FOOD AND NUTRITION

ABSTRACT

Food and nutrition play a fundamental role in human health, development, and overall well-being. Proper nutrition provides essential nutrients required for growth, energy, and disease prevention. A well-balanced diet provides essential nutrients that support bodily functions and enhance immunity. Access to safe, nutritious, and affordable food remains a challenge, particularly in low-income and conflict-affected regions. The rise in processed and unhealthy food consumption leads to obesity, hypertension, and other chronic illnesses. This chapter explores the significance & concept of nutrition, classification, and their functions in maintaining health.

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I. INTRODUCTION

Food and nutrition are major elements for health maintenance and the prevention of chronic diseases. Evidence over the year shows that diet plays an increasingly important role in individual and public health, and a proper level of nutrition is highly relevant in bodily functions for better lifespan. Proper nutrition has come to be viewed as playing a critical role in the sustenance of life processes from growth and development through maintaining immune function and producing energy to reducing disease development, such as cardiovascular, obesity, and diabetes ailments. In the recent past, dietary patterns have been in the limelight of discussion in regard to their association with the risk of development of chronic diseases and management of active conditions through food. As malnutrition, obesity, and diet-related diseases become a growing concern for the world's population, knowledge of the science of food and nutrition becomes an important factor in making informed decisions at the individual, community, and policy levels. This chapter explores the key principles of food and nutrition, the connection between diet and disease prevention, and strategies for improving nutritional health on a global scale.

II. TERMS &DEFINITIONS

Food: Any thing that provides energy and nutritional support

Diet: Total amount of food consumed by organism

Nutrition: Process of utilising food for body growth, development, repair of tissues, and metabolism

Nutrient: Organic or inorganic complex in food utilized for a specific function

Nutritive Value: It explains the overall quality of forage components and its impact on body growth

Dietetics: Practical application of nutritional principles that includes planning of meals for sick and well beings

DRI: DRI is dietary reference intake. This is the amount of nutrients required to maintain optimal body growth and to prevent deficiency disease.

RDA: RDA is the recommended dietary allowance. RDA is the average daily nutrient intake level to fulfill all requirements of all individuals at a particular life stage.

TUL: TUL is tolerable upper intake level. This is highest average daily intake poses no risk of adverse effects.

