal of nitrogen especially for kidneys and liver. Dehydration can occur because of disposal of nitrogen, which may affect workout. It is, therefore important to have adequate water when consuming increased level of proteins.

FATS: - Fat is a highly concentrated fuel that has limited water solubility. Fats also referred to as lipids (from the Greek **lipos**, meaning fat), exist in the body in several forms. Lipid is general term that includes oil, fats, and waxes. Oils are liquid at room temperature, while fats remain solid. Fats contain carbon, hydrogen and oxygen. The basic unit of fat is the fatty acid, which is also the part of fat that is used for energy production. The most common form of lipid is triglyceride, which is composed of three fatty acids and a glycerol molecule. Approximately 98% of dietary fat is in the form of **triglycerides**, and about 90% of fat in the body is stored in the adipose tissue depots, mostly in the **subcutaneous** tissues. Another common lipid is cholesterol.

Simple fats: - consist of a glyceride molecule linked to one, two, or three units of fatty acids. According to the number of fatty acids attached, simple fats are divided into **monoglycerides** (one fatty acids), **diglycerides** (two fatty acids), and **triglycerides** (three fatty acids). More than 95 % of the stored fat in the human body is in the form of triglycerides.

Based on the degree of hydrogen saturation fatty acids are said to be saturated or unsaturated.

In **saturated fatty acids** the carbon atoms are fully saturated with hydrogen, therefore only single bonds link the carbon atoms on the chain. This saturated fatty acids frequently referred to as saturated fats. Saturated fatty acids tend to be solid at room temperature and are generally derived from fat of animal [meats, cheese and butter] origin. Exceptions do exist and examples of common oils high in saturated fats are palm kernel oil and coconut oil, which is liquid at room temperature. The consumption of saturated fats is also associated with a great risk for cardiovascular disease.

In **Unsaturated fatty acids** the carbon atoms are not completely saturated with hydrogen, rather double bonds are formed between the unsaturated carbon atoms. These are generally found in plant products.

Unsaturated fatty acids have at least one or more i.e., Monounsaturated fatty acids (one double bond) and poly-unsaturated fatty acids (two or more double bonds) and tend to be liquid at room temperature. **Polyunsaturated fatty acids** are primarily found in vegetable oils and are the preferred source of fat for lowering the risk of cardiovascular disease.

Note: In general, saturated fat increases the blood cholesterol level, and poly- unsaturated fats tend to decrease cholesterol.

COMPOUNDS FATS: - Compounds fats are a combination of simple fat and other chemicals, e.g. phospholipids (triglycerdies), Glucolipids (carbohydrates, fatty acids and nitrogen), lipoproteins (are water soluble aggregates of protein with either triglycerides, phospholipids, or cholesterol.

Lipoproteins transport fats (cholesterol, triglycerides) in the body and have a significant role in the development and prevention of heart disease.

HDL - Cholesterol refers to High density Lipoprotein cholesterol. (Good cholesterol)

LDL- cholesterol refers to low density lipoprotein cholesterol. (Not good for heart)

Function of Fats:-

1. Proper functioning of the body.
2. Important for energy source, provide up to 70% of total energy during the resting state.
3. Support and cushion vital organs.
4. Make up essential components of cell membranes and nerve fibre.
5. Serve as a precursor for steroid hormones.
6. Fatty acids provide the raw materials (help in the control of blood pressure, blood clotting and other body functions).
7. Fat maintain skin & hair.

8. Store and transport fat soluble vitamins A, D, E and K.
9. Serve as an insulator to preserve body heat.

VITAMINS: - Vitamins are compounds of carbon that are absolutely essential for the normal working of the body. It is needed by cells to perform specific functions that promote growth and maintain health, including enabling cells to utilize carbohydrates, fats, and proteins for energy. Thirteen different vitamins have been isolated, analyzed, classified, and synthesized, and recommended dietary allowance (RDA) levels have been established. Vitamins are classified as either water-soluble or fat-soluble:

FAT SOLUBLE VITAMINS: - The fat soluble vitamins, which include vitamin A, D, E and K. once absorbed, they are bound to lipids and transported throughout the body. Excess fat-soluble vitamins are stored within the fat stores of the body, and excessive intake of fat-soluble vitamins can cause toxic accumulations.

Vitamin A: It is needed for normal growth especially for keeping the eyes and skin healthy (milk, butter, egg, carrots, cod liver oil, tomatoes, pumpkin and green leafy vegetables).

Vitamin D: it is important for formation of strong bones and teeth. "Sunshine vitamin", (cheese, butter, milk, green vegetables, fish liver oil and sunlight).

Deficiency: - disease called rickets which affect children and in which the bones are soft and out of shape.

Vitamin E: It is important to protect the cell membranes and also important in the formation of red blood cells (RBC) (Vegetable oil, butter, milk, whole grains, corn, nuts, seeds, spinach and other green leafy vegetables).

Vitamin K: It helps in the clotting the blood. (Cabbage, cauliflower, spinach and other green leafy vegetables, cereals, soyabeans, bacteria in the intestines normally also produce)

Deficiency: causes excessive bleeding form wounds.

WATER SOLUBLE VITAMINS: - Include vitamin thiamine ($B_{1)}$, riboflavin ($B_{2)}$, Niacin (B_3), pyridoxine (B_6), cobalamin ($B_{12)}$ and C are not stored by the body. Once absorbed, are transported throughout the body in water. Water-soluble vitamins function largely as coenzymes, which are small molecules that combine with larger protein compounds (apoenzymes) to form active enzymes that accelerate the interconversion of chemical compound. Coenzymes participate directly in chemical reactions, but when the reaction is completed, they remain intact to be used again. In general, any excess of water-soluble vitamins is excreted in the urine.

B_1 (thiamin): important for growth and development, necessary for changing carbohydrates into energy (seafood, milk, meat, peas, cereals and green vegetables).

B_2 (riboflavin): important for body growth and red blood cell production, help in releasing energy form carbohydrates. (yeast, egg, meat and peas)

Deficiency: - skin disease and retarded growth.

B_3 (niacin): important for healthy skin, digestion and nerves system, (whole cereals, tomatoes, potatoes, meat and fish)

Deficiency: - pellagra, which affects the skin alimentary canal and nervous system.

B_{12}: needed for forming red blood cells and for healthy nervous system. (liver, milk, eggs and fish)

Deficiency: - anemia which is a deficiency of red blood cells (RBCs).

C: needed for the maintenance of the ligaments, tendons, and other supportive tissue and strong blood vessels. (Amla, citrus fruits, tomatoes, green leafy vegetables and potatoes)

Deficiency: scurvy in which gums swell up and bleed.

Special considerations:-

1. Vitamins are essential for metabolism of fats and carbohydrates.
2. Vitamins do not yield energy but act for repair and maintenance work.
3. Water soluble vitamins (B & C) are not stored; thus supplements of vitamins B and C is required.
4. Fat-soluble vitamins (A, D, E & K) can be stored in liver and fatty tissues.
5. Vitamins do not increase physical work capacity; rather it is a psychological concept.
6. Vitamins E help in recovery of muscle cramps.
7. During training fresh fruits and vegetables are recommended.

MINERALS: - Minerals contain elements needed by our body in small quantities. But these are essential for proper growth and functioning of the body. Approximately 4% of the body mass (about 2 kg for a 50-kg woman), is composed of a group of 22, mostly metallic, elements collectively called minerals. Minerals are constituents of enzymes, hormones, and vitamins; they are combined with other chemicals (for example, calcium phosphate in bone and iron in the heme of hemoglobin) or exist singularly (such as free calcium in body fluids). Their deficiency in our diet causes deficiency diseases. They are supplied in the form of salts by different foods some of the important minerals are mentioned below.

In the body, minerals are classified as major minerals (required in amounts of more than 100 mg daily) and minor or trace minerals (required in amounts of less than 100 mg daily). The total quantity of the body's trace minerals is less than 15g) or approximately 0.5 oz). Any excess minerals are useless to the body and even may be toxic.

Iron: it is important for the formation of haemoglobin (which is the oxygen-carrying pigment found in red blood cells). Iron found in meat, fish, liver, eggs, green vegetables, turnip, germinating wheat grains and yeast. (10mg/daily)

Calcium: Calcium is needed for the formation of strong bones and teeth and also for clotting of blood and muscle contraction. Ca is found in milk and milk products, green leafy vegetables. (800mg/daily)

Phosphorus: It is required for development of strong bones and teeth and also for making energy rich compounds in the cells from body. (meat, eggs, fish and whole grains). (750mg/daily)

Potassium: it is important for growth and keeping cells and blood healthy. (green and yellow vegetables). (2000mg/daily)

Sodium: it is needed for the proper functioning of the nervous system. (green and yellow vegetables). (500mg/daily)

Iodine: Iodine is essential for proper thyroid function. It deficiency causes a disease called goiter in which a gland in the throat swells up. Iodine is found in iodized salt, sea food and water.

Fluoride: Fluoride is important to make the enamel (polish) of the teeth hard and prevent dental caries. (coffee, spinach, onion and tea). (4mg/daily)

Copper: it is helpful in red blood cells, connective tissue and nerve fibres formation & functioning. (grains, nuts & chocolate). (3mg/daily)

Zinc: Zinc is required for insulin production and also for functioning of male prostate, digestion and metabolism. (meat, eggs, fish)

Chloride: it is needed for muscle and nerve function and also for digestion. (meat, milk products and fish). (750mg/daily)

Special consideration:-

1. Minerals are essential in strenuous physical activity.
2. Supplementation of iron is must for females.
3. Supplements of calcium and phosphorus may be given to young athletes.

WATER: - water makes up from 40 to 60% of an individual's body mass and constitutes 65 to 75% of the weight of muscle and approximately 50% of the weight of body fat. The body has two main water "compartments:" intracellular, referring to inside the cell, and extracellular, referring to fluids surrounding the cells. Of total body water, an average of 62% is intracellular and 38% is extracellular.

Functions of body water: - water is a remarkable nutrient. Without water, death occurs within days. It serves as the body's transport and reactive medium; diffusion of gases

always takes place across surfaces moistened by water. Nutrients and gases are transported in aqueous solution; waste products leave the body through the water in urine and foaces. Water has tremendous heat-stabilizing qualities because it can absorb considerable heat with only a small change in temperature. Water lubricates joints.

Normally, approximately 2.5 L of water is required each day for a fairly sedentary adult in a normal environment. This water is supplied from three sources: a. from liquids, b. in foods, and c. during metabolism.

a. Water from liquids. The average individual normally consumes 1200 mL or 41 oz of water each day. Of course during exercise and thermal stress, fluid intake can increase five or six times above normal.
b. Water in foods. Most foods, especially fruits and vegetables, contain large amounts of water. Such foods as lettuce, watermelon and cantaloupe, pickles, green beans, and broccoli are examples of foods that have high water content, whereas the water content is relatively low in butter, oils, dried meats, chocolate, cookies, and cakes.
c. Metabolic water. Carbon dioxide and water are formed when food molecules are degraded for energy. This water is termed metabolic water and accounts for about 25% of the daily water requirement of a sedentary person.

During resting condition, the primary avenue of water loss (approximately 60%) is through excretion from the kidneys (urination). Water loss as a result of evaporation from both the skin and respiratory tract accounts for approximately 35% of the total water loss. The remaining 5% is the result of water loss in the feces. Water loss is accelerated during exercise because of the increase in metabolic heat production. Sweat rate can vary greatly and depends on environmental conditions (ambient temperature, humidity, and wind velocity), clothing (insulation and moisture permeability), and the intensity of physical activity. Sweat rates generally range between 1.0 to 1.5 $L.h^{-1}$, which is equivalent to about a 2% decrease in body water per hour in a 155-lb (70-kg) man.

Conclusion:

Nutrition may be defined as the science of food and its relationship to health. It is concerned primarily with the part played by nutrients in body growth, development and maintenance. However, nutritional requirements are much greater for athletes than the average population. The nutritional needs of the athlete have been the focus of much research concerning what to eat, when to eat, and which nutritional supplements to take in order to maximize athletic performance.

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