

Introduction to Nutrition

Nutrition is the study of nutrients and their relationship with the food and the living beings. It can be defined as **a science of food and its relationship to health**.

The **science of nutrition** interprets the **interaction of nutrients** and other substances in food, **in relation to the maintenance, growth, reproduction, health and disease of an organism**. It also includes **food intake and absorption, assimilation and catabolism of nutrients, and excretion of waste products**.

The **diet** refers to the **amount of food that a person, normally, takes every day**.

A **proper diet is essential** from the beginning of life **for proper growth, development and to remain active**. Healthy diet includes **preparation of food and its storage in the way that reduces the risk of diseases**.

HISTORY OF NUTRITION

Study of nutrition, probably, began during the 6th century BC, although the **first recorded dietary advice**, carved into a Babylonian stone tablet in about **2500 BC**, cautioned those with pain to avoid eating onions for three days.

Later in **1500 BC**, it was first described that scurvy is due to **vitamin C deficiency**.

- In **1747, James Lind**, a physician in the British navy, performed the first scientific

nutrition experiment. He **discovered that lime juice can save sailors** (who had been at sea for years) **from scurvy** (a deadly and painful bleeding disorder).

- Later in **1794, Lavoisier** demonstrated that **oxidation of food is the source of body heat** and thus, described the process of metabolism.
- In **1816, Francois Magendie** identified **protein as an essential dietary component**. He **discovered** that dogs fed on only carbohydrates (sugar), fat (olive oil) and water died evidently of starvation, but those who were also fed protein had survived.
- In **1820, Coindet** discovered the **role of iodine in the treatment of goiter**.
- In **1824, Shutter** invented the **role of cod liver oil in the treatment of rickets**.
- In **1849, Regnault** explained the process of the **determination of respiratory quotient**.
- In **1880, Carl Voil** performed studies on **protein requirement** and its **metabolism**.
- In **1887, Takaki** reported that **beriberi can be prevented**.
- Thereafter in **1897, Eijkman** performed more studies about beriberi and observed that one of its causes is **polished rice**, which **develops polyneuritis**.

- **In the early 20th century, Voit and Rubner**, independently, by applying the principle of physics in nutrition, **measured calorie (energy) expenditure** in different species of animals.
- **In 1906, Willcock and Hopkins** demonstrated that **amino acid tryptophan is essential for life**.
- **In 1941, the first Recommended Dietary Allowances (RDAs) were established** by the Food and Nutrition Board of the National Research Council (NRC), USA.
- **In 1992, The US Department of Agriculture (USDA) introduced the Food Guide Pyramid.**

ADVANCES IN NUTRITION RESEARCH

As mentioned above, until the nineteenth century nutrition had only a limited role

and that most of the current information is based on the discoveries which were made between the 19th and the 20th century (Table 1.1).

However, significant advances in the field of human nutrition have been made **over the past 50 years**. During this period, the **science of nutrition has also moved out of the laboratory and gained recognition as an independent scientific discipline.**

- **Importance of the food has now been well recognized in human health and disease.**
- **Several specific nutritional diseases, such as protein energy malnutrition (PEM), endemic goiter, nutritional anemia, nutritional blindness, etc. have been identified.**
- **Also, new technologies have been developed for their diagnosis and control.**

Table 1.1: History of nutrition discoveries

<i>Year</i>	<i>Scientist</i>	<i>Discovery</i>
1747	James Lind	Role of orange and lemon in the cure of scurvy
1794	Lavoisier	Energy metabolism and respiration
1816	Francois Magendie	Dietary significance of protein
1820	Coindet	Role of iodine in treatment of goiter
1824	Shutter	Role of cod liver oil in treatment of rickets
1849	Regnault	Determination of respiratory quotient
1880	Carl Voil	Studies on protein requirement and metabolism
1887	Takaki	Prevention of beriberi
1897	Eijkman	Role of polished rice in development of polyneuritis
1906	Willcock and Hopkins	Significance of tryptophan for life
1901	Hopkins	Vitamins as accessory food factors
1909	McCollum and Davis	Importance of fat-soluble substance for growth
1915	Goldberger	Discovery of pellagra-preventing factor
1916	McCollum	Importance of fat-soluble A for growth
1922	Evans and Bishops	Importance of vitamin E in reproduction
1934	Dam	Discovery of vitamin K
1935	Williams	Kwashiorkor, its cause and cure
1941	Food and Nutrition Board, NRC, USA	First RDA

- The discipline of nutrition has also extended its influence in several other fields such as **agriculture, animal husbandry, economics and sociology**, which, in turn, led to green revolution and white revolution, resulting in overall **increase in food production**, storage and utilization.

CONCEPTS OF NUTRITION

Nutrition, basically, involves the bodily requirement of energy and various nutrients in the desired quality and quantity for maintenance of physical and mental health.

Accordingly nutritional concepts include a number of factors which include:

- Energy (calorie)
- Dietary nutrients
 - Macronutrients
 - Micronutrients
- Health and well-being

In spite of the increase in food production, poorer sections of the population, however, have continued to suffer from malnutrition. It is due to the **association of nutrition with several other factors**, such as **infections and immunity, fertility, maternal and child health**, and family health, which is receiving further scientific attention.

Accordingly, greater emphasis is being laid on **integrating nutrition into primary health care system** towards the **formulation of national dietary goals to promote health**.

Recently, a great deal of interest has also been focused on the **role of dietary factors in the pathogenesis of non-communicable diseases** such as **coronary heart disease, diabetes and cancer**.

With the newer concepts and approaches, the science of nutrition is now becoming more dynamic.

ROLE OF NUTRITION IN MAINTAINING HEALTH

World Health Organization (WHO) defined **health as a state of complete physical,**

mental and social well-being, and not merely the absence of disease or infirmity.

WHO made further clarifications in 1986 that health is a positive concept emphasizing social and personal resources as well as physical capacities. Accordingly, it includes both physical health and mental health.

Physical Health

A person who has good physical health is likely to have bodily functions and processes working at their peak. This is not only due to an absence of disease, but regular exercise, balanced nutrition and adequate rest, etc. all of which contribute to good health.

Mental Health

Mental health refers to a person's emotional, social and psychological well-being.

Both of these are important and related to each other. For example, if an individual is not physically healthy, he or she may not be mentally healthy also, and may suffer from stress and, subsequently, depression. Similarly, if a person is mentally ill such as under depression, the individual may suffer from weight loss which, in turn, may affect physical ability to perform work. Further, such an individual may not only be performing his/her own work well, but will affect his/her utility for the family as well as society.

Factors Affecting Physical and Mental Health

As discussed above, wellness (**good physical and mental health**) is a continuous process. It is **regulated by several factors**, which include:

- **Balanced diet:** One should consume a balanced diet, mostly from the natural sources, every day.
- **Physical activity:** The individual must perform some type of exercise, at least 30 minutes each day for 5 days a week.

- **Lifestyle:** Besides balanced diet and exercise, one must adopt a lifestyle to remain busy to lead a stress-free life with a positive outlook.
- **Routine check-up:** One must undergo routine laboratory and medical check-up periodically, particularly, for the life-threatening diseases such as weight gain, obesity and cardiovascular disease, or a chronic infection.
- **Social work:** One should contribute to the family and the society, to the best of his/her physical and mental health, and financial status.

Role of Nutrition in Maintaining Physical and Mental Health

Nutrition plays an important role in maintaining health, both physical health and mental health.

1. **Nutrition is not only a basic component of preventive medicine but also effective in corrective medicine** for many common health problems.
2. **Many common symptoms and diseases can often be prevented with better nutrition.** According to US Department of Health and Human Services (2000), **several leading causes of death, including cardiovascular diseases** (atherosclerotic heart disease and hypertension), **cerebrovascular disease** (stroke), **diabetes and some cancers, have a strong link with the type and amount of food consumed.**
3. **Nutrition knowledge of both, the general public as well as health professionals, is critical, if we are to succeed in reducing morbidity and mortality** from these killer diseases.
4. With the advancements in the fields of molecular biology, biochemistry and genetics, it is now well understood that a disease may be genetically biased, but **is influenced by environmental factors including nutrition.**
5. **Role of nutrients and other biologically active food components on gene expression is also the focus of exciting field of nutrition,** called nutritional genomics or **nutrigenomics.**

COMMON NUTRITIONAL PROBLEMS IN INDIA

India is in the phase of economic development. Accordingly, it is facing a dual burden of malnutrition which includes, both undernutrition and overnutrition.

Undernutrition

Pre-transition diseases like undernutrition (undernourishment) are persisting due to poverty, large family size, unhealthy life style and poor health care system, faulty feeding habits, inadequate sanitation (resulting in frequent infections), or migratory population (or people) living in rural areas or urban slums, particularly, those belonging to socially-backward groups and landless laborers.

Low birth-weight babies, preschool children, adolescent girls, pregnant and lactating women, and elderly socially-deprived persons are at high risk of developing undernutrition.

Undernutrition may be a result of intake of quantitatively as well as qualitatively inadequate diet. The diet may be either less in quantity or may be **lacking in one or more nutrients.** For example:

- **Protein-energy malnutrition (PEM)**, which includes **marasmus** (reduced intake of total food, including calories) and **kwashiorkor**, a deficiency of protein, particularly, in infants and young children.
- **Iron deficiency anemia (IDA)**, in pregnant women and children, particularly, those with helminthic infections.
- **Iodine deficiency disorders (IDD).**
- **Vitamin A deficiency** (night blindness and Bitot's spots, etc.).

- **Vitamin B-complex deficiencies**, particularly the deficiency of **riboflavin** (vitamin B₂), **folate** (folic acid) and **vitamin B₁₂** (cyanocobalamin).
- **Vitamin D and calcium deficiencies** leading to **osteoporosis**.

Overnutrition

Prevalence of overnutrition is emerging as a significant post-transitional problem, especially, in urban areas. Causative factors include:

- **Over consumption of energy-rich diets containing increased amounts of saturated fat and highly processed sugar**
- **Lack of dietary fiber** and complex carbohydrates, particularly, by the higher income group
- **Lack of physical activity and sedentary lifestyle**
- **Increased consumption of alcohol** (empty calories), and
- **Use of tobacco**

All these factors in turn lead to the prevalence of diet-related chronic degenerative noncommunicable diseases, such as:

- Obesity
- Diabetes
- Hypertension
- Cardiovascular diseases (CVD), and
- Various types of cancer.

FACTORS AFFECTING FOOD AND NUTRITION

Since we consume food, it is essential to advocate nutrition in terms of food, rather than nutrients. Apart from supplying nutrients, food provides a host of other components (non-nutrient phytochemicals) as well, which have a positive impact on our health.

Food consumption, which largely depends on production and distribution, determines health and nutritional status of the population. This is largely determined by the availability and palatability of food.

The food we eat says a lot about our character, personality and where we are from. Food also reflects family history, culture and religious background, economic status, how one feels, where one goes and what one does socially. Thus, a number of factors affect the availability and intake of food and nutrition. These include:

- **Socioeconomic factors:** Our social existence is, probably, one of the biggest contributors to what we eat. The people, we live with, work with and socialize with, have a great deal of influence over what we eat. Some of the foods are considered to be **only for those with low income**, yet these foods are just as nutritious and can be prepared in as many delicious ways as the more expensive foods.
- **Cultural factors:** Eating and choosing food is no longer just about feeding our body what it needs and what tastes good, but food practices are different and vary from culture to culture, and generation to generation. Whether our background is European or African, Asian or Latin American, cultural influences contribute to food, what we eat or bring home. These influences can blend into preparation and serving methods, too. For example, **Mexican dishes** often include abundance of beans, rice and cheese. **Middle Eastern menus** are known for their olives and olive oil, fruits, vegetables and spices. **Chinese foods** include many stir-fry and combination meals. **Indian foods** often are deep fried and high in fat, etc.
- **Traditions:** Dietary habits and eating patterns form our **family's traditions** make our food habit in our young age.
- **Production:** Each region of the country is known for its distinct type of foods produced in that area. For example, **North East region** is famous for its supply of **seafood and fresh-fishes**; in the **Western Coast** (with its warm weather and trendy lifestyle) one can often find

many **fresh and Asian/Pacific-type of foods**, etc.

- **System of distribution:** A public distribution shop, also known as **fair price shop**, is a part of India's public food distribution system established by the Government of India, which distributes rations at a subsidized price to the poor. Locally these are known as **ration shops** and **public distribution shops**, and **chiefly sell wheat, rice and sugar** at a price lower than the market price, called **Issue Price**. The basic objective of the public distribution system in India is to provide essential consumer goods **at cheap and subsidized** prices to the consumers so as to insulate them from the impact of rising prices of these commodities and maintain the minimum nutritional status of the population.
- **Lifestyle: Friends, peers and colleagues have a big influence over food** choices. Teens choose fast food, like pizza, French fries, hot dogs, shakes and soft drinks, because everyone else is eating these items. On the other hand, they might choose not to eat at all, in order to trim down, like their friends. Some of the foods have more prestigious value than others and we have to use them as **company foods**, to honor or impress our friends, clients or officers, though they may cost more, may be hard to get, take a lot of time to prepare or are unusual.
- **Food habits:** Food habits also have deep psychological roots and are associated with religious customs and beliefs. For example, even some vegetarians do not take onion and garlic; Muslims avoid pork while Hindus avoid beef, etc. Some persons like much salt; others only a little; some like very sweet food; others do not; some like spicy food while others prefer bland food, etc.