Fatigue: Sense of energy depletion

Paresthesias: Prickling “pins & needles” sensation in arms, hands & legs

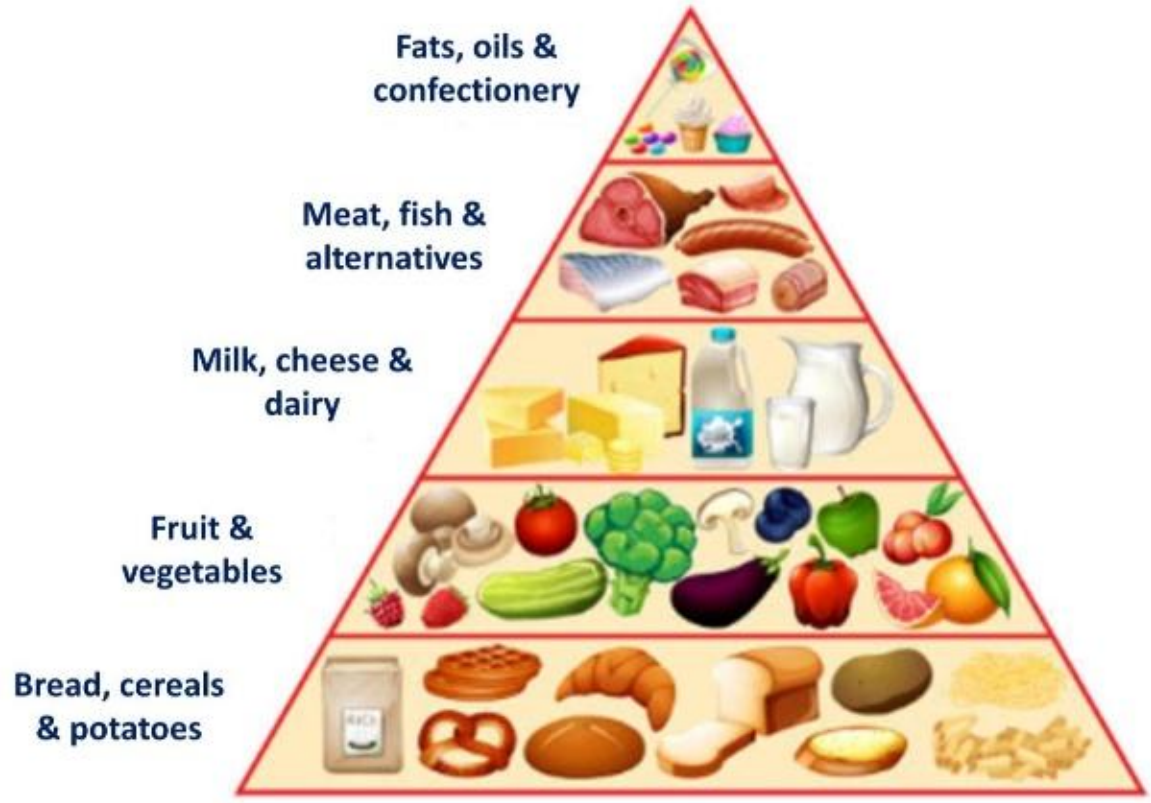

Figure 38: Healty Food Pyramid

Concept of Nutrition

Nutrition is the science dealing with the relationship between living organisms and the substances taken internally to provide nourishment. It involves the processes by which organisms ingest and utilize food for growth, energy, maintenance, and overall health. Nutrition basically addresses the role different nutrients-carbohydrates, proteins, fats, vitamins, minerals, and water-play in maintaining optimal bodily functions and preventing malnutrition and disease. The human body needs many different types of nutrients that are used in a number of different functions, carbohydrates, proteins, fats, vitamins, minerals and fibers. [1, 2]

Nutrition and Health

The World Health Organization (WHO) defines health as "a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity." To maintain good health and nutritional status, it is essential to consume a balanced diet that provides all necessary nutrients in appropriate proportions. The essential requisites of good health include–

1. Maintaining the structural integrity and functional efficiency of body tissues, supporting an active and productive lifestyle.
2. Promoting mental well-being.
3. Attaining optimal growth and development, which reflects the full potential of an individual's genetic makeup.
4. Withstanding the natural process of aging with minimal disability and functional limitations.
5. Possessing the ability to resist and combat diseases, including:
    - Preventing infections (immunocompetence)
    - Reducing the risk of degenerative diseases
    - Resisting the impact of environmental toxins and pollutants [3]

III. CHARACTERISTICS OF FOOD

1. **Taste:** It involves five basic taste sensations: sweet, sour, salty, bitter, and umami [4]

2. **Texture:** Physical sensation in the mouth like crunchiness, chewiness, etc

3. **Aroma:** Smell of food contributes to the flavor& eating experience. [5]

4. **Nutritional Value:** Components of essential nutrients in food essential for health, growth, and overall well-being.

5. **Appearance:** It includes color, texture, presentation etc. Good appearance causes appetite, willing to eat. In food industry, appearance influence consumer choice & perception of quality.

6. **Shelf Life:** This is specific in which food remains safe and suitable for consumption [6]

Functional Classification of Nutrients

- Energy giving: Carbohydrate & Lipid
- Body building: Protein & lipids
- Protective: Vitamins & Minerals

Classification of Nutrients Based on Requirement

- **Macronutrient:** These are energy rich nutrients required in larger quantity. It includes carbohydrate, proteins and lipid.
- **Micronutrient:** These are essential for metabolic functions, required in small quantity. Micronutrient does not provide energy. They only act as precursors for coenzymes, cofactor of enzymes etc. It includes vitamins and minerals.

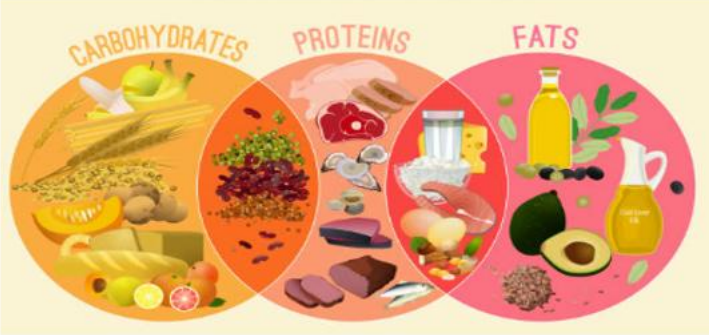

Figure 39: Micronutrient

Dietary Patterns

- **Omnivorous:** Mix diet of plant and animal products
- **Pollotarian:** Semi-vegetarian diet including poultry products (like eggs) excluding meat & pork
- **Flexitarian:** Semi-vegetarian plant-centered diet with occasional use of red meat
- **Vegan:** Restricted vegetarian diet
- **Lacto-ovo vegetarian:** A vegetarian diet with consumption of animal dairy products like milk, eggs etc. [7,8]

Energy Expenditure

At rest, high daily energy expenditures are seen primarily in organs such as the heart, kidneys, liver, brain, and skeletal muscles. Of these, the brain and muscles

are the most metabolically active at rest. Brain has limited energy stores - it requires a continuous replenishment of energy substrates from the blood flow; these must be transported through the blood-brain barrier. Under physiological conditions and nutrition, glucose is the major energy source of the brain. When supply becomes limited, glucose is substituted by other energy substrates: lactate, medium-chain triglycerides, and ketone bodies. [9].

Table 1: Energy Expenditure of Different Body Parts

Body Part	Energy Expenditure (kcal/kg/day)
Brain	300 - 400 kcal/kg/day
Skeletal Muscle	13 - 24 kcal/kg/day
Heart	300 - 350 kcal/kg/day
Liver	120 - 150 kcal/kg/day
Kidneys	250 - 350 kcal/kg/day
Adipose Tissue	5 - 10 kcal/kg/day

IV. NUTRIENTS

Nutrients are a type of biomolecules in food that provide energy encourage repair and growth to carry out life processes. Carbohydrate, Proteins, Lipid, Vitamin & Minerals are 5 major nutrients.

1. **Carbohydrates:** Carbohydrates are essential biomolecules consisting of carbon, hydrogen & oxygen atoms. They are chemically polyhydroxy aldehyde or ketones. They are the primary energy source present in grains, vegetables, fruits and milk and dairy products. In human 1 gram of carbohydrate provide 4 kcal energy. Carbohydrates in balance diet contribute 50 to 80 % of total energy.

   Forms of Carbohydrates

   - **Monosaccharides**

     Ex**.** Glucose, Fructose, Galactose etc.

     Glucose is the simplest primary form of carbohydrates that utilizes to provide energy via metabolic pathways.

- **Disaccharides:** Disaccharides are carbohydrates composed of two monosaccharide units joined together by a glycosidic bond. Ex. Lactose, Sucrose & Maltose.

  Lactose is milk sugar. Sucrose is found in table sugar & Maltose is malt sugar produced in human body during digestion.

- **Complex Carbohydrates**

  Complex carbohydrates include oligosaccharides and polysaccharides.

  Ex**.** Raffinose, Stachyose, Starch, Pectin, Cellulose, Glycogen etc.

  Raffinose, stachyose found in legumes. Starch, pectin & cellulose are plant polysaccharides found in grains, fruits & vegetables while glycogen animal polysaccharide. Pectin & cellulose are fiber polysaccharides essential for gut health. The recommended fiber intake is greater than 38 g for male and 25 g for female. Thus, optimal carbohydrate diet includes intake of fiber-rich, nutrient-dense whole grains, vegetables, fruits, legumes etc.

Which types of carbohydrates we eat?

- Grains, such as bread, noodles, pasta crackers, cereals, rice & pasta
- Snack foods &sweets such as cakes, cookies candy other deserts
- Starchy vegetables such as potatoes, corn & peas

2. **Protein:** Proteins are the vital nutrients that support the mechanical and structural framework needed for bodily formation, growth, and repair. Adequate quantity is required for body functions, health & survival. Recommended protein intake is varying age to age. For an adult it is 0.8 to1gm/kg of total body mass. Biologically proteins are polymer of amino acids available naturally in food sources like legumes, meats, dairy foods, vegetables, and grains. 1 gm of protein provides 4 kcal of energy. [9,10]

   Functions of Proteins

   - Maintain osmotic balance
   - Ensure overall body growth and development
   - Form antibodies, hormones & other essential components like Hb, enzymes etc.

- High protein diets promote weight loss via increased insulin sensitivity, fatty acid oxidations.

3. **Lipids:** Lipids are water insoluble (wax like characteristics), essential macronutrient known to stored form of energy in body. Lipids contribute in structural framework, regulating body temperature and other metabolic activities. Triglycerides are major form of lipids found in oils, meats, dairy and plant products. Metabolically lipids provide more energy than carbohydrates and proteins. For healthy age groups 1 to 3, 4 to 18, & adults, approx. 40%, 20% & 30% energy come from lipid respectively. 1gm of lipid provides 9 kcal energy.

   Functions of Lipids

   - Storage form of energy, regulate body temperature
   - Act as structural framework in cells membrane
   - Act as a chemical messengers & signalling molecules

4. **Vitamins:** Vitamins are an organic & essential micronutrient present in minutes amounts in natural foodstuffs.

   Particularly, Vitamins involved in energy-yielding metabolic reactions, DNA synthesis, vision, and neuronal functions and critically required for brain and muscular functions.

   There are two types of vitamins
   - Fat soluble
   - Water soluble
   - **Fat Soluble Vitamins:** Fat soluble vitamins are vitamin A, D, E & K
   - **Water Soluble Vitamins:** Water soluble vitamins are B& C
     The source, RDA, biochemical role, clinical disorders are summarized in tabulated form [7].

Table 2: Source of Vitamins, chemical name, RDA &their role

Vitamin	Chemical Name	Source	RDA	Role
Vitamin A	Retinol, Retinal, Retinoic Acid	Carrots, sweet potatoes, spinach, liver, dairy products	Men: 900 µg RAE Women: 700 µg	Vision, immune function, reproduction, and cell

			RAE	communication.
Vitamin C	Ascorbic Acid	Citrus fruits, berries, tomatoes, bell peppers	Men: 90 mg Women: 75 mg	Antioxidant, collagen synthesis, immune function, iron absorption.
Vitamin D	Calciferol (D2 - Ergocalciferol, D3 - Cholecalciferol)	Sunlight, fatty fish, fortified dairy, eggs	600 IU (15 µg) 800 IU (20 µg) for 70+	Calcium absorption, bone health, immune function.
Vitamin E	Tocopherols, Tocotrienols	Nuts, seeds, vegetable oils, green leafy vegetables	15 mg	Antioxidant, protects cell membranes, immune function.
Vitamin K	Phylloquinone (K1), Menaquinones (K2)	Leafy greens, broccoli, soybeans, fermented foods	Men: 120 µg Women: 90 µg	Blood clotting, bone health.

Table 3: Vitamin B Complex

Vitamin	Chemical Name	Source	RDA	Role
Vitamin B1	Thiamine	Whole grains, pork, nuts, seeds, legumes	Men: 1.2 mg Women: 1.1 mg	Energy metabolism, nerve and muscle function.
Vitamin B2	Riboflavin	Dairy products, eggs, green leafy vegetables, meat	Men: 1.3 mg Women: 1.1 mg	Energy production, skin health, antioxidant activity.
Vitamin B3	Niacin (Nicotinic Acid)	Meat, fish, poultry, fortified cereals, peanuts	Men: 16 mg Women: 14 mg	Energy production, DNA repair, and cholesterol metabolism.
Vitamin B5	Pantothenic acid	Widespread among foods	5 mg/day	Involved in fatty acid metabolism
Vitamin B6	Pyridoxine	widespread among foods	1.3 mg/day	Amino acid metabolism, neurotransmitter synthesis, hemoglobin production.

Vitamin B7	Biotin	Eggs, nuts, seeds, fish, sweet potatoes	30 µg	Carbohydrate, fat, and protein metabolism.
Vitamin B9	Folate	Green leafy vegetables, and legumes	400 mcg/day	DNA synthesis, cell division, red blood cell formation.
Vitamin B12	Cobalamin	Only in animal products	2.4 mcg/day	Acts as coenzymes

Table 4: Clinical deficient disorders of vitamins [11,12]

Vitamin	**Deficiency Disorder**
Vitamin A	Color blindness, decreased growth rate, Slow bone development, Risk of respiratory and diarrheal infections
Vitamin C	Scurvy
Vitamin D	Rickets and Osteomalacia
Vitamin E	Oxidative damage of tissue, Neurological abnormalities such as peripheral neuropathy, muscular & functional abnormalities
Vitamin K	Gastrointestinal malabsorptive disorders
Vitamin B1	Beri beri
Vitamin B2	Sore throat, angular stomatitis, glossitis& dermatitis
Vitamin B3	Pellagra
Vitamin B5	Irritability, fatigue, Sleep disturbances, paresthesias, GI complaints, muscle cramps &hypoglycemia
Vitamin B6	Microcytic anemia, Seborrheic dermatitis, convulsions and confusion
Vitamin B7	Thinning & loss of hair, dermatitis, lethargy, depression
Vitamin B9	Megaloblastic anemia, developmental disorders (neural tube defects) etc
Vitamin B12	Pernicious anemia

V. MINERAL ELEMENTS

Minerals or inorganic elements have important roles in nutrition. They are found in a variety of forms in organic compounds such as hemoglobin, phospholipids, and thyroid hormones and in inorganic compounds sodium chloride and calcium phosphate & as free ions. They are integral to the structure of every cell in the body. The hard structural tissues (bone) are high in calcium, phosphorus, and magnesium, while the soft tissues are higher in potassium. Minerals play an integral role in many bodily functions, such as muscle contraction, nerve function following stimulation, water balance, acid-base balance, and food metabolism. The key fluids of the body Blood, lymph, and interstitial fluid contain varying amounts of the essential minerals sodium, potassium, calcium,

phosphorus, and chloride. Besides, calcium, magnesium, and phosphorus play an important role in the structural aspects of bones while iron, copper, and cobalt are important in the formation of hemoglobin and erythrocytes. [3]

Table 5: Source of Minerals& Mode of Action

Mineral	Sources	Mode of Action	Refrences
Calcium (Ca)	Dairy products, leafy greens, almonds, fish (with bones)	Forms bones and teeth; regulates muscle contraction, nerve signaling and blood clotting	[13-16]
Magnesium (Mg)	Nuts, seeds, whole grains, leafy vegetables	Cofactor for enzymes	[13-16]
Potassium (K)	Bananas, oranges, potatoes, spinach, beans	Maintains fluid balance, nerve transmission and muscle contractions	[13-16]
Sodium (Na)	Table salt, processed foods, seafood	Regulates fluid balance, nerve signaling and muscle contraction	[13-16]
Chloride (Cl)	Table salt, seaweed, rye, tomatoes	Maintains fluid and electrolyte balance; forms hydrochloric acid in stomach	[13-16]
Iron (Fe)	Red meat, poultry, fish, lentils, spinach	Component of hemoglobin and myoglobin; transports oxygen in the blood and muscles.	[13-16]
Zinc (Zn)	Meat, shellfish, legumes, seeds, nuts	Cofactor for numerous enzymes, supports immune function, wound healing, and nucleic acid synthesis	[13-16]
Copper (Cu)	Shellfish, nuts, seeds, whole grains	Assists in iron absorption, part of enzymes for energy production and antioxidant defense	[13-16]
Iodine (I)	Iodized salt, seafood, dairy, eggs	Essential for thyroid hormone formation	[13-16]

Selenium (Se)	Brazil nuts, seafood, eggs, whole grains	Part of antioxidant enzymes; protects cells from oxidative damage.	[13-16]
Manganese (Mn)	Whole grains, nuts, leafy vegetables, tea	Cofactor for enzymes in metabolism and bone formation; has antioxidant properties.	[13-16]
Sulfur (S)	Protein-rich foods (meat, fish, eggs, legumes)	Part of amino acids and vitamins involved in detoxification and connective tissue structure	[13-16]

Common Nutritional Concern

Obesity: Linked to excess caloric intake and poor diet quality.

Nutritional Deficiencies: Because of poor intake or malabsorption such as Iron deficiency anemia, Vitamin D deficiency etc

Food Allergies and Intolerances: Conditions such as lactose intolerance, gluten sensitivity and nut allergies usually require balance dietary planning [11, 12]

Medicinal Value of Food

The medicinal value of food refers to the potential of various food stuffs to prevent, manage, or treat various health conditions due to the bioactive compounds, nutrients, and other beneficial attributes in them.

Table 6: Medicinally Valuble Compounds of Different Food

Food	Key Nutrients	Medicinal Value / Health Benefits	References
Garlic	Allicin, Selenium, Vitamin C, B6	Antimicrobial, antioxidant, blood pressure, and cholesterol levels.	[17]
Ginger	Gingerol, Vitamin C, Magnesium	Anti- inflammatory, antiviral, antitumor, alleviates nausea and improves digestion	[18]

Turmeric	Curcumin	Anti-inflammatory, antioxidant, boosts brain function and immunity	[19]
Blueberries	Anthocyanins, Vitamin C, Fiber	Improves brain function, supports heart health, and combats oxidative stress.	[20]
Spinach	Iron, Vitamin A, C, K, Folate	Supports bone health, boosts immunity, and improves eye health.	[21]
Avocado	Monounsaturated fats, Vitamin E, Potassium	Heart health, anti-inflammatory, improves nutrient absorption.	[22]
Almonds	Vitamin E, Magnesium, Fiber	Protective effects against diabetes, obesity, metabolic syndrome and CVDs	[23]
Tomatoes	Lycopene, Vitamin C, Potassium	Antioxidant, reduces cancer risk, supports cardiac health, and improves skin health.	[24]
Lemons	Vitamin C, Flavonoids, Potassium	Antibacterial, antifungal, and antiproliferative properties	[25]
Broccoli	Sulforaphane, Vitamin C, K, Folate	Antioxidant, anti-inflammatory, and anticancer properties	[26]
Yogurt	Probiotics, Calcium, Vitamin B12, D	Improves digestion, boosts immunity	[27]

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