Food, Nutrition and Health

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Food plays a very vital role in maintaining proper health and also helps to prevent and cure many ailments. Eating can be defined as the consumption of food and liquid to sustain life and to meet our body's basic needs for growth, development, and function. The nutrients in food enable the cells in our bodies to perform their necessary functions. A proper diet is essential from the very early stages of life for proper growth, development and to remain active. Food consumption, which largely depends on production and distribution, determines health and nutrition of the population.

Nutrients that we obtain through food have vital effects on physical growth and development, maintenance of normal body function, physical activity and health. Our diet must provide all essential nutrients in the required amounts. Requirements of essential nutrients vary with age, gender, physiological status and physical activity. Dietary intakes lower or higher than the body requirements can lead to under-nutrition (deficiency diseases) or over-nutrition (diseases of affluence) respectively. Eating too little food during the vulnerable periods of life such as infancy, childhood, adolescence, pregnancy and lactation and eating too much at any age can lead to harmful consequences. An adequate diet, providing all nutrients, is needed throughout our lives. The nutrients must be obtained through a judicious choice and combination of a variety of foodstuffs from different food groups. Carbohydrates, fats and proteins are macronutrients, which are needed in large amounts. Vitamins and minerals constitute the micronutrients and are required in small amounts. These nutrients are necessary for physiological and biochemical processes by which the human body acquires, assimilates and utilizes food to maintain health and activity [(1)].

Carbohydrates

Carbohydrates are either simple or complex, and are major sources of energy in all human diets. Carbohydrate consumed in food yields 3.87 calories of energy per gram for simple sugars, [(2)] and 3.57 to 4.12 calories per gram for complex carbohydrate in most other foods [(3)]. The carbohydrates are divided into four chemical groups: monosaccharides, disaccharides, oligosaccharides, and polysaccharides. In general, the monosaccharides and disaccharides, which are smaller (lower molecular weight) carbohydrates, are commonly referred to as sugars [(4)].

The simple carbohydrates, glucose and fructose, are found in fruits, vegetables and honey, sucrose in sugar and lactose in milk, while the complex polysaccharides are starches in cereals, millets, pulses and root vegetables and glycogen in animal foods. The other complex carbohydrates which are resistant to digestion in the human digestive tract are cellulose in vegetables and whole grains, and gums and pectins in vegetables, fruits and cereals, which constitute the dietary fibre component. In India, 70-80% of total dietary calories are derived from carbohydrates present in plant foods such as cereals, millets and pulses.

Dietary fibre delays and retards absorption of carbohydrates and fats and increases the satiety value. Diets rich in fibre reduce glucose and lipids in blood and increase the bulk of the

stools. Diets rich in complex carbohydrates are healthier than low-fibre diets based on refined and processed foods [5]. Lactose from dairy products can be a major source of carbohydrate for young children. In addition, milk represents an excellent source of high quality protein, calcium, and riboflavin. In most populations, even those with low lactase activity, milk can be ingested in small amounts, especially after meals with dilution by co-ingestion. Fermented dairy products can be valuable items in the diet of most people irrespective of intestinal lactase status [6].

The Food and Agriculture Organization and World Health Organization jointly recommend that national dietary guidelines set a goal of 55–75% of total energy from carbohydrates, but only 10% directly from sugars (their term for simple carbohydrates) [7].

Proteins

Proteins are essential nutrients for the human body. Proteins are primary structural and functional components of every living cell. Almost half the protein in our body is in the form of muscle and the rest of it is in bone, cartilage and skin. Proteins are complex molecules composed of different amino acids. Certain amino acids which are termed “essential”, have to be obtained from proteins in the diet since they are not synthesized in the human body. Other nonessential amino acids can be synthesized in the body to build proteins. Proteins perform a wide range of functions and also provide energy (4 Kcal/g, 16.7 kJ/ g). Protein requirements vary with age, physiological status and stress. More proteins are required by growing infants and children, pregnant women and individuals during infections and illness or stress [8].

Animal foods like milk, meat, fish and eggs and plant foods such as pulses and legumes are rich sources of proteins. Animal proteins are of high quality as they provide all the essential amino acids in right proportions, while plant or vegetable proteins are not of the same quality because of their low content of some of the essential amino acids. However, a combination of cereals, millets and pulses provides most of the amino acids, which complement each other to provide better quality proteins [1].

Meat, products from milk, eggs and fish are sources of complete protein [9]. Vegetarian sources of proteins include legumes, nuts, seeds and fruits. Legumes, some of which are called pulses in certain parts of the world, have higher concentrations of amino acids and are more complete sources of protein than whole grains and cereals. Protein powders – such as casein, whey, egg, rice and soy are processed and manufactured sources of protein. These protein powders may provide an additional source of protein for bodybuilders [10].

The generally accepted daily protein dietary allowance, measured as intake per kilogram of body weight, is 0.8 g/kg [11].

Fat

Dietary fat consists of heterogeneous mixtures of triacylglycerols (triglycerides) and small proportions of phospholipids, glycolipids, monoacylglycerols, diacylglycerols and unsaponifiable fraction composed of fat soluble chemicals collectively designated as non-glyceride components. Fatty acids, the building blocks of various lipids, are classified into 3

groups: saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs) and polyunsaturated fatty acids (PUFAs). Most of the SFAs consisting of straight even-numbered chains of 4-24 carbon atoms are classified as short (<10:0), medium (12:0 and 14:0) or long (16:0-24:0) chain fatty acids. Unsaturated fatty acids (MUFAs and PUFAs) containing one or more double bonds in trans configuration are called trans fatty acids (TFAs). PUFAs are grouped into two series (n-6 or n-3) depending on whether the double bond closest to the methyl end is located at C6 or C3 position. [12]

The small amount of fat present as integral component in each and every item of food (invisible fat), the fat in processed and ready to eat foods (hidden fat) and visible fat (vegetable oil, ghee, butter and vanasapti), used as cooking fat together contribute to total fat intake. [12]

Oils and fats such as butter, ghee and hydrogenated vegetable oil constitute dietary visible fats. Fats are a concentrated source of energy providing 9 Kcal/g or 37.7kJ/g. Fats serve as a vehicle for fat-soluble vitamins like vitamins A, D, E and K and carotenes and promote their absorption. They are also sources of essential polyunsaturated fatty acids. It is necessary to have adequate and good quality fat in the diet with sufficient polyunsaturated fatty acids in proper proportions for meeting the requirements of essential fatty acids. The type and quantity of fat in the daily diet influence the level of cholesterol and triglycerides in the blood. Diets should include adequate amounts of fat particularly in the case of infants and children, to provide concentrated energy since their energy needs per kg body weight are nearly twice those of adults. Adults need to be cautioned to restrict intake of saturated fat and cholesterol. Excess of these substances could lead to obesity, diabetes, cardiovascular disease and cancer. [1]

In general, adults should obtain at least 15% of their energy intake from dietary fats and oils. Women of childbearing age should obtain at least 20% to better ensure an adequate intake of essential fatty acids, needed for foetal and infant brain development. Active individuals who are not obese may consume up to 35% fat energy, as long as saturated fatty acids do not exceed 10% of energy intake. Sedentary individuals should limit fat to not more than 30% of energy intake and saturated fatty acids should be limited to less than 10% of intake [8].

Vitamin and mineral

Vitamins are chemical compounds required by the body in small amounts. An organic chemical compound (or related set of compounds) is called a vitamin when the organism cannot synthesize the compound in sufficient quantities, and must be obtained through the diet; thus, the term "vitamin" is conditional upon the circumstances and the particular organism. For example, ascorbic acid (vitamin C) is a vitamin for humans, but not for most other animal organisms [13]. Thirteen vitamins are universally recognized at present. Vitamins are classified by their biological and chemical activity, not their structure.

Vitamins are essential for numerous body processes and for maintenance of the structure of skin, bone, nerves, eye, brain, blood and mucous membrane. They are either water soluble or fat-soluble. Vitamins A, D, E and K are fat-soluble, while vitamin C, and the B-complex vitamins such as thiamin (B_1), riboflavin (B_2), niacin (B_3), pantothenic acid (B_5), pyridoxine (B_6), folic acid (B_9) and cyanocobalamin (B_{12}) are water soluble. Pro-vitamins like beta-carotene

are converted to vitamin A in the body. Fat soluble vitamins can be stored in the body while water-soluble vitamins are not and get easily excreted in urine. Vitamins B-complex and C are heat labile vitamins and are easily destroyed by heat, air or during drying, cooking and food processing. [5] The details about the vitamins are given in the table below.

Minerals are inorganic elements found in body fluids and tissues. The important macro minerals are sodium, potassium, calcium, phosphorus, magnesium and sulphur, while zinc, copper, selenium, molybdenum, fluorine, cobalt, chromium and iodine are microminerals. They are required for maintenance and integrity of skin, hair, nails, blood and soft tissues. They also govern nerve cell transmission, acid/base and fluid balance, enzyme and hormone activity as well as the blood- clotting processes [1].

Macrominerals

Many elements are essential in relative quantity; they are usually called "bulk minerals". Some are structural, but many play a role as electrolytes. Elements with recommended dietary allowance (RDA) greater than 200 mg/day are, in alphabetical order.

- Calcium: a common electrolyte, but also needed structurally
- Chlorine: as chloride ions; very common electrolyte
- Magnesium: required for processing ATP and related reactions (builds bone, causes strong peristalsis, increases flexibility, increases alkalinity)
- Phosphorus: required component of bones; essential for energy processing
- Potassium: a very common electrolyte (heart and nerve health)
- Sodium: a very common electrolyte; in general not found in dietary supplements, despite being needed in large quantities, because the ion is very common in food: typically as sodium chloride, or common salt. Excessive sodium consumption can deplete calcium and magnesium leading to high blood pressure and osteoporosis.
- Sulfur: for three essential amino acids and therefore many proteins (skin, hair, nails, liver, and pancreas). Sulfur is not consumed alone, but in the form of sulfur-containing amino acids [17]

Trace minerals

Many elements are required in trace amounts, usually because they play a catalytic role in enzymes. Some trace mineral elements (RDA < 200 mg/day) are, in alphabetical order:

- Cobalt required for biosynthesis of vitamin B_{12} family of coenzymes. Animals cannot biosynthesize B_{12}, and must obtain this cobalt-containing vitamin in the diet

- Copper required component of many redox enzymes, including cytochrome c oxidase
- Chromium required for sugar metabolism
- Iodine required not only for the biosynthesis of thyroxine but also it is presumed for other important organs as breast, stomach, salivary glands, thymus, etc.
- Iron required for many enzymes, and for hemoglobin and some other proteins
- Manganese (processing of oxygen)
- Molybdenum required for xanthine oxidase and related oxidases
- Nickel present in urease
- Selenium required for peroxidase (antioxidant proteins)
- Zinc required for several enzymes such as carboxypeptidase, liver alcohol dehydrogenase, and carbonic anhydrase [17]

World Health Organization Recommendations

The World Health Organization (WHO) has also published diet recommendations with the goal of reducing risk of chronic disease. WHO recommendations are expressed as a range of average daily intakes from lower to upper limits [14].

Total Energy	**Sufficient to support normal growth, physical activity, and body weigh t (body mass index = 20–22)**
Total Fat	15%–30% of total energy
Saturated Fatty acids	0%–10% total energy
Polyunsaturated fatty acids	3%–7% total energy
Dietary cholesterol	0–300 mg/day
Total carbohydrate	55%–75% total energy
Complex carbohydrates	50%–75% total energy
Protein	10%–15% total energy
Salt	upper limit of 6 g/day (no lower limit set)
Dietary fiber	27–40 g/day
Refined sugars	0%–10% total energy

Table: Vitamins and its solubility, RDA, Deficiency diseases and common food sources [15, 16]

Vitamin Name	Solubility	Recommended Dietary Allowances (male, age 19-70)	Deficiency Diseases	Food Sources
Vitamin A (Ratinol, Retinal)	Fat	900 µg	Night-blindness, Hyperkeratosis, and Keratomalacia	Liver, orange, ripe yellow fruits, leafy vegetables, carrots, pumpkin, squash, spinach, fish, soy milk, milk
Vitamin B1 (Thiamine)	Water	1.2 mg	Beriberi, Wernicke-Korsakoff syndrome	Pork, oatmeal, brown rice, vegetables, potatoes, liver, eggs
Vitamin B2 (Riboflavin)	Water	1.3 mg	Ariboflavinosis, Glossitis, Angular stomatitis	Dairy products, bananas, popcorn, green beans, asparagus
Vitamin B3 (Niacin, Niacinamide)	Water	16.0 mg	Pellagra	Meat, fish, eggs, many vegetables, mushrooms, tree nuts
Vitamin B5 (Pantothenic acid)	Water	5.0 mg	Paresthesia	Meat, broccoli, avocados
Vitamin B6 (Pyridoxine, pyridoxamine, pyridoxal)	Water	1.3-1.7 mg	Anemia	Meat, vegetables, tree nuts, bananas
Vitamin B7 (Biotin)	Water	30 µg	Dermatitis, enteritis	Raw egg yolk, liver, peanuts, leafy green vegetables
Vitamin B9 (Folic acid, folinic acid)	Water	400 µg	Megaloblastic anemia	Leafy vegetables, pasta, bread, cereal, liver
Vitamin B12 (Cyanocobalamin, hydroxycobalamin, methylcobalamin)	Water	2.4 µg	Megaloblastic anemia	Meat and other animal products
Vitamin C (Ascorbic acid)	Water	90 mg	Scurvy	Many fruits and vegetables, liver
Vitamin D (Cholecalciferol (D3), Ergocalciferol (D2))	Fat	10 µg	Rickets and Osteomalacia	Fish, eggs, liver, mushrooms
Vitamin E (Tocopherols, tocotrienols)	Fat	15 mg	Deficiency is very rare; sterility in males and abortions in females, mild hemolytic anemia in newborn infants	Many fruits and vegetables, nuts and seeds
Vitamin K (phylloquinone, menaquinones)	Fat	120 µg	Bleeding diathesis	Leafy green vegetables such as spinach, egg yolks, liver

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