MEDICINAL VALUE OF FOOD

Next to air and water, food is the prime necessity for life. It contains various **organic**

and **inorganic substances** referred to as nutrients that an organism eats or drinks, in order to maintain life and for growth. These include carbohydrates, lipids, proteins, vitamins, minerals and water, which are used in the body of an organism **to sustain growth, repair and vital processes, and to furnish energy**. The substance is ingested by an organism and assimilated by the organism's cell to provide energy, maintain life or stimulate growth. Daily intake of food has a direct influence on the health and well-being of an individual.

Dietary modifications based on the nutrients may include decreased calories intake for weight reduction or consuming extra calories for weight gain; balance the amount of carbohydrates, fat or proteins; high fiber diet; low fat and/or low cholesterol diet; decreased amount of a nutrient such as low sodium diet; or to exclude a particular food due to allergy or intolerance.

Recent knowledge in medicine and allied sciences has provided new insight and opened up new vistas in the science of nutrition. Researchers have provided information on dietary patterns and components of food that have added benefits for health, such as **phytonutrients, carotenoids, plant sterols, flavonoids, pre- and probiotics, and nutraceuticals**.

CLASSIFICATION OF FOODS

Foods may be grouped in many ways, though some foods can also be placed in more than one group. Since each food has a different nutritional profile, from the nutritional point of view foods can be grouped as:

- **Foods of plant origin and animal origin.**
- **As energy-yielding foods, body building foods and protective foods.**
- **According to chemical composition** in several groups such as cereals and pulses (which are rich in carbohydrates; etc. Chapter 15).

FOOD STANDARDS

Food standards refer to the **set of criteria that a food must meet**, if it is approved, to be suitable for human consumption, such as source, composition, appearance, freshness, permissible additives and bacterial content. Some Governments have imposed very strict quality parameters for ingredients and their storage practices. There are many **regulatory bodies that help maintain standards in the quality of food**. Each country has its own such agency (Chapter 14).

ELEMENTS OF NUTRITION

There are six elements of nutrition called carbohydrates, lipids, proteins, vitamins, minerals and water. These are essential to supply energy, build and maintain body cells, and regulate metabolic processes. These are classified as macronutrients and micronutrients (Chapter 3).

Macronutrients

Macronutrients include **carbohydrates (including dietary fiber), fat (lipids) and proteins**. These are required by the body in relatively large amounts and are also referred to as the **proximate principles of food**. Macronutrients are oxidized in the body to **provide energy** that is required for various activities of life. Together with water, these form bulk of the food.

- **Carbohydrates:** Carbohydrates are the cheapest source of energy and are easily available. These are the main sources of energy for the body, which provide about 55–60% of the daily calories requirement. In addition, carbohydrates also serve as the components of cell membrane and receptors.

Carbohydrates are classified according to the number of sugar units as **monosaccharides** (such as glucose and fructose), **disaccharides** (such as sucrose and lactose) and **polysaccharides** (such as starch and glycogen; Chapter 5).

- **Dietary fiber:** Dietary fiber includes several **complex carbohydrates** which are resistant to digestion in the human digestive tract, e.g. **cellulose, gums and pectin, etc.** (Chapter 6).
- **Fats:** Fats or lipids include a group of substances which are poorly soluble, or nearly insoluble, in water but are soluble in organic solvents. Over 90% of the dietary fat includes **triacylglycerols** (triglycerides), which consist of a molecule of glycerol (glycerin) with 3 fatty acids.

A **fatty acid** contains a -COOH group attached to the unbranched hydrocarbon chain, where different carbon atoms are connected to each other by the single bonds only (**saturated fatty acids**) or may also contain both single as well as double bonds, referred to as **unsaturated fatty acids**. Other types of dietary lipids include **cholesterol, phospholipids, sterols** and **carotenoids**.

Fat may be obtained from two different sources, i.e. from plants (oilseeds) and **animals** (meat, egg, milk and dairy products). **Plant fats** are superior to animal fats because fat from plant sources **contains more polyunsaturated fatty acids (essential fatty acids) and no cholesterol**.

Cholesterol in diet should be restricted because excess intake of cholesterol **leads to** its deposition in tissues, thereby causing **atherosclerosis** (Chapter 7).

- **Proteins:** Proteins are organic compounds that consist of amino acids which are joined by peptide bonds. Proteins are needed for their content of certain amino acids that are essential to human body for the biosynthesis of proteins, body repair in adult, and for body building and growth in children.

Human body proteins are made up of only **20 standard amino acids**, out of which nearly 10 amino acids can be synthesized in the body but the remaining 10 cannot be synthesized in the body, hence they

have to be supplied through the diet. Therefore, these amino acids are referred to as **essential amino acids**. Through digestion, proteins are broken down by proteases into free amino acids.

According to their source, proteins may be of good quality or poor quality.

Good quality proteins are mainly obtained from animal sources (e.g. meat, fish, eggs and dairy products). These contain all the essential amino acids needed by the body. These proteins are also referred to as **proteins of high biological value**.

Poor quality proteins are obtained from plant sources. They have **low biological value**, since an individual protein may lack one or the other essential amino acid.

Vegans and vegetarians cannot get all the amino acids they need, from a single source. However, combining plant foods from different sources provide good quality protein, e.g. pulses and cereals (Chapter 8).

Micronutrients

Micronutrients include **vitamins and minerals**. These are required, comparatively, in small quantities and are also referred to as **protective foods**.

- **Vitamins:** Vitamins are a group of organic compounds and perform a variety of functions in the body. Every vitamin is chemically different from each other. Although they do not yield energy but vitamins enable the body to use other nutrients. Since body is generally unable to synthesize most of the vitamins, these must be provided through food.

Vitamins are divided into the two groups as follows:

Fat soluble vitamins, which include vitamins **A, D, E and K**, and **water soluble vitamins**, which include **B vitamins** and **vitamin C** (Chapter 9).

- **Minerals:** Minerals are the **inorganic substances**. These are required by the body in small amounts. Our body requires different amounts of each mineral.

All the minerals and trace elements are present in healthy tissues, where their concentration remains relatively constant. Besides, there are certain elements, like nickel, vanadium, tin, boron, etc., which have not been shown to have any function in human body, thus are not dietary essential (Chapter 10).

Besides, vitamins and minerals, **antioxidants and phytochemicals**, too, may be referred to as micronutrients, since they are also required in small quantities and said to protect (or influence) some of the body systems. Their essentiality, however, has not been well established like that of vitamins and minerals.

ENERGY

Energy is a prime requisite for body functions and growth. Energy is also required for doing physical work. Body gets energy from the combustion of carbohydrates, fat and proteins. Energy, present in these macronutrients is locked in chemical bonds, and is released when food is metabolized. Thus, body converts chemical energy present in food to mechanical, electrical and heat energy.

CALORIE

The **unit of energy is calorie**. A **calorie is defined as the quantity of heat required to raise the temperature of 1 g of water by 1°C, more specifically from 14.5°C to 15.5°C**. Its **large unit is kilocalorie, which is equal to 1000 calories**. In the context of nutrition, the large unit, i.e. kilocalorie (kcal), is used. **The calorie value, we see on a food package is actually in kilocalories**. The SI unit of energy is joule (J). **One kcal is approximately 4.2 kJ**.

Energy requirement is defined as the **calories intake that is required to maintain**

energy balance in a healthy person of a defined age, gender, weight, height and level of physical activity consistent with good health.

BASAL METABOLIC RATE

Basal metabolic rate (BMR) is the **amount of energy expenditure** (per hour) **while at rest**, in a neutrally temperate environment and the post-absorptive state (meaning that the digestive system is inactive, i.e.

about twelve hours of fasting in humans). The amount of energy at complete physical and mental rest **meets the requirement for the functioning of vital organs**, i.e. the heart, lungs, kidneys, nervous system, intestine, liver, sex organs, muscles and skin, etc. The BMR remains constant throughout the day under normal conditions and constitutes about 50–75% of the total energy expenditure by an individual. It is **expressed in terms of kcal/h** (Chapter 4).



SOME IMPORTANT QUESTIONS

1. Define nutrition. Describe the role of nutrition in maintaining health.
2. What is a nutrient? Describe various dietary nutrients.
3. Describe factors affecting food and nutrition.
4. Write notes on:
 - i. Nutritional problems in India
 - ii. Medicinal value of foods
 - iii. Food standards
 - iv. Undernutrition
 - v. Overnutrition
 - vi. Macronutrients
 - vii. Micronutrients