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MATS CENTRE FOR DISTANCE & ONLINE EDUCATION

Nutrition for Health

**Bachelor of Science (B.Sc.)
Semester - 1**



SELF LEARNING MATERIAL

General Elective
Nutrition For Health
CODE:ODL/MSS/BSCB/107

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Module-1

Basic concepts in food and nutrition

Objectives

Understand the fundamental principles of food and nutrition, including the role of nutrients in maintaining health and preventing disease.

Identify the different types of nutrients, their sources, and their physiological functions in the human body.

Develop awareness of balanced diets and the impact of nutritional choices on overall well-being and lifestyle.

Unit -1.1. Basic Terms Used in the Study of Food and Nutrition

Understanding the fundamental terms in food and nutrition is essential for anyone studying health, dietetics, or public health. These terms form the building blocks for analyzing diets, planning nutritional interventions, and understanding how food affects the human body.

1.1.1 Concept and Definitions

Food: Food is defined as “a substance consisting essentially of protein, carbohydrate, fat, and other nutrients used in the body of an organism to sustain growth and vital processes and to furnish energy”.

Nutrition: Nutrition is the scientific study of food and its constituents influence the body’s health, growth, development, prevention of diseases, absorption, metabolism and utilization of nutrients to sustain body functions and overall health.

A very basic principle in nutrition is the concept of nutrients chemical substances that are required for the body to operate as it should. It involves knowledge of nutrients, how they are digested, absorbed, and used.

Balanced Diet: Diet that includes all essential nutrients in the right proportions to maintain health, vitality, and well-being. A balanced diet as consuming the right types and amounts of foods and drinks to supply energy and essential nutrients needed for the body’s cells, tissues, organs, and normal growth and development. An imbalance in dietary intake can lead to malnutrition, which includes both undernutrition and overnutrition.



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Malnutrition: Malnutrition refers to a condition that results from an imbalance in a person's intake of energy and/or nutrients. A condition resulting from an imbalanced intake of nutrients can be undernutrition (deficiency) or overnutrition (excess).

Undernutrition: Undernutrition refers to deficiencies in calories or nutrients, often resulting in stunted growth, weakness, or conditions, or deficiencies (eg., anaemia, rickets).

Overnutrition: Overnutrition, on the other hand, occurs when an individual consumes more calories or nutrients than needed, often leading to obesity, diabetes, or cardiovascular diseases.

Metabolism: Understanding how the body processes food is essential in nutrition. Digestion is the mechanical and chemical breakdown of food into smaller components that can be absorbed. Once food is broken down, absorption takes place, mainly in the small intestine, allowing nutrients to enter the bloodstream and reach cells. These nutrients are then used in metabolism, the sum of all chemical processes in the body.

Metabolism is divided into anabolism (the building up of body tissues and storage of energy) and catabolism (the breaking down of nutrients to release energy). The set of chemical processes by which the body converts food into energy and building blocks for growth and maintenance.

Dietary Requirements: The basal metabolic rate (BMR) is the number of calories the body requires at rest to maintain essential functions such as breathing, heart rate, and body temperature. Factors like age, sex, weight, and muscle mass influence BMR, and it plays a critical role in determining daily energy needs. The amount of each nutrient an individual needs daily, based on age, sex, activity level, and physiological status (e.g., pregnancy, illness).

Calories (Kcal): A unit of energy. Food energy is measured in calories, and each macronutrient contributes a specific number of calories per gram. Another important concept in nutrition is calorie or kilocalorie (kcal), which measures the energy provided by food. Carbohydrates and proteins provide 4 kcal per gram, while fats provide 9 kcal per



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gram. Monitoring caloric intake is important for maintaining a healthy weight, often assessed using the Body Mass Index (BMI). BMI is calculated by dividing weight in kilograms by the square of height in meters. It classifies individuals as underweight, normal weight, overweight, or obese, and is widely used in public health assessments.

Health: Nutritional health also relies on the dietary guidelines provided by governments or health organizations, which recommend patterns of healthy eating to prevent chronic diseases. These guidelines typically encourage the consumption of fruits, vegetables, whole grains, lean proteins, and healthy fats, while limiting sugar, salt, and processed foods. Eat can be categorized into simple food groups like cereals, milk, meat and alternatives, fruits, vegetables, fats, and sugars, each with its own set of distinct nutrients added to the diet.

Some of them are antioxidants, too, reducing free radical activity and the risk of chronic diseases like cancer and cardiovascular disease. Fortification is an example of public health policy used to add necessary vitamins or minerals to foodstuffs that are widely used to avoid mass deficiencies. Some examples are iodized salt, vitamin D-fortified milk, and iron-enriched cereals.

Hydration is crucial to maintaining body temperature, supporting digestion, carrying nutrients, and expelling waste. Apart from water, dietary fiber is the undigested portion of plant foods and contributes significantly to the health of the digestive system and prevents constipation and helps manage blood sugar and cholesterol levels.

Fiber is present in whole grains, fruits, vegetables, and legumes, and is an integral component of any healthy diet of major concern in international nutrition is food security, which is the having regular access to safe, nutritious, and affordable food.

Nutrients: A nutrient is any substance obtained from food that supports growth, energy, and bodily functions. Nutrients are broadly categorized into macronutrient—needed in large quantities—and micronutrient.



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Macronutrient: Generally, macronutrients include carbohydrates, proteins, fats, and water, providing energy and building blocks for the body

Micronutrient: The micronutrients, like vitamins and minerals are not only crucial but also vital in their function. For example, vitamin C- strengthens the immune system, vitamin A, maintains vision, and minerals such as calcium and iron- plays a role in bones and blood function.

1.1.2. Summary

Understanding basic terms in food and nutrition is essential for promoting health and preventing disease. Food provides essential nutrients—carbohydrates, proteins, fats, vitamins, and minerals—that support growth, energy, and bodily functions. Nutrition is the science of how the body uses these nutrients through processes like digestion, absorption, and metabolism, which includes anabolism (building up) and catabolism (breaking down). Health guidelines emphasize whole foods, hydration, dietary fiber, and food fortification (e.g., iodized salt, iron-fortified cereals) to prevent nutrient deficiencies. Access to safe, nutritious, and affordable food—food security—is critical for overall well-being.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

1. **Which of the following provides the highest number of calories per gram?**
 - a) Carbohydrates
 - b) Proteins
 - c) Fats
 - d) Vitamins
2. **What is the main function of dietary fiber in the human body?**
 - a) Provides energy
 - b) Builds muscles
 - c) Helps in digestion and prevents constipation
 - d) Increases blood sugar



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3.What is the unit used to measure the energy value of food?

- a) Gram
- b) Liter
- c) Calorie (kcal)
- d) Joule

4.What does BMI stand for?

- a) Body Mass Index
- b) Basal Metabolism Indicator
- c) Balanced Meal Intake
- d) Basic Metabolic Index

5.Which of the following is an example of food fortification?

- a) Adding sugar to juice
- b) Iodizing salt
- c) Frying vegetables
- d) Blending fruits

Answer keys: 1.c) Fats,2.c) Helps in digestion and prevents constipation, 3.c) Calorie (kcal), 4.a) Body Mass Index, 5.b) Iodizing salt

B. Short Answer Questions

1. Define nutrition.
2. What is a balanced diet ?
3. Differentiate between undernutrition and overnutrition.
4. What is metabolism?
5. Name two micronutrients and their functions.

C. Long Answer Questions

1. Explain the concept of a balanced diet and its importance.
2. Describe the role of macronutrients and list their calorie values.
3. What is malnutrition? Discuss its two types with examples.
4. What is BMR, and how does it influence dietary requirements?
5. Explain food fortification and its significance in public health.



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Unit-1.2. Understanding relationship between Food, Nutrition, and Health

1.2.1. Food, nutrition, and health: These are intricately connected elements of human existence. Knowing their relationship is necessary to sponsor well-being, prevent illness, and provide a high standard of life. Food is the main source of energy and nutrients for the body, but nutrition is a term that designates the way the body uses those nutrients. Health is then the result of good nutrition and proper choice of food. When the correct food is eaten in the correct amounts, it maintains physical, mental, and emotional well-being.

The foundation of nutrition food is any material eaten to supply the body with nutritional requirements. It normally comprises the necessary nutrients such as carbohydrates, proteins, fats, vitamins, minerals, and water. These nutrients are required for growth, energy, repair of body tissues, and regulation of body processes. Foods can be of animal origin (like meat, eggs, and dairy) or plant origin (like fruits, vegetables, grains, legumes, and nuts).

Food serves three primary functions in the human body: It has three main roles in the human body----

Energy supply–via carbohydrates and fats, which power metabolic and physical activity.

Body construction- through proteins, which are essential for cell repair and construction.

Protective and regulatory functions–through vitamins and minerals, which assist in maintaining immune function and internal balance. Quality, variety, and amount of food eaten influence directly the nutritional status of the individual, which is an essential determinant of health.

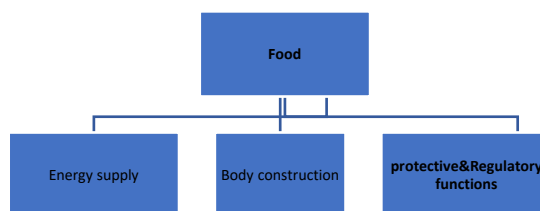


Fig.1.1. Types and functions of food



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Functions of food -Physiological, psychological and social

Food is not just a basic necessity for survival—it plays multiple roles in human life. Beyond merely providing nutrients, food has deep physiological, psychological, and social significance. Food is much more than just a basic necessity for survival; it plays a multifaceted role in human life that extends beyond simply providing nutrients. It holds profound physiological, psychological, and social significance that deeply influences health and well-being. These diverse roles is essential for students and professionals in nutrition, public health, psychology, and social sciences, as food impacts not only the biological functioning of the body but also mental health and social interactions.

Food plays a vital role in our psychological and social lives, far beyond mere nourishment. Psychologically, eating affects our mental state, mood, and emotions by providing sensory satisfaction through taste, aroma, colour, and texture, which creates pleasurable experiences that contribute to overall well-being. It also offers emotional comfort, as people often turn to food in response to feelings like stress, sadness, or celebration, using it as a coping mechanism—for instance, enjoying soup when sick or ice cream after a breakup. Food is deeply intertwined with memory and personal associations, evoking nostalgia and connecting us to our past through dishes linked to childhood, family, or special occasions. Nutritionally, some foods promote mental health; omega-3 fatty acids will decrease depression symptoms, B vitamins improve brain function, and minerals such as magnesium and zinc affect mood and anxiety regulation.

Socially, food is a key component of cultural identity and social bonding. Shared meals bring about connection, conversation, and emotional intimacy, such as family lunches or special celebrations. Food also carries cultural heritage and a special role in rituals and celebrations, like biryani at Indian weddings or turkey during Thanks giving.

Secondly, sharing food conveys hospitality and may reflect social status and generosity, as in lavish feasts or corporate lunches. Lastly, cultural



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norms and customs related to food ensure respect and social order, be it in table manners, grace before meals, or waiting for the elders to begin eating.

All together, these social and psychological functions demonstrate food's deep influence on human life beyond health. Generally speaking, the functions of food are broadly categorized into these three physiological functions pertaining to the body's biological needs, psychological functions related to emotional and mental well-being, and social functions related to culture, tradition, and relationships.

All of these elements play a role towards the overall harmony and well-being of individuals and communities, reflecting the intricacy and significance of food in human existence. An understanding of these dimensions is essential for those studying nutrition, public health, psychology, and social sciences.

1.2.1.1. Physiological Functions-

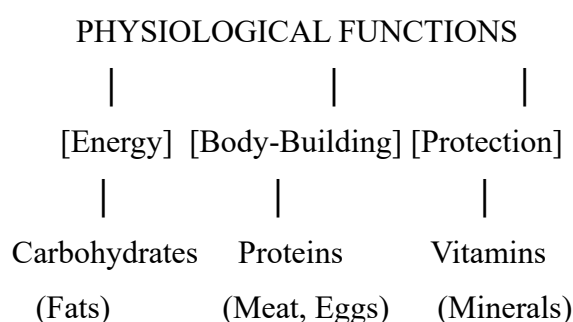
Physiologically, food serves as the primary source of energy required for all bodily activities, including involuntary processes such as breathing, blood circulation, and digestion. This energy primarily comes from carbohydrates and fats, with proteins also contributing when necessary. Carbohydrates and proteins each yield about 4 kilocalories per gram, while fat yields a denser 9 kilocalories per gram, and so lipids are the most calorie-dense macronutrient. Staple foods that are common sources of energy include rice, bread, oils, butter, sugar, and cereals.

In addition to providing energy, food serves a critical body-building role by providing proteins required for the development, repair, and maintenance of tissues, muscles, organs, and immune cells. This role is essential in times of growth, recovery from illness, and recovery from injury, and foods like milk, meat, eggs, pulses, and soybeans provide high-quality proteins. Food also consists of other micronutrients vitamins and minerals that play protective and regulatory functions.

These nutrients help defend the body against diseases and regulate essential biological processes including digestion, blood clotting, enzymatic reactions, and hormone production. For example, vitamin C

boosts immune function, calcium and vitamin D maintain bone health, iron is vital for oxygen transport in the blood through Haemoglobin, and iodine ensures proper thyroid hormone synthesis and metabolic regulation. Finally, water, an often overlooked but critical component of food, supports hydration, maintains fluid balance, helps regulate body temperature, facilitates the removal of metabolic waste, and aids nutrient transport throughout the body. Sources of hydration include drinking water itself, fruits, soups, and milk.

Figure1.2.2. Physiological Functions of Food



1.2.1.2. Psychological Functions –

Psychologically, food profoundly affects our mental and emotional well-being. Eating is not merely a physical act but also a sensory experience that brings pleasure through the taste, aroma, color, and texture of foods. This sensory satisfaction plays a significant role in psychological health by stimulating the senses and uplifting mood—for instance, enjoying sweets like chocolate or traditional comfort foods can evoke feelings of joy and contentment. Food also provides emotional comfort; people often turn to eating in response to feelings of stress, sadness, or celebration, a behavior known as emotional eating. For example, sipping warm soup during illness or indulging in ice cream after a personal setback can provide solace and emotional relief. Furthermore, food carries strong memories and emotional associations, connecting individuals to their personal histories, family traditions, and special occasions. This makes certain foods deeply meaningful and capable of evoking nostalgia and a sense of belonging—such as birthday cakes, holiday meals, or cherished family recipes. From a nutritional perspective, specific nutrients in food contribute to mental



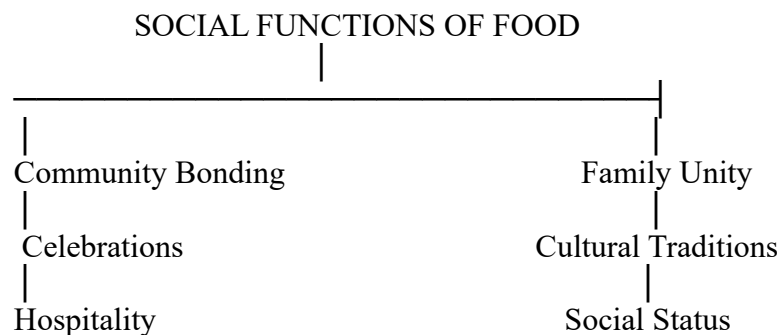
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health. Omega-3 fatty acids, found in fish and some plant oils, have been shown to reduce symptoms of depression, while B vitamins support brain function and magnesium and zinc play roles in mood regulation and anxiety reduction. Therefore, food is instrumental not only in physical but also in maintaining psychological health.

1.2.1.3. Social Functions -

Socially, food serves as a cornerstone of culture, tradition, and human connection. Meals often bring families and communities together, fostering social bonding, shared conversation, and emotional closeness. For example, a Sunday family lunch, festive feasts during holidays, or community potluck dinners create opportunities for interaction and strengthen social ties. Food also represents cultural identity and heritage, playing a central role in rituals, religious ceremonies, and national celebrations. Dishes such as biryani at Indian weddings, turkey on Thanks giving in the United States, or dates during Ramadan are emblematic of cultural values and communal identity.

Figure 1.2.3: Social Functions of Food



Offering food is a universal sign of hospitality, the type and quality of food served often reflect social status, wealth, or generosity. Elaborate wedding feasts, business luncheons, or traditional banquets can serve to demonstrate respect and social standing. Additionally, different cultures have specific etiquette and norms surrounding food that promote respect, discipline, and order within society. These rules may include how food is eaten—whether with hands or utensils—rituals like saying grace before meals, or customs such as waiting for elders to begin eating, all of which underscore the role of food in social structure.



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1.2.2. Nutrition: It is the branch of science that explores the intricate interactions between the human body and nutrients and how food is absorbed, metabolized, transported, digested, and finally excreted. Good nutrition exists when a person takes all six major groups of nutrients carbohydrates, proteins, fats, vitamins, minerals, and water in proper and balanced quantities to support life and enhance growth.

Every nutrient is important carbohydrates serve as major energy sources; proteins are required for repairing tissues and maintaining immune function; fats deliver energy and essential fatty acids; vitamins and minerals assist with many metabolic and regulatory processes; and water is needed for hydration, digestion, and temperature regulation. The quality, variety, and quantity of food consumed directly affect an individual's nutritional status, which is a critical determinant of health. Nutrition is the science that studies the complex interactions between nutrients and the human body, encompassing how food is digested, absorbed, transported, metabolized, and eventually excreted. Proper nutrition occurs when an individual consumes all six primary classes of nutrients—carbohydrates, proteins, fats, vitamins, minerals, and water—in adequate and balanced proportions to sustain life and promote growth. Each nutrient plays a vital role: carbohydrates provide primary energy; proteins are essential for tissue repair and immune function; fats supply energy and essential fatty acids; vitamins and minerals support various metabolic and regulatory functions; and water is critical for hydration, digestion, and temperature regulation. The adequacy and balance of these nutrients directly determine nutritional health, with deficiencies or excesses potentially leading to health problems such as stunted growth from protein-energy malnutrition or obesity and heart disease from excessive fat intake.

1.2.3. Health: According to the World Health Organization, health is a state of complete physical, mental, and social well-being, not merely the absence of disease, and nutrition is a fundamental contributor to this holistic health. Well-nourished individuals exhibit better physical development, mental alertness, and immune resilience, with nutrients



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like calcium and vitamin D strengthening bones, omega-3 fatty acids and B-vitamins supporting cognitive function, and vitamins A, C, E alongside minerals like zinc bolstering immune defenses. The relationship between food, nutrition, and health forms a continuous cycle: food choices determine nutrient intake, which influences nutritional status and overall health, which in turn affects the ability to access and consume food. This cycle is influenced by factors such as socioeconomic status, cultural practices, education, food availability, and existing health conditions. Effective public health interventions targeting these factors are crucial for improving nutrition and health outcomes. Ultimately, a balanced diet rich in whole grains, lean proteins, healthy fats, fruits, vegetables, and adequate water intake is essential for maintaining good health, preventing nutritional deficiencies, and reducing the risk of chronic diseases like diabetes, hypertension, and cardiovascular disorders.

Incorporating variety and moderation in the diet ensures that the body receives a broad spectrum of nutrients, reducing the risk of chronic diseases like heart disease, hypertension, diabetes, and certain cancers. A balanced diet is an eating plan that contains a variety of foods in proper proportions to provide the body with all the necessary nutrients carbohydrates, proteins, fats, vitamins, minerals, fiber, and water. By including a variety of foods from different groups such as cereals and grains for carbohydrates and fiber, fruits and vegetables for vitamins and antioxidants, proteins from pulses, meat, and dairy for tissue repair and immunity, healthy fats for essential fatty acids and vitamin absorption, and water for hydration and metabolic processes, a balanced diet helps prevent nutrient deficiencies and lowers the risk of chronic diseases like diabetes and heart disease.

1.2.4. Summary

Finally, today's food industry has brought us the idea of functional foods, or foods that offer some extra benefit over plain old nutrition. As science becomes increasingly knowledgeable about food and health's intricate connection, it is vital to grasp these foundational terms in order to make informed food choices and encourage lifelong health. A strong



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foundation in basic food and nutrition terms is crucial for understanding how to achieve and maintain optimal health. Health, on the other hand, adds to the body's efficiency in processing and gaining from food, forming a self-generating loop. Generally, the well-nourished population is not just healthier but also more productive and resilient and thus the pillar of a healthy and growing society. The macro and micronutrients are both indispensable to human health. Together, balanced intake of macro- and micronutrients ensures optimal physical health, energy, mental function, and disease prevention. Food plays essential and multifaceted roles that go well beyond mere nutrition. Its physiological functions provide energy, build and repair the body, protect against diseases, and maintain vital regulatory processes. Psychologically, food supports emotional well-being through sensory satisfaction, emotional comfort, and mental health benefits. Socially, it is central to cultural expression, social bonding, hospitality, and the maintenance of societal norms. Together, these functions highlight the profound importance of food in sustaining not only physical health but also psychological and social harmony within individuals and communities. Understanding these diverse roles enriches our appreciation of food and underscores the importance of balanced, culturally sensitive, and holistic approaches to nutrition and health. A deeper understanding of these functions helps professionals design nutrition programs, guide healthy behavior, and appreciate the broader significance of food in society.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

1. Which of the following is not one of the six primary classes of nutrients?

- a) Carbohydrates
- b) Proteins
- c) Fiber
- d) Fats



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2.What is the main function of carbohydrates in the body?

- a) Repair tissues
- b) Provide energy
- c) Support bone structure
- d)Regulate hormones

3.Which nutrient is essential for tissue repair and immune function?

- a) Fats
- b) Carbohydrates
- c) Proteins
- d. Water

4.Which vitamin is particularly important for vision and immunity?

- a) Vitamin C
- b) Vitamin A
- c) Vitamin D
- d)Vitamin B

5.Which mineral is essential for oxygen transport in the blood?

- a) Calcium
- b) Zinc
- c) Iron
- d) Iodine

6.Which of the following nutrients provides the highest amount of energy per gram?

- a) Carbohydrates
- b) Proteins
- c) Fats
- d)Vitamins

7. Which psychological role of food is associated with emotional comfort and coping mechanisms?

- a) Hydration
- b) Emotional eating
- c) Nutrient absorption
- d)Cultural rituals



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8. Which of the following best illustrates the social function of food?

- a) Vitamin D for bone health
- b) Protein for muscle repair
- c) Family meals during holidays
- d) Omega-3 for mood regulation

9. Which nutrient is essential for oxygen transport in the blood?

- a) Calcium
- b) Iodine
- c) Iron
- d) Magnesium

10. How does food contribute to psychological well-being?

- a) Only by providing vitamins and minerals
- b) Through calorie counting and dieting
- c) By offering sensory pleasure, emotional comfort, and mental health benefits
- d) Only during illness and recovery

Answer Keys: 1.c) Fiber, 2.b) Provide energy, 3.c) Proteins, 4.b.) Vitamin A, 5.c) Iron, 6. c) Fats, 7. b) Emotional eating, 8.c) Family meals during holidays, 9.c) Iron, 10.c) By offering sensory pleasure, emotional comfort, and mental health benefits

B. Short Answer Questions

1. Define a balanced diet and explain its importance in maintaining health.
2. List three factors that affect the relationship between food, nutrition, and health.
3. How does poor nutrition affect immune health?
4. Name two fat-soluble and two water-soluble vitamins and one function of each.
5. Write important macronutrients.

C. Long Answer Questions

1. Explain the relationship between food, nutrition, and health. How do food choices influence nutritional status and overall health outcomes? Support your answer with relevant examples.



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2. Define and differentiate between macronutrients and micronutrients.
3. Discuss the concept of a balanced diet. What are its components, and how does it help prevent malnutrition and chronic diseases?
4. Explain the continuous cycle of food, nutrition, and health.
5. Write short notes on nutrition.

Module -2 Nutrients

Objectives

To understand the Role of Nutrients in Energy Production

To Identify how carbohydrates, fats, and proteins provide energy for bodily functions. Proteins, vitamins, minerals, and water contribute to normal growth and development.

Recognize the role of nutrients in the formation and repair of body tissues.

To analyse the specific nutrients, support the maintenance of healthy tissues and body repair processes.

Unit.2.1. Nutrients (Macronutrients)

These are the substances required by our body for energy, growth, development, and the proper functioning of physiological processes. They are broadly classified into two categories based on the amount required by the body: macronutrients and micronutrients. Both are essential, though needed in different quantities, and work together to maintain overall health.

Table.2.1. Types of nutrients

Nutrients		
Macronutrients	Micronutrients	Water
Carbohydrates, proteins, water and fats (needed in large amounts), all of which are required in large quantities to provide energy and build body tissues.	Vitamins and minerals (required in small quantities), are needed in smaller amounts but are just as critical for health, as they support immune function, metabolism, and cellular repair.	It is an essential nutrient that supports all bodily functions.



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They are categorized in three groups based on the quantity needed by the body macronutrients and micronutrients. Both are needed, but in varying amounts, and complement each other to achieve general health.

2.1.1. Macronutrients Definition, types and significance

Macronutrients are those nutrients which the body needs in great amounts. They are mainly accountable for energy supply and are essential for our cells and tissues' structure and function. Three main macronutrients are carbohydrates, proteins, and fats, and two other elements water and dietary fiber also rank as essential macronutrients although they are not an energy source.

Macronutrients, or those required in large quantities, consist of carbohydrates (the body's main source of energy yielding 4 kcal per gram), proteins help for tissue growth and repair, fats are helpful for storage of energy, protection of organs, and absorption of vitamins, and water are needed for temperature regulation, transport of nutrients etc. Carbohydrates are the body's main source of energy and yield 4 kcal per gram. They are present in rice, wheat, potatoes, sugar, bread, and fruits. They are either simple (e.g., glucose, sugar, honey) or complex (e.g., whole grains and starchy vegetables) with the latter more nutritious and yielding longer-lasting energy.

Proteins are essential for constructing and repairing body tissues, building enzymes and hormones, and aiding immune function. Sources are eggs, milk products, legumes (dal), soybeans, chicken, and fish. These are mainly composed of amino acids, nine of which are essential and must be obtained through the diet.

Fats serve as a dense source of energy (9 kcal/g), help in the absorption of fat-soluble vitamins (A, D, E, and K), and provide insulation. Healthy fats, such as those from nuts, seeds, avocados, fish, and olive oil, support brain and heart health, while trans fats and saturated fats from fried or processed foods should be consumed in moderation.

Water is an essential component of all body processes, accounting for around 60% of body weight. It regulates body temperature, facilitates digestion, transports nutrients, and removes waste. An adult should ideally consume 2–3 liters of water daily through fluids and food.



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Dietary fiber, though not digestible, plays a key role in maintaining digestive health. It adds bulk to the stool, prevents constipation, and helps regulate blood sugar and cholesterol levels. For example: fruits, vegetables, whole grains, and legumes.

2.1.1.1. Carbohydrates: These are one of the three primary macronutrients essential for human health, along with proteins and fats. Chemically, they are organic compounds composed of carbon, hydrogen, and oxygen, and they serve as the body's main source of energy. Carbohydrates are divided into simple carbohydrates, like sugars (disaccharides and monosaccharides), and complex carbohydrates, like starches and dietary fiber (polysaccharides).

Their main role is to supply quick energy. In digestion process, carbohydrates are converted into glucose, which travels in the bloodstream and powers cellular activity. A gram of carbohydrate yields 4 kcal of energy, the most efficient of all body fuels. For example, glucose is the chief fuel for brain function and muscle contractions during exercise.

Aside from producing energy, carbohydrates also have a protein-sparing action, which is that when the intake of carbohydrates is adequate, proteins may be utilized for their main functions like the formation of tissues and the synthesis of enzymes rather than being allocated for energy. Moreover, carbohydrates aid in the complete metabolism of fats. Without sufficient carbohydrates, the body metabolizes fat partially, resulting in the buildup of ketone bodies, a state referred to as ketosis, which results in fatigue, nausea, and foul-smelling breath.

Another extremely important role for complicated carbohydrates is the amount of fiber they contain. Although not digestible, fiber is very important for digestive system health, facilitating bowel movements, managing blood sugar, lowering cholesterol, and promoting feelings of fullness. Foods such as whole grains, fruits, and vegetable Notes prevent constipation and lower the risk of chronic conditions like heart disease and type 2 diabetes.



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Carbohydrates are abundant in the diet and found predominantly in plant-based foods. Quick-digesting simple carbohydrates that give quick energy are present in table sugar (sucrose), honey, fruit (fructose), milk (lactose), and processed foods such as candies and sodas. Though they can be fast fuel, excessive intake can cause blood sugar peaks and weight gain. Complex carbohydrates, by contrast, consist of longer chains of sugars, which take longer to digest, providing long-term energy. These are whole grains (such as brown rice, oats, and wheat), legumes (such as lentils and beans), starchy vegetables (such as potatoes and corn), and fiber-rich fruits and vegetables (such as apples, spinach, and broccoli). Millets such as ragi, jowar, and bajra are also great sources of complex carbs, high in fiber, minerals, and antioxidants. Complex carbohydrates are more nutritionally dense compared to simple carbohydrates and also help with digestive health and metabolic balance.

Carbohydrate deficiency is quite uncommon in individuals with a well-balanced diet, but it may be seen in individuals on strict low-carb or ketogenic diets, individuals with eating disorders, or those afflicted with chronic disease. Inadequate carbohydrate supply can lead to low energy levels, physical and mental tiredness, and less endurance.

One of the first impacts of carbohydrate deficiency is the onset of ketosis, wherein the body starts burning fat as a source of energy. Although it may initially lead to weight loss, it can also lead to headaches, nausea, bad breath, and even ketoacidosis in uncontrolled diabetics, which may be life-threatening. In sustained deficiency, the body can begin to utilize muscle protein as a source of energy, resulting in muscle wasting and weight loss, a condition seen in starvation or severe malnutrition. Also, lack of dietary fiber, a part of complex carbohydrates, may cause constipation, erratic bowel movements, and predispose to disorders of the colon. The brain, which is mainly dependent on glucose for its function, can be harmed in deficiency, leading to mental problems including poor concentration, irritability, dizziness, and memory loss.



Populations at risk for carbohydrate deficiency include individuals on very restrictive or fad diets, those with anorexia or bulimia, patients with digestive disorders that hinder nutrient absorption, and diabetics with poorly regulated glucose control.

2.1.1.2. Functions, dietary, sources and clinical manifestations of deficiency of Lipid

It is referred to as fats and oils, are a varied group of hydrophobic molecules that consist of triglycerides, phospholipids, and sterols like cholesterol. Being an important class of macronutrients, lipids have critical roles in several biological functions, including the generation of energy, structural support of cells, hormone production, and so on.

One of the main roles of lipids is that they are a concentrated source of energy, yielding 9 kilocalories per gram, twice the energy yielded by carbohydrates or proteins. Energy in excess of requirement is deposited in the body as triglycerides in adipose tissue, an energy reservoir that can be drawn upon when fasting, during illnesses, or for extended durations of physical exercise. For instance, upon prolonged exercise or starvation, the body hydrolyzes stored fat into fatty acids to provide energy.

Lipids are also major structural lipids of cell membranes. Phospholipids and cholesterol constitute the lipid bilayer of membranes around each cell, controlling the movement in and out of substances, as well as the fluidity and stability of the membrane. This is particularly important in nerve cells, as the human brain consists of almost 60% fat, highlighting the central function of lipids in neurological activity. In addition to energy and structure, lipids are insulation and protection for the body. Subcutaneous fat functions as thermal insulation, regulating body temperature, while fat that covers organs like the kidneys also acts as a cushion against physical damage. Another important function of lipids is facilitating the absorption of fat-soluble vitamins—A, D, E, and K. Without adequate dietary fat, these vitamins cannot be absorbed efficiently, which can lead to deficiencies. For instance, consuming healthy fats along with vitamin A-rich foods like carrots or spinach significantly enhances absorption. Additionally, lipids act as precursors



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for bioactive molecules, including steroid hormones (such as estrogen, testosterone, and cortisol) and eicosanoids like prostaglandins, which regulate processes like inflammation, immune responses, and blood clotting.

From a dietary point of view, lipids are present in animal and plant foods and appear in various forms. Saturated fats, which are generally solid at room temperature, occur primarily in animal foods like butter, ghee, cheese, red meat, and full-fat milk. Dietary intake of saturated fats has been linked with elevated LDL (bad) cholesterol and heart diseases.

On the other hand, unsaturated fats that are normally liquid oils are healthier and belong to two categories monounsaturated fats (MUFA) in olive oil, avocados, and nuts, and polyunsaturated fats (PUFA) in soybean oil, sunflower seeds, flaxseeds, and oily fish. PUFAs contain essential fatty acids such as omega-3 and omega-6, which the body is unable to produce and needs to take through the diet. Lastly, trans fats, which are man-made through hydrogenation, occur in most fried and processed foods. These fats are proven to raise heart disease risk considerably and need to be eliminated altogether.

Generally, lipids are crucial to human health. A balanced diet should include adequate healthy fats, especially unsaturated fats and essential fatty acids, while limiting saturated and trans fats. This helps maintain optimal energy levels, supports cellular functions, and promotes long-term well-being.

Table 2.2.-Types of Fat with different sources

Type	Sources	Health Implications
Saturated fats	Butter, ghee, cheese, fatty meats, coconut oil	Excess linked to heart disease
Monounsaturated fats	Olive oil, canola oil, avocado, nuts	Heart-healthy
Polyunsaturated fats	Fish oil (salmon, mackerel), flaxseeds, walnuts	Essential for brain and heart
Trans fats	Packaged baked goods, fried fast foods	Increase bad cholesterol (LDL)

Essential Fatty Acids (EFAs) are a crucial component of dietary lipids, required for maintaining overall health and physiological function.



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Humans cannot synthesize certain fatty acids on their own, specifically omega-3 (alpha-linolenic acid) and omega-6 (linoleic acid), which must therefore be obtained from the diet. These lipids are required for a variety of body functions, such as brain development, anti-inflammatory processes, and cardiovascular health. Omega-3s are naturally crucial in pregnancy and early life, as they aid in neurological and visual development, while omega-6 fatty acids play a role in immune function and growth of cells.

Lipid deficiency, especially essential fatty acids, can cause a variety of clinical presentations. One of the most significant impacts is stunted growth and development, particularly in children and infants. Fat is a principal energy source and membrane structural component of cells, and a lack of adequate intake can result in neurological impairments, developmental delay, and growth retardation. For example, infants who are fed with low-fat formulas have experienced delayed eye and brain development as a result of the lack of EFAs.

Another symptom is skin and hair disorders, as EFAs contribute to the integrity of the skin barrier and hair condition. Inadequate intake can lead to dry, scaling skin, dermatitis, brittle hair, and impaired wound healing. Comments Lipids also facilitate the absorption of fat-soluble vitamins A, D, E, and K. When fat consumption is insufficient, absorption of these nutrients is impaired, and additional illness results. Vitamin A deficiency can lead to night blindness and compromised immunity, vitamin D deficiency rickets in children, adults, both involving soft or distorted bones. Neurological dysfunction caused by oxidative damage to nerve tissues can result from a deficiency of vitamin E, and a deficiency of vitamin K can hinder blood clotting and lead to excessive bleeding or bruising.

Furthermore, lipids are the precursor to steroid hormones, such as those involved in reproduction and stress. Thus, inadequate fat intake can cause hormonal imbalance, which influences fertility, menstrual function, and the body's capacity to manage stress. Apart from these, inadequate consumption of omega-3 fatty acids has been associated



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with increased risk of cardiovascular diseases, depression, and cognitive impairment in the elderly. Studies have shown that low-omega-3 diets can lead to inflammation, increased cholesterol, and weakening of brain function with age.

There are various groups who are especially vulnerable to lipid deficiency, such as very low-fat dieters, patients with malabsorption diseases such as celiac disease or cystic fibrosis, and premature infants or children whose diet is severely limited in fat by illness. Finally, lipids are vital macronutrients that have key functions in energy storage, cell structure, absorption of vitamins, and the production of hormones.

Though excessive consumption of unhealthy fats like trans-fat and saturated fat is problematic, avoidance of fats altogether is also dangerous. A balanced diet supplemented with avocados, plant oils, fatty fish, seeds, and nuts provides the body with the essential fatty acids needed to maintain overall health. While lipid deficiency is not very common in industrialized countries, it has severe effects when it does happen.

Hence, public health guidelines emphasize adding healthy fats to the everyday diet but avoiding excessive consumption of harmful ones deficiency, though rare in industrially developed nations, can cause severe clinical problems like growth retardation, dermatosis, vitamin deficiencies, and endocrinopathies. Thus, diet recommendations stress consumption of healthy fats with diversity of sources and restricting the intake of unhealthy fats such as trans fats.

2.1.1.3. Functions, Dietary, sources and deficiency of the Proteins

Proteins are complex organic compounds made of amino acids, commonly known as the building blocks of life. They are required macronutrients critical to the structure and function of all cells in the human body of the 20 amino acids the body needs, nine are essential, i.e., they have to be derived from the diet since the body cannot produce them. Proteins are needed in comparatively large quantities and are found in all living tissues. The Recommended Dietary Allowance (RDA) for the adult should be around 08 grams per kilogram body



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weight per day, though this need is different according to age, sex, state of health, and activity.

Proteins are involved in a broad range of physiological functions. To begin with, they are involved in body-building and tissue repair and hence in the growth and maintenance of muscles and other tissues and also in the repair of wounds and replacement of damaged cells. They are also involved in enzymatic functions because most of the enzymes participating in digestion, energy metabolism, and detoxification like amylase and pepsin are protein-based. Moreover, proteins are a crucial part of immune function, aiding in the construction of antibodies that defend the body against infection. Protein hormones such as insulin and growth hormone control various body processes such as metabolism and reproduction. Transport and storage are also supported by proteins, including molecules such as Haemoglobin, which carries oxygen in the blood, and albumin, which preserves fluid balance.

While proteins are not the body's major source of energy, they can be utilized to supply energy (4 kcal/g) in case carbohydrates and fats are not available. Proteins in the diet are categorized according to their amino acid composition. Complete proteins have all nine of the essential amino acids in sufficient quantity and are commonly consumed in animal sources such as eggs, milk, Notes meat, poultry, and fish or in certain vegetable sources like soybeans, quinoa, and chia seeds.

Incomplete proteins, however, like cereals, legumes, nuts, and seeds, are missing one or more of the essential amino acids. But when eaten in complementary pairs for instance, rice and beans they can give the complete balance of essential amino acids. Thus, a balanced diet with a range of protein foods is essential to satisfy the body, nutritional requirements and ensure optimum health.

Protein is a vital macronutrient essential for numerous body functions including tissue repair, muscle maintenance, immune defense, enzyme activity, and hormone production. Ensuring adequate protein intake is crucial for individuals across all age groups, especially those with



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higher physiological demands such as growing children, pregnant or lactating women, and the elderly. One of the most practical ways to enhance protein intake, especially in vegetarian or low-income settings, is to combine plant-based protein sources like rice and beans, lentils with cereals, or chapati with dal to provide all the essential amino acids that the body cannot produce on its own.

Table 2.3. Common Protein-Rich Foods with example

Food Group	Examples	Type
Animal-based	Eggs, meat, fish, cheese, milk, yogurt	Complete
Legumes	Lentils, chickpeas, kidney beans, soybeans	Incomplete (except soy)
Nuts & Seeds	Almonds, peanuts, sunflower seeds	Incomplete
Grains	Brown rice, wheat, oats	Incomplete
Plant-based combos	Rice + lentils, peanut butter + bread	Complete (when combined)

This practice of combining complementary proteins ensures a more complete protein profile. For vegetarians, incorporating dairy products such as milk, yogurt, and paneer, or soy-based products like tofu and soy milk, can significantly enhance protein quality and quantity. Non-vegetarians are advised to opt for lean meats, poultry, and fish, which are not only high in protein but also lower in saturated fats, thereby supporting both muscle health and heart health. Increasing the intake of eggs, nuts, and seeds can also contribute to a well-balanced protein-rich diet. When the body does not receive enough protein, a range of clinical manifestations can arise, which are often more severe in vulnerable populations such as infants, pregnant women, and those with chronic illnesses.

One of the most serious outcomes of prolonged protein deficiency is Protein-Energy Malnutrition (PEM), a condition primarily seen in developing countries where food insecurity is prevalent. It is commonly seen in young children after weaning and is characterized by edema (swelling, especially in the legs and feet), fatty liver, stunted growth, skin lesions, weak immunity, and hair changes like thinning and discoloration. On the other hand, Marasmus is caused by a combined deficiency of both protein and energy. It leads to severe wasting,



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extreme thinness, sunken eyes, dry, wrinkled skin, and overall growth retardation. Unlike kwashiorkor, edema is absent in marasmus, but the effects are equally devastating and may lead to mortality if untreated. Beyond childhood malnutrition, deficiency of protein has other far-reaching consequences. One outcome is weakened immune function, as protein is needed for the synthesis of antibodies and immune cells. In children, inadequate protein intake hampers physical growth and can also affect cognitive development, leading to delayed learning abilities and late onset of puberty. In adults, particularly in elderly individuals, a lack of protein results in muscle wasting or sarcopenia—a condition marked by the loss of muscle mass, reduced strength, and increased frailty, which raises the risk of falls and fractures. Furthermore, protein plays a major role in wound healing, as it supports the formation of new tissues. A deficiency slows down recovery from injuries, surgeries, increasing the risk of infection and complications. The appearance of hair, skin, and nails is also affected; keratin, the primary protein found in these tissues, diminishes, leading to brittle nails, hair loss, and dry, flaky skin.

Certain groups of people are more at risk for protein deficiency and should be monitored closely for signs and symptoms. Pregnant and lactating women require higher protein intake to support fetal development and milk production. If their dietary needs are not met, both mother and child may suffer from nutritional deficits. The elderly population often faces reduced appetite, dental issues, or chronic illness, all of which may contribute to low protein intake and muscle loss. Similarly, patients with chronic illnesses such as cancer, HIV/AIDS, or kidney disease may have increased protein requirements or experience difficulty digesting and absorbing nutrients. Strict vegetarians and vegans, while often healthy, can also be dangerous, if they do not properly plan their diets to include complete plant or animal proteins.



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2.1.2. Summary

Macronutrients—including carbohydrates, proteins, fats, water, and dietary fiber—are needed in large amounts and are vital for energy production, body structure, and maintaining bodily functions. Carbohydrates, fats, and proteins specifically provide the energy necessary for daily activities and bodily operations, while proteins also play a key role in the formation, repair, and maintenance of body tissues.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

1. **Which of the following is considered a macronutrient?**
 - a) minerals
 - b) Vitamins
 - c) Fats
 - d) water
2. **What is the main function of carbohydrates in the body?**
 - a) Build muscle
 - b) Store genetic information
 - c) Provide energy
 - d) Regulate hormones
3. **Which nutrient is essential for tissue growth and repair?**
 - a) Carbohydrates
 - b) Fats
 - c) Proteins
 - d) Water
4. **Which of the following is a macronutrient?**
 - a) Water
 - b) Fiber
 - c) Iron
 - d) Protein
5. **Which macronutrient is essential for body building?**
 - a) Vitamin A
 - b) Vitamin C
 - c) Protein



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d) Vitamin D

Answer keys: 1. c) Fats, 2.c) Provide energy, 3.c) Proteins. 4.d) protein,
5.c) Protein

B. Short Answer Questions

1. What are the three main types of macronutrients?
2. Write functions of macronutrients?
3. Name two functions of water as a nutrient.
4. Give one example of diseases with deficiencies of protein.
5. What are the functions of carbohydrate in the body?

C. Long Answer Questions

1. Explain the role of carbohydrates, proteins, and fats in providing energy and supporting body functions.
2. Describe the functions and dietary sources of proteins.
3. Write short notes on carbohydrate
4. Define macronutrient with examples
5. Define nutrients and explain about types of macronutrients



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Unit.2.2. Micronutrients Definition, Types and Significance

Micronutrients, needed in smaller quantities, consist of vitamins and minerals that the body must have for immune function, bone health, wound healing, regulation of metabolism and brain function. Vitamins are categorized into fat-soluble (A, D, E, K) and water-soluble (B-complex and C), and each of them plays a specialized role like vitamin A for sight and immunity, vitamin D for absorption of calcium, and vitamin C for healing and immune protection. Normally nutrients needed in minute amounts expressed in milligrams or micrograms. They do not supply energy, but their deficiency can result in severe health complications. Micronutrients are of two broad categories: Vitamins and Minerals.

2.2.1. Vitamins: These are organic substances required for several biochemical reactions. Vitamin A maintains vision and immunity and is present in carrots, mangoes, and spinach; its lack can result in night blindness. Vitamin B12, which is present in animal foods, is needed for the production of red blood cells and nerve function.

Folic acid is essential in pregnancy to avoid neural tube defects and is present in leafy vegetables and citrus fruits. Vitamin C, known for boosting immunity and aiding iron absorption, is abundant in amla, oranges, and guava, while Vitamin D, synthesized through sunlight exposure, aids calcium absorption. Vitamin D deficiency may result in rickets in children and osteomalacia in adults. Vitamin E (from oils and nuts) maintains healthy skin, and Vitamin K (from green leafy vegetables) is involved in clotting blood.

i). Fat-soluble vitamins: These vitamins like A, D, E, and K are organic fat- and oil-soluble compounds. In contrast to water-soluble vitamins, they need dietary fat for absorption and are stored to some degree in the liver and adipose tissue. These vitamins are involved in vision, bone health, immune function, antioxidant protection, and blood clotting but the toxicity can result from excessive intake because they are accumulated in body tissues.

Vitamin A: Vitamin A comes in two forms preformed vitamin A (retinol and retinyl esters), which is found in foods of animal origin,



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and provitamin A (beta-carotene) from plant sources. It has a crucial role in vision, especially night vision, by being part of rhodopsin in the retina and also needed for cell differentiation, immunity, and skin health, all assisting in epithelial tissue maintenance. The chief food sources are liver, egg yolk, full-fat milk, carrots, sweet potatoes, spinach, and mangoes. A deficiency will result in night blindness, xerophthalmia (dry-eye syndrome), enhanced susceptibility to infections, and stunted development in school children. Excessive consumption particularly from animal sources or from supplements will cause hypervitaminosis, symptoms include headache, damage to liver skin inflammation, hair-loss etc.

Vitamin D: Vitamin D is a fat-soluble vitamin—specifically a group called calciferols—that also functions like a hormone. The most important forms are D₃ (cholecalciferol) and D₂ (ergocalciferol). Unlike most vitamins, you can produce it in your skin upon exposure to UVB sunlight. It also affects the immune system and has been associated with advantages in mood control. Food sources are fatty fish (mackerel, salmon), fish liver oils, egg yolk, and fortified foodscereals, milk).

Deficiency leads to softening of bones and increase fracture susceptibility. Dietary sources include fatty fish (salmon, mackerel), fish liver oils, egg yolk, and fortified foods (milk, cereals). Deficiency can cause bone-softening conditions and contribute to increased fracture risk. In severe cases, it may be linked to immune dysfunction. However, excessive intake—through high-dose supplements—may result in hypercalcemia, leading to nausea, kidney stones, and cardiovascular issues.

Vitamin E: Vitamin E refers to a group of antioxidants known as tocopherols and tocotrienols, with alpha-tocopherol being the most biologically active. It acts as a chain-breaking antioxidant, protecting cell membranes from damage caused by free radicals and oxidative stress. Vitamin E also supports immune function and aids in red blood cell stability.



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Common sources include vegetable oils (sunflower, safflower, wheat germ), nuts, seeds, and green leafy vegetables. Deficiency is rare and usually occurs only in individuals with fat malabsorption syndromes, leading to neuromuscular problems, anemia, and impaired immune response. Excess supplementation can interfere with blood clotting, especially in individuals on anticoagulant therapy.

Vitamin K: Vitamin K exists in two primary forms: vitamin K1 (phylloquinone) found in green plants and vitamin K2 (menaquinones) produced by gut bacteria and present in fermented foods. It is crucial for blood clotting, as it activates factors II, VII, IX, X and supports bone health through the activation of osteocalcin.

Dietary sources include leafy greens (spinach, kale), broccoli, cabbage, and natto (fermented soy). Vitamin K deficiency is uncommon but may result in excessive bleeding, particularly in newborns and those on long-term antibiotics. Fortunately, toxicity is rare, though excess vitamin K can interfere with anticoagulant medications.

ii) Water-soluble vitamins: These are necessary nutrients which dissolve in water and are not held in large amounts within the human body. In contrast to fat-soluble vitamins, which are preserved in fats, water-soluble vitamins are eliminated via urine when taken in surplus, and so constant diet is required. These vitamins have pivotal functions in energy production, cell metabolism, growth, immunity, and tissue repair. Deficiencies, although less prone to toxicity, can cause serious health complications if not treated in time

The main water-soluble vitamins include the B-complex group—such as Thiamine (B₁), Riboflavin (B₂), Niacin (B₃), Folate (B₉), and Cobalamin (B₁₂)—as well as Vitamin C (ascorbic acid).

Thiamine (Vitamin B₁): It plays a vital role in carbohydrate metabolism, acting as a coenzyme (thiamine pyrophosphate) involved in energy production through the Krebs cycle. It is also crucial for nerve impulse transmission and maintaining muscle tone, especially in the digestive tract. Major dietary sources include whole grains, pork, legumes, seeds, and fortified cereals. A deficiency of thiamine may lead to beriberi, which occurs in two forms: dry beriberi affects the nervous



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system, resulting in muscle weakness and peripheral neuropathy, while *wet beriberi* impacts the cardiovascular system, causing fluid retention and an enlarged heart. In alcoholics, a more severe deficiency may result in Wernicke-Korsakoff syndrome, marked by confusion, memory issues, and eye movement abnormalities.

Riboflavin (Vitamin B₂): It is an essential water-soluble vitamin that acts as a precursor to essential cofactors FAD and FMN, which are involved in cellular respiration and various redox reactions. Riboflavin supports skin health, vision, and the conversion of food into energy. Good sources include dairy products, lean meats, eggs, green leafy vegetables, and enriched grains. Although riboflavin deficiency is uncommon in isolation, when it occurs, it can cause ariboflavinosis, with symptoms such as cracked lips (cheilosis), inflamed mouth corners (angular stomatitis), swollen tongue (glossitis), sore throat, and seborrheic dermatitis. Riboflavin deficiency often coexists with other B-vitamin deficiencies, particularly niacin and B₆.

Niacin (Vitamin B₃): It is essential for the formation of coenzymes NAD and NADP, which are central to metabolism, DNA repair, and antioxidant functions. Rich food sources include meats, poultry, fish, legumes, whole grains, and cereals that are fortified. A niacin deficiency causes pellagra, which in the past was common in populations relying on maize diets. Pellagra is classically described by the "three Ds": dermatitis, diarrhoea, and dementia. Untreated, it can eventually lead to death as a result of extensive dysfunction in cellular energy production. The protein amino acid tryptophan can be metabolized into niacin, providing an added protective dietary component if enough protein is eaten.

Pyridoxine (Vitamin B₆): It is a water-soluble B-complex vitamin that is required for many metabolic processes in the human body. It plays a critical role in amino acid metabolism, neurotransmitter synthesis (including serotonin, dopamine, and GABA), hemoglobin formation, immune function, and hormonal regulation. The active coenzyme form, pyridoxal 5'-phosphate (PLP), is involved in over 100 enzyme



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reactions, particularly related to protein metabolism. Pyridoxine also helps convert stored glycogen into glucose for energy and supports cognitive development and mood regulation. Rich dietary sources of Vitamin B6 include poultry (such as chicken and turkey), fish (like tuna and salmon), bananas, potatoes, fortified cereals, leafy green vegetables, and whole grains. Deficiency of pyridoxine can result in symptoms such as fatigue, irritability, depression, confusion, cracked lips, sore tongue (glossitis), weakened immune function, and peripheral neuropathy, especially in people with alcohol dependency or those taking certain medications (e.g., isoniazid). In infants, deficiency may cause seizures and irritability. While toxicity from food is rare, high doses from supplements may lead to nerve damage and sensory neuropathy. Pyridoxine is also used therapeutically to treat conditions like premenstrual syndrome (PMS), pregnancy-related nausea, certain types of anaemia, and to prevent nerve damage in patients taking anti-tuberculosis drugs. Thus, maintaining an adequate intake of Vitamin B6 through a balanced diet is essential for overall health and well-being.

Folate (Vitamin B₉): It is critical for DNA synthesis, cell division, and the formation of red and white blood cells. It is particularly vital during pregnancy and infancy, where rapid cell growth and development occur. Folate is found in abundance in green leafy vegetables, legumes, citrus fruits, liver, and fortified grain products. A lack of folate can cause megaloblastic anaemia, where red blood cells become large and immature, leading to fatigue, pallor, and weakness. In pregnant women, folate deficiency increases the risk of neural tube defects, such as spina bifida, in the developing foetus. Elevated homocysteine levels, often seen in folate deficiency, are also associated with a higher risk of cardiovascular disease.

Vitamin B₁₂ (Cobalamin): It plays a key role in red blood cell formation, neurological function, and DNA synthesis. It also works closely with folate in regulating homocysteine levels. Unlike other B vitamins, B₁₂ is found only in animal-derived foods, including meat, dairy, eggs, and fish. Fortified cereals and nutritional yeast can provide B₁₂ in plant-based diets. B₁₂ deficiency causes megaloblastic anemia



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similar to folate deficiency but also presents with neurological symptoms, such as numbness, poor coordination, and cognitive decline. If left untreated, nerve damage can become irreversible. Those at higher risk include vegans, the elderly, and individuals with malabsorption issues, such as pernicious anaemia or gastrointestinal surgeries affecting the stomach or ileum.

Vitamin C: It is also known as ascorbic acid, is a water-soluble vitamin that plays a vital role in maintaining overall health. It is a powerful antioxidant that protects cells from damage caused by free radicals and supports the immune system, helping the body fight infections. One of its key functions is aiding in the synthesis of collagen, a structural protein necessary for the health of skin, blood vessels, bones, and connective tissues. Vitamin C also improves iron absorption from plant-based foods, reducing the risk of iron-deficiency anaemia. It is essential for wound healing, maintaining healthy gums, and enhancing skin elasticity. Rich dietary sources of Vitamin C include citrus fruits (such as oranges, lemons, and amla), guava, strawberries, kiwi, papaya, tomatoes, bell peppers, broccoli, and green leafy vegetables.

Deficiency of Vitamin C leads to scurvy, a disease characterized by bleeding gums, weakness, delayed wound healing, joint pain, and bruising due to poor collagen formation. Because the body cannot produce or store Vitamin C, it must be obtained regularly from the diet. Cooking and prolonged storage can destroy Vitamin C, so fresh, raw, or lightly cooked vegetables and fruits are preferred. Overall, Vitamin C is crucial for maintaining immunity, tissue repair, and iron metabolism, making it an essential part of a balanced diet.

2.2.2. Minerals: Calcium, Iron, Iodine and Zinc

Minerals are inorganic substances that are necessary for different body functions in the human body. These are differed from vitamins and all are not organic but rather elements that do not contain carbon and occur naturally. They can be categorized as two broad groups according to the amount needed by the body microminerals (required in greater amounts) and trace minerals (required in small amounts).



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Macro minerals are calcium, phosphorus, magnesium, sodium, potassium, chloride, and sulphur. These are crucial in the construction of bones and teeth, regulation of fluid balance, nerve conduction, and muscle contraction. For instance, calcium is important for bone function, iron is required for hemoglobin synthesis, iodine controls thyroid hormones, and zinc aids immunity and healing of wounds. Dietary sources of minerals include varying dairy products, green leafy vegetables, nuts, meat, fish, legumes, and whole grains are all rich in varying minerals. Both deficiencies and overages can create disease conditions calcium deficiency can create osteoporosis, iron deficiency creates anemia, and iodine deficiency can create goiter. Excessive mineral consumption, usually in the form of supplements, can be toxic and produce symptoms such as kidney stones (excess calcium) or gastrointestinal upset (excess zinc). Therefore, a well-balanced diet containing a variety of whole foods is the optimal method for obtaining sufficient and safe levels of minerals for overall health and disease prevention.

Table-2. 3. Minerals and Functions

Mineral	Function	Sources
Calcium	Bone and teeth formation	Milk, cheese, green vegetables
Iron	Haemoglobin production	Meat, spinach, lentils
Iodine	Thyroid hormone production	Iodized salt, seafood
Zinc	Immune function, wound healing	Meat, seeds, legumes
Magnesium	Muscle and nerve function	Nuts, seeds, whole grains

Calcium: The most prevalent mineral found in the body, calcium is necessary for bone growth and maintenance and for creating healthy teeth. Nearly 99% of calcium is deposited in the skeletal system, lending structural strength, whereas 1% performs vital functions in muscle contraction, blood coagulation, nerve impulses, and hormone secretion. Key food sources are milk, yogurt, cheese (dairy products), spinach, kale (leafy green vegetables), fortified plant milk, and tofu prepared from calcium salts.



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A lack of calcium, which is usually associated with a lack of vitamin D, can cause brittle bones and susceptibility to fractures and rickets in children, and osteoporosis in adults, and lead to bone deformity. On the other hand, too much from supplements will result in kidney stones or hypercalcemia, but this is rare with normal dietary intake.

Iron: It is crucial for the transport of oxygen, metabolism of energy, and immune response. In the blood, it is a component of hemoglobin within red blood cells (RBC), which allows oxygen to be delivered to tissues, and also of myoglobin in muscles. Iron is also needed by enzymes which are part of energy generation and immune protection. There are two forms of dietary iron: heme iron, from meat, poultry, and fish, which is highly absorbable, and non-heme iron, in plant foods, fortified cereals, legumes, and dark green leafy vegetables. Absorption of non-heme iron is increased when it is eaten with foods high in vitamin C. Iron deficiency is the most prevalent micronutrient deficiency globally and leads to iron-deficiency anemia, with symptoms of fatigue, pallor, and decreased cognitive function. Conversely, too much iron—most often from supplements—is responsible for causing damage to organs through oxidative stress and is particularly dangerous in people with genetic conditions such as hemochromatosis.

Iodine: It is an essential trace mineral necessary for thyroid hormone synthesis, which controls metabolism, growth, and neurodevelopment. The body does not make iodine, so it is acquired from food. Iodized salt, seafood (fish, seaweed, shellfish), milk and dairy products, and some fortified foods are good sources.

Iodine deficiency can cause goiter an enlargement of the thyroid gland and hypothyroidism, with symptoms of fatigue, weight gain, and decreased heart rate. In pregnant women, iodine deficiency raises the risk of cretinism, a condition in infants characterized by intellectual disability and failure to grow. Although toxicity of iodine is uncommon, high levels from seaweed or supplements can result in overactivity of the thyroid gland or upset thyroid hormone balance.



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Zinc: It is a type of trace mineral that participates in more than 300 enzyme reactions associated with immune system function, wound healing, DNA synthesis, protein metabolism, and growth and development. It also plays a role in taste and smell function and cell division. Sources of dietary zinc are oysters, red meat, poultry, beans, nuts, whole grains, and milk. Phytates in whole grains and legumes inhibit zinc absorption, but soaking or fermentation procedures can minimize this inhibition.

These are inorganic substances essential for the structure and regulation of the body. Iron assists in the formation of hemoglobin and anemia prevention and occurs in red meat, spinach, and jaggery. Calcium, necessary for bone and teeth health, is rich in dairy products and sesame seeds. Iodine, contained in iodized salt and seafood, controls thyroid function and goiter prevention. Zinc, magnesium, and selenium are concerned with immunity, muscle functions, antioxidant defenses, and are contained in seeds, nuts, green leafy vegetables, and fish.

2.2.3. Water: It is a crucial nutrient, because it constitutes 50–70% of the human body and supports all vital functions. Water is the medium for life's biochemical reactions—acting as a solvent, reactant, and carrier that dissolves nutrients and transports them to cells, while also flushing waste through urine, sweat, and feces. It regulates body temperature via perspiration, cushions organs and joints, maintains blood volume, supports digestion, and enables cellular activities such as enzyme function and neural signalling. Water enters the system through drinking, foods, metabolic production, and bodily fluids; the gastrointestinal tract absorbs most of it—about 8–8.5 L daily in the small intestine, with the remainder absorbed by the large intestine. Metabolic water—generated during nutrient oxidation—adds roughly 8–10% to overall water intake.

Daily adequate intake varies: general recommendations, including water from food and beverages, range from 2.2–2.7 L for women and 3–3.7 L for men. Other guidelines suggest 8–10 cups (about 2–2.4 L) per day, with fluid requirements rising in high-heat conditions, during physical activity, or with advanced age. Insufficient intake leads to



dehydration, which impairs cognitive and physical performance, disrupts digestion and kidney function, and can cause serious health issues. On the other hand, although overhydration (water intoxication) is rare, it can pose its own risks and should be avoided.

2.2.4. Summary

Nutrients are essential substances the body requires for energy, growth, development, and the proper functioning of physiological processes. They are classified into macronutrients and micronutrients based on the quantity needed. In contrast, micronutrients—vitamins and minerals—are required in smaller amounts but are equally important, supporting metabolism, immune function, and cellular repair. Both types of nutrients work together to maintain overall health and ensure normal growth and development.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

1. Which of the following is considered a micronutrient?

- a) Carbohydrates
- b) Proteins
- c) Vitamins
- d) Fats

2. Which of the following is a fat-soluble vitamin?

- a) Vitamin B12
- b) Vitamin C
- c) Vitamin D
- d) Vitamin B6

3. Iron is essential for which of the following biological functions?

- a) Bone formation
- b) Oxygen transport in blood
- c) DNA replication
- d) Hormone regulation

4. Which of the following is a micronutrient?

- a) Water



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- b) Fiber
- c) Iron
- d) Glucose

5. Which vitamin is essential for blood clotting?

- a) Vitamin A
- b) Vitamin C
- c) Vitamin K
- d) Vitamin D

Answer keys: 1. c) Vitamins, 2.c). Vitamin D, 3. b). Oxygen transport in blood 4.c) Iron, 5.c) Vitamin K

B. Short Answer Questions

1. What are the three main types of micronutrients?
2. Why are micronutrients needed in smaller amounts compared to macronutrients?
3. Name two functions of water as a nutrient.
4. Give one example each of a fat-soluble and a water-soluble vitamin.
5. What is the role of dietary fiber in the body?

C. Long Answer Questions

1. Explain the causes, symptoms, and prevention of iron deficiency anemia.
2. Describe types of vitamins with functions
3. Explain about the minerals, and water contribute to normal growth and development.
4. Discuss the importance of micronutrients in maintaining immune function and cellular health. Provide examples.
5. What are micronutrients? Give two examples.

Unit-2.3. Milk, Milk products and food groups

2.3.1. Milk: It is a nutrient-rich liquid, produced by the mammary glands of mammals and considered as a complete food because it provides a rich source of essential nutrients such as proteins, calcium, vitamins, and fats in easily digestible forms. Human consumption typically includes cow, buffalo, goat, and camel milk, with cow and buffalo milk being the most common in many parts of the world.

Table.2.4. Nutritional Composition of Milk (per 100 ml of cow milk)

Nutrient	Amount
Energy	66–70 kcal
Protein	3.2–3.4 g
Fat	3.5–4.0 g
Carbohydrate (Lactose)	4.8–5.0 g
Calcium	120–130 mg
Vitamin B2	0.2–0.3 mg
Water	~87%

Note: Milk is naturally low in iron, vitamin C, and fiber.

Milk plays a major role in human nutrition, offering a wide range of health benefits and physiological functions. The important advantages of milk is its contribution to bone health, as a rich source of calcium and often fortified with vitamin D, both essential for the development and maintenance of strong bones and the prevention of osteoporosis. For children, milk helps as an important source of protein and energy, supporting not only physical growth but also cognitive development. In addition, milk is also helpful for dental health because of its rich content of calcium and phosphorus, which are useful in developing and maintaining healthy teeth as well as inhibiting dental caries.

2.3.2. Milk Products: Milk proteins, such as casein and whey, also play an important role in muscle repair and maintenance, thus making milk a good post-exercise recovery beverage. In addition, the high-water content in milk helps in hydration, helping in keeping the body's fluid level in balance. There are different kinds of milk that can be consumed based on various dietary requirements and choices.

Whole milk has around 3.6–4% of fat and is high in energy, while toned or low-fat milk provides a lesser amount of fat ranging around 1.4–3%,



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which is good for those controlling fat intake. Skimmed milk with less than 0.6% fat serves the best for those who require low-calorie and low-fat foods but do not want to compromise on protein and calcium. Also, plant-based milk alternatives made from soy milk, almond milk, and oat milk have found favor among those who are lactose intolerant, have milk protein allergy, or are on vegan diets.

Milk also forms the foundation for a vast group of dairy foods that have specific nutritional characteristics and cooking applications. Curd or yogurt (dahi) results from fermenting milk with lactic acid bacteria, making it packed with probiotics that support digestive and gut health, as well as calcium and protein. Cheese, as a concentrated form of milk fat and protein, is rich in calcium, calories, and vitamin B₁₂, although it must be eaten moderately as it contains saturated fat and sodium. Paneer or cottage cheese, an Indian staple, is an unaged fresh cheese that is rich in protein, calcium, and phosphorus and hence is perfect for vegetarians to build muscle. Butter and ghee, derived from the fat portion of milk or cream, are concentrated energy foods and carry fat-soluble vitamins (A, D, E, and K). Interestingly, ghee is very much respected in Ayurvedic medicine for its therapeutic value. Cream, the high-fat layer skimmed from milk, is commonly used in desserts and savory dishes, while khoa, condensed milk, and milk powder are used extensively in traditional sweets, offering high energy and protein content and a long shelf life.

Incorporating milk and dairy products into the diet offers multiple health benefits. Regular consumption can boost immunity—particularly through probiotic-rich curd—prevent rickets and osteoporosis, support muscle development, and provide a sense of satiety, which helps in controlling appetite and avoiding overeating. However, not everyone can tolerate milk. Individuals with lactose intolerance are unable to digest lactose, the natural sugar in milk, and may experience bloating, gas, and diarrhea. Others may suffer from milk allergy, which is an immune response to milk proteins like casein or whey, causing symptoms such as skin rashes, swelling, or respiratory

problems. For these individuals, lactose-free milk, plant-based milk alternatives, and probiotic supplements can be suitable options.

2.3.3. Food groups: Understanding food groups, including dairy, is essential for planning a balanced diet. Food groups are classified based on similar nutrient compositions, and recognizing their role helps ensure that daily nutritional requirements are met effectively. Milk and milk products, as part of the dairy group, contribute significantly to calcium, protein, and vitamin intake, reinforcing their importance in a well-rounded, nutritious diet.

Table 2.5. Major Food Groups (According to Indian Council of Medical Research - ICMR)

Food Group	Examples	Key Nutrients
1. Cereals and Grains	Rice, wheat, maize, millet	Carbohydrates, fiber, B-vitamins
2. Pulses and Legumes	Lentils, chickpeas, soybeans	Proteins, fiber, iron
3. Milk and Milk Products	Milk, curd, cheese, paneer	Calcium, protein, vitamin B12
4. Fruits and Vegetables	Apple, spinach, carrot, banana	Vitamins, minerals, fiber
5. Fats and Oils	Ghee, butter, vegetable oils, nuts	Energy, essential fatty acids
6. Meat, Fish, Eggs	Chicken, fish, eggs	Proteins, iron, vitamin B12
7. Sugar and Sweets	Sugar, honey, jaggery, desserts	Energy (simple carbohydrates)

The importance of including all food groups in a balanced diet lies in ensuring the body receives a complete range of macronutrients (carbohydrates, proteins, and fats) and micronutrients (vitamins and minerals) essential for growth, energy, and overall health. Consuming a variety of foods from different groups promotes nutrient density and supports key bodily functions such as immune defence, muscle repair, and metabolic regulation. A well-balanced diet also aids in maintaining healthy body weight, regulating blood sugar levels, and managing cholesterol, thereby reducing the risk of chronic diseases like diabetes, hypertension, and heart disease.

On the other hand, skipping food groups can lead to significant health problems. For instance, avoiding dairy products may result in calcium



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and vitamin D deficiencies, contributing to weakened bones and a higher risk of osteoporosis. Excluding fruits and vegetables can cause a lack of vitamins A and C and dietary fiber, which negatively impacts immune function and may lead to constipation and digestive issues. Conversely, consuming excess fats and added sugars without balancing with other food groups can lead to weight gain and elevate the risk of cardiovascular disease. Therefore, incorporating all food groups in appropriate proportions is vital for maintaining optimal health and preventing nutritional deficiencies.

2.3.4. Summary

Milk and its products play a vital role in human nutrition, offering a rich source of essential nutrients like calcium, protein, and vitamin B12, which support bone strength, muscle repair, and dental health. Milk's nutritional composition, including its energy content, protein, and high-water percentage, makes it beneficial for growth, hydration, and post-exercise recovery. Dairy products like curd, cheese, paneer, and ghee provide additional health benefits, such as probiotics for gut health, concentrated nutrients for energy, and muscle-building proteins, especially for vegetarians. However, individuals with lactose intolerance or milk allergies need alternatives like plant-based milks. As part of the dairy food group, milk contributes significantly to a balanced diet. Including all major food groups—cereals, pulses, dairy, fruits and vegetables, meats, fats, and sugars—ensures the intake of both macronutrients and micronutrients essential for energy, immunity, growth, and disease prevention. Skipping food groups can lead to nutrient deficiencies and health risks, making dietary variety and balance crucial for overall well-being.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

1. Which key nutrient in milk supports bone strength and dental health?

- a) Vitamin C
- b) Iron
- c) Calcium



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d) Fiber

2. Which dairy product is rich in probiotics and supports gut health?

- a) Paneer
- b) Curd
- c) Ghee
- d) Butter

3. What makes milk a good post-exercise recovery drink?

- a) High sugar content
- b) High water and protein content
- c) Presence of iron
- d) Lack of fat

4. Which of the following is NOT typically found in high amounts in milk?

- a) Calcium
- b) Vitamin C
- c) Protein
- d) Vitamin B12

5. What happens if food groups like fruits and vegetables are avoided in the diet?

- a) Improved digestion
- b) Fiber and vitamin deficiencies
- c) Increased energy
- d) Better immunity

Answer Keys: 1. c) Calcium, 2. b) Curd, 3. b) High water and protein content, 4. b) Vitamin C, 5. b) Fiber and vitamin deficiencies

B. Short Answer Questions

1. Name two key nutrients found in milk that help build and maintain strong bones.
2. Why is paneer considered beneficial for vegetarians?
3. List two plant-based milk alternatives.
4. What are the potential consequences of lactose intolerance?
5. Mention one health benefit of consuming ghee in moderation.



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C. Long Answer Questions

1. Explain the nutritional benefits of milk and its role in supporting growth and development.
2. Discuss how different milk products (e.g., curd, paneer, cheese, ghee) contribute to overall health.
3. Why is it important to include all major food groups in a balanced diet? Illustrate with examples.
4. Analyze the dietary challenges faced by individuals with lactose intolerance or milk allergies and suggest suitable alternatives.
5. How does the exclusion of certain food groups affect long-term health and what are the preventive dietary measures to avoid deficiencies?



Unit-2.4. Lifestyle Diseases: Type 2 Diabetes, Hypertension, Obesity and Coronary heart disease (CHD)

2.4.1. Type 2 Diabetes: Diabetes mellitus (T2DM) is a progressive and chronic metabolic disease in which the body fails to utilize insulin effectively, a state of insulin resistance, along with a subsequent relative lack of insulin. This results in sustained hyperglycemia.

T2DM is the most prevalent type of diabetes globally and usually progresses slowly, remaining undetected for years because of its insidious onset and mildly present symptoms at first. It usually strikes adults above 40 years of age, although its prevalence is more and more growing in the younger population, including children and adolescents, because of expanding rates of obesity and physical inactivity.

Causes and risk factors for Type 2 diabetes are multifactorial. Obesity, especially central fat accumulation, is a very strong predictor of insulin resistance and is strongly associated with physical inactivity and unhealthy eating habits. Physical inactivity, which involves excessive sitting and lack of physical activity, also plays an important role in aberrant glucose metabolism. An intake of high-sugar, unhealthy fat, low-fiber foods can speed up the onset of insulin resistance.

The causes and risk factors associated with Type 2 diabetes are multifactorial. Obesity, particularly the accumulation of abdominal fat, is one of the strongest predictors of insulin resistance and is closely tied to poor dietary habits and physical inactivity. A sedentary lifestyle, characterized by prolonged sitting and lack of exercise, also contributes significantly to impaired glucose metabolism. Consuming a diet high in sugars, unhealthy fats, and low in dietary fiber can accelerate the development of insulin resistance. In addition to lifestyle factors, genetics play a critical role; individuals with a family history of diabetes are at a significantly higher risk.

Typical symptoms include excessive thirst (polydipsia) and increased urination (polyuria) as the body tries to eliminate excess glucose in the urine. Individuals may experience persistent fatigue, weakness, and blurred vision due to the osmotic effects of high blood sugar levels.



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Delayed wound healing is another hallmark of diabetes, often accompanied by frequent infections, especially of the skin and urinary tract. As the condition progresses, nerve damage (neuropathy) can cause tingling, numbness, or burning sensations, particularly in the hands and feet, increasing the risk of foot ulcers and complications. In the long run, uncontrolled diabetes can result in a wide range of severe complications.

Long-term hyperglycemia affects blood vessels and organs, greatly putting someone at risk of cardiovascular diseases like heart attack and stroke. Diabetic nephropathy, or kidney damage, can lead to kidney failure if not treated correctly. Nerve damage, or diabetic neuropathy, can lead to numbness and mobility impairment, whereas eye damage, or retinopathy, can cause eventual blindness if left untreated. The most feared among the complications is the creation of foot ulcers, which, once infected and not treated, can be followed by amputation.

The extent and severity of these complications are determined, to a great extent, by how well blood glucose, blood pressure, and lipids are controlled in the long term. Type 2 diabetes is both preventable and controllable, most importantly by lifestyle modification. A healthy diet with low glycemic index (GI) foods, whole grains, vegetables, and lean proteins is vital for regulating blood sugar levels. Refined sugar, saturated fats, and processed foods must be avoided as far as possible. Physical activity for at least 150 minutes a week in the form of brisk walking, swimming, or cycling enhances insulin sensitivity and aids in weight loss. Modest weight loss even a mere 4–10% of body weight can be an important improvement in case of glucose tolerance as well as lower the risk of complications. Where lifestyle interventions alone are not adequate, physicians may initiate oral hypoglycemic medication like metformin, or insulin therapy might become necessary.

Monitoring blood glucose levels at regular intervals at home or in clinic is helpful to individuals to monitor their progress and modify their management accordingly. Type 2 diabetes is both preventable and manageable, particularly through lifestyle changes. A balanced diet focusing on low glycemic index (GI) foods, whole grains, vegetables,



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and lean proteins plays a crucial role in controlling blood sugar levels. Refined sugars, saturated fats, and processed foods should be minimized. Regular physical activity, such as brisk walking, swimming, or cycling for at least 150 minutes per week, improves insulin sensitivity and supports weight management. Modest weight loss—even just 4–10% of body weight—can significantly improve glucose tolerance and reduce the risk of complications. In cases where lifestyle measures alone are insufficient, doctors may prescribe oral hypoglycemic agents such as metformin, or insulin therapy may be required. Regular monitoring of blood glucose levels, either at home or in clinical settings, helps individuals track their progress and adjust their management strategies accordingly.

2.4.2. Hypertension: It is commonly known as high blood pressure, is a chronic medical condition in which the force of blood against the artery walls remains consistently elevated over time. It is often referred to as the "silent killer" because it may present no noticeable symptoms while still causing significant and potentially life-threatening damage to the heart, kidneys, and other vital organs. A normal blood pressure reading is considered to be less than 120/80 mmHg, while a reading of 140/90 mmHg or higher is classified as hypertension. The condition can be classified into stages depending on the severity of the elevation. There are two main types of hypertensions:

A variety of causes and risk factors contribute to the development of hypertension. These include a diet high in salt, obesity, physical inactivity, chronic stress, smoking, and excessive alcohol consumption. A family history of hypertension and aging also increase a person's risk. Other risk factors include diabetes, obesity, lack of physical activity, poor diet, and a history of heart disease in the family. Most of these risk factors occur together, particularly in people who have other lifestyle-related diseases such as type 2 diabetes and obesity.



Table.2.4.1. Types of Hypertensions

Hypertension	
Primary hypertension	Secondary Hypertension
Primary(essential) Hypertension accounts for the majority of cases and has no identifiable medical cause. Instead, it is associated with lifestyle factors such as poor diet, lack of exercise, and stress.	Secondary hypertension , on the other hand, arises from underlying medical conditions such as kidney disease, thyroid disorders, or certain medications. Identifying the type of hypertension is essential for choosing the appropriate management strategy.

The most frequent symptoms of CHD are chest pain or discomfort (also known as angina), shortness of breath, tiredness, palpitations, and in more serious instances, a heart attack (myocardial infarction). In most individuals, CHD can be asymptomatic until it reaches a more serious phase, and thus regular screening and early detection are paramount.

Complications of CHD are potentially fatal. These include heart attack, heart failure (when the heart is not able to circulate blood effectively), arrhythmias (abnormal heart rate), and sudden cardiac death. Diagnosis of CHD generally includes a variety of tests like electrocardiograms (ECG), stress tests, echocardiograms, angiography, and blood tests to evaluate lipid profiles and other cardiovascular markers.

Prevention and treatment of CHD need a multi-faceted strategy. Heart-healthy eating with a diet low in saturated fat and high in fiber, fruits, and vegetables forms a key starting point. Daily physical exercise, including brisk walking or aerobic exercises, sustains cardiovascular fitness and keeps one's weight in check. Regulation of blood sugar in diabetics and blood pressure in hypertensive individuals is also vital. Stopping smoking and reducing alcohol intake greatly lowers risk. Medications such as statins, beta-blockers, or aspirin to control



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symptoms or prevent worsening are often prescribed in most cases. In more severe cases, surgical intervention such as angioplasty (to widen clogged arteries) or coronary artery bypass surgery may be required.

Even though hypertension generally develops over time, it can last for years without causing any symptoms. The main symptoms may appear, can include like headaches, lightheadedness, blurred vision, and occasional nosebleeds. These symptoms are not unique to hypertension, though, and tend only to become evident when blood pressure levels are critically high. If left untreated, hypertension can result in serious complications.

These encompass a high risk of stroke, heart attack, chronic kidney disease, eye damage (hypertensive retinopathy), and aneurysms weakened vessel walls that will rupture. High blood pressure for a long period puts a continuous strain on the cardiovascular system and results in irreversible organ injury and excess mortality. Dietary and lifestyle modification play a vital role both in prevention and treatment of hypertension.

The DASH (Dietary Approaches to Stop Hypertension) diet is strongly advised. It emphasizes a diet low in sodium and rich in fruits, vegetables, whole grains, lean proteins, and low-fat dairy. Avoiding processed and salty foods is crucial, as is maintaining a healthy body weight through regular physical activity. Limiting alcohol intake, quitting smoking, and managing stress through relaxation techniques like yoga and meditation can greatly reduce blood pressure levels. Where lifestyle modifications are not adequate, physicians can prescribe antihypertensive drugs, such as ACE inhibitors, beta-blockers, or diuretics, to manage blood pressure and mitigate the risk of complications.

2.4.3. Obesity – Causes, Risks, and Management

Chronic illness is characterized as a state of abnormal or excessive body fat that can be negatively impact upon the condition of health. It is usually assessed the Body Mass Index and is derived from dividing an individual's weight in kilograms by the square of their height in



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meters. A Body Mass Index of 30 kg/m² or more can be defined as obese, while a BMI of 25–29.9 kg/m² is overweight. Although BMI does not take into consideration muscle mass or fat distribution, it remains a convenient screening measure for population studies and for clinical use.

The etiologies of obesity are complex, involving multiple factors that frequently include an interaction of lifestyle, biological, psychological, and environmental elements. A poor diet, rich in processed foods, sugary beverages, and high-fat meals, contributes significantly to excess calorie consumption. Genetic predisposition also plays a role—some individuals may inherit a tendency to gain weight more easily or have a slower metabolic rate, hormonal imbalances, including thyroid dysfunction and polycystic ovary syndrome (PCOS), can affect fat storage and appetite regulation. Psychological factors such as stress, emotional eating, and lack of sleep can also promote overeating and metabolic imbalance.

In addition, obesity has also been associated with some cancers, such as breast, endometrial, and colon cancer. It may also result in obstructive sleep apnea, wherein surplus fat tissue in the neck reduces the airway size and disturbs breathing when asleep. In females, it can lead to infertility and pregnancy complications like gestational diabetes or preeclampsia. Obesity prevention and control demand a long-term and sustainable strategy that seeks to address lifestyle and behavioral issues. The key to weight management is taking on a calorie-restricted, nutrient-dense diet with sufficient protein, vitamins, and minerals. It is best complemented by daily exercise, for example, brisk walking, swimming, cycling, or strength training for 30 to 60 minutes a day.

In cases where emotional or binge eating contributes to weight gain, behavioral therapy or counselling can help individuals develop healthier coping strategies. Limiting intake of sugar, trans fats, and ultra-processed foods is critical to reducing overall calorie consumption. Ensuring adequate sleep, managing stress levels, and staying well-hydrated also play supportive roles in achieving and maintaining a healthy weight. For individuals with severe or morbid



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obesity, where traditional methods fail, bariatric surgery may be recommended. These surgical options reduce stomach size or affect nutrient absorption to facilitate significant weight loss.

The position of nutrition in preventing obesity is pivotal. Dietary intake of foods high in fiber, including fruits, vegetables, beans, and whole grains, enhances satiety and maintains gut health, which potentially assists in weight control in the long term. Avoiding trans fats, which are also present in fried and processed foods and have been implicated in weight gain and heart disease, is crucial. Moderate consumption of healthy fats, like olive oil, nuts, and avocados, can facilitate heart health without leading to excess calorie intake. Refined sugar and sugary beverages must be limited since they raise blood sugar levels quickly and provide unwanted calories. Mindful eating habits like slowing down, not watching TV or using electronic devices during meals, and paying attention to actual hunger cues can also regulate portions and avoid overconsumption.

2.4.4. Coronary Heart Disease (CHD): It is also known as ischemic heart disease, is a condition in which the coronary arteries, responsible for supplying oxygen-rich blood to the heart muscle, become narrowed or blocked. This occurs due to atherosclerosis, a buildup of plaque (fatty deposits) within the arterial walls, which restricts blood flow and can ultimately lead to serious cardiac events such as heart attacks.

Several risk factors contribute to the development of CHD. These include high levels of LDL cholesterol (the “bad” cholesterol), low levels of HDL cholesterol (the “good” cholesterol), high blood pressure (hypertension), and smoking. Other contributing factors are diabetes, obesity, physical inactivity, an unhealthy diet, and a family history of heart disease. These risks often overlap, especially among individuals with other lifestyle-related conditions like type 2 diabetes and obesity. The most typical presentation of CHD is chest pain or discomfort (often called angina), shortness of breath, tiredness, palpitations, and, in the most advanced situations, a heart attack (myocardial infarction). In most individuals, CHD can be asymptomatic, until it reaches an



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advanced risky stage, and therefore regular screening and early detection are important.

The main complications of CHD may be fatal. They include heart attacks, heart failure (inability of the heart to supply blood), arrhythmias (abnormal heartbeat), and sudden cardiac arrest. The diagnosis of CHD usually consists of a series of tests like electrocardiograms (ECG), stress tests, echocardiograms, angiography, and blood tests to determine lipid profiles and other cardiovascular markers.

Successful prevention and control of CHD need a multi-treatment approach. A low-fat, heart-healthy diet, high in fiber, fruits, and vegetables, forms the cornerstone. Physical activity, e.g., brisk walking or aerobic exercises, keeps cardiovascular fitness and ensures weight control. Keeping blood sugars under control in diabetic patients and hypertension in hypertensive individuals is also necessary. Smoking cessation and alcohol moderation lower risk by a great deal. For most, medications such as statins, beta-blockers, or aspirin are used to treat symptoms or halt advancement. In advanced cases, surgery such as angioplasty (to widen blocked arteries) or coronary artery bypass grafting may be required.

Specific dietary recommendations for heart health include the use of unsaturated fats such as olive oil and flaxseed oil, and the inclusion of omega-3-rich fatty fishlike salmon or mackerel. It is advisable to avoid red and processed meats, reduce intake of salt, sugar, and alcohol, and consume more soluble fiber from foods like oats, legumes, fruits, and vegetables, which help lower cholesterol.

2.4.5. Summary

At last, the life style diseases such as Type 2 Diabetes, Hypertension, Obesity, and CHD are closely linked and largely preventable through informed lifestyle and dietary choices. Therefore, promoting public health awareness, encouraging routine screenings, and fostering a culture of balanced nutrition, physical activity, and stress management are key strategies in reducing the global burden of lifestyle-related illnesses. Hypertension is a controllable but potentially fatal disease.



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Early detection by regular checks on blood pressure, and adherence to healthy lifestyle habits are crucial in curbing its impact on individuals and public healthcare systems.

Milk and milk products are an essential component of the human diet, offering a wide range of nutrients critical for growth, development, and health maintenance. Their inclusion helps build strong bones, support the immune system, and contribute to muscle health. Alongside, a clear understanding of food groups is fundamental for designing a balanced, wholesome, and diverse diet. Together, these concepts help the foundation of nutritional science and public health nutrition management.

The fat-soluble vitamins A, D, E, and K are essential for many physiological processes including vision, bone health, antioxidant protection, and blood coagulation. Monitoring intake through diet and healthcare guidance is crucial to maintain optimal health and prevent complications related to both deficiency and excess. Water-soluble vitamins such as Thiamine, Riboflavin, Niacin, Folate, Vitamin B₁₂, and Vitamin C are vital for maintaining a wide range of physiological processes, from energy metabolism to immune defense and neurological health.

These four minerals—calcium, iron, iodine, and zinc—are indispensable for maintaining structural integrity, physiological function, and metabolic health. Deficiencies can result in diverse health issues ranging from impaired growth, cognitive deficits, weakened immunity, to metabolic disorders, while excessive supplementation may also lead to adverse effects. Achieving a balanced intake through a diverse, nutrient-rich diet—alongside targeted supplementation when necessary—ensures optimal health and prevents both deficiency and toxicity risks.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

1. Which of the following water-soluble vitamins is primarily involved in carbohydrate metabolism?



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- a) Niacin
- b) Thiamine
- c) Riboflavin
- d) Folate

2. A deficiency of which vitamin leads to the condition called pellagra, characterized by dermatitis and dementia?

- a) Vitamin C
- b) Riboflavin
- c) Niacin
- d) Vitamin B₁₂

3. Which vitamin works closely with folate to regulate homocysteine levels and support red blood cell formation?

- a) Vitamin B₁
- b) Vitamin C
- c) Vitamin B₁₂
- d) Riboflavin

4. Wernicke-Korsakoff syndrome is associated with a severe deficiency of:

- a) Niacin
- b) Folate
- c) Thiamine
- d) Vitamin C

5. What is the main dietary source of Vitamin B₁₂?

- a) Leafy vegetables
- b) Whole grains
- c) Animal-derived foods
- d) Citrus fruits

6. Which disease is caused by a deficiency of niacin (Vitamin B₃)?

- a) Beriberi
- b) Pellagra
- c) Scurvy
- d) Rickets



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7. Which of the following is a common symptom of Vitamin B₁₂ deficiency?

- a) Night blindness
- b) Peripheral neuropathy and megaloblastic anemia
- c) Goiter
- d) Brittle bones

8. Which vitamin enhances the absorption of non-heme iron from plant-based foods?

- a) Vitamin B₆
- b) Vitamin A
- c) Vitamin C
- d) Vitamin D

9. Which mineral is essential for the synthesis of thyroid hormones?

- a) Iron
- b) Calcium
- c) Zinc
- d) Iodine

10. Which water-soluble vitamin deficiency can cause the disease beriberi?

- a) Vitamin C
- b) Thiamine (Vitamin B₁)
- c) Riboflavin (Vitamin B₂)
- d) Folate (Vitamin B₉)

Answer Keys: 1.b) Thiamine,2.c) Niacin,3.c) Vitamin B₁₂, 4.c) Thiamine,5. c) Animal-derived foods,6. b) Pellagra,7. b) Peripheral neuropathy and megaloblastic anemia,8.c) VitaminC,9. d) Iodine,10. b) Thiamine (VitaminB₁)

B. Short Answer Questions

1.Explain the two types of beriberi and the Vitamin B₁₂ systems they affect.

2. Why are water-soluble vitamins required daily in the diet?



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3. What are the symptoms of megaloblastic anemia caused by folate deficiency?

4. Name three good dietary sources of Vitamin C.

5. Write different Fat soluble and water-soluble vitamins.

C. Long Answer Questions

1. Explain the various functions of carbohydrates in the human body, including their role in energy production, protein-sparing action, and fat metabolism.

2. Describe the classification and dietary sources of lipids, including saturated fats, unsaturated fats (MUFA and PUFA), trans fats, and essential fatty acids.

3. Differentiate between simple and complex carbohydrates in terms of their structure, digestion, energy release, and nutritional benefits.

4. Elaborate on the structural, hormonal, and vitamin-related functions of lipids in the human body.

5. Write short notes about Vitamins.

Module-3 Food Adulteration

Objectives

Food adulteration refers to the deliberate addition, substitution, or removal of components in food, typically driven by the goal of gaining economic advantage (e.g., increasing volume, reducing costs, or hiding inferior quality). To ensure Consumer Safety & Protect Public Health. The foremost objective is to prevent health hazards arising from contaminated or compromised food products—whether they contain harmful chemicals, unhygienic ingredients, or toxic adulterants.

By preventing fraud and deception, authorities aim to uphold consumer rights and ensure that consumers get what they pay for. This fosters honest commerce and discourages economically motivated adulteration.

Unit-3.1.PFA definition of food adulteration

3.1.1. Food adulteration

It refers to the deliberate alteration or contamination of food articles that reduces their quality or endangers consumer health. Under the Prevention of Food Adulteration Act, 1954 (PFA Act), Section 2(ia) defines an article as adulterated if it fails to meet the nature, substance, or quality expected by the buyer; contains harmful substances; substitutes cheaper ingredients; or has valuable elements extracted, thereby deceiving or harming the consumer. The law further includes food prepared in unsanitary conditions, infested with insects or obtained from diseased animals, or containing non-prescribed additives like illegal colours or preservatives, even if not overtly harmful. Adulteration may also occur through misleading labelling or misrepresentation of identity or origin, termed misbranding under the Act.

Types and Motivations Behind Food Adulteration

Adulteration generally falls into three categories:

- Intentional adulteration, often for economic gain, such as adding starch or water to milk or mixing cheap oils into ghee.



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- Incidental adulteration, arising from unhygienic processing or storage conditions.
- Metallic adulteration, from accidental contamination with metals during processing.

Common adulterants include starch in paneer, chalk or rice flour in turmeric, synthetic dyes in sweets, and cheap oils in mustard oil or ghee. The motives are typically unethical shortcuts to increase volume, reduce costs, and enhance visual appeal rather than genuine preservation or safety.

Health Implications and Public Concern: Adulterated food can harm health via toxic additives, nutrient dilution, bacterial contamination, or allergic reactions. Examples include synthetic dyes causing health issues, water-diluted milk, or rancid oils. These not only compromise nutrition but can lead to poisoning, weakened immunity, and chronic illnesses. High-profile scandals—like melamine in powdered milk or artificial colours in pani puris—underscore the seriousness of the problem.

3.1.2. Regulatory Mechanisms and Enforcement under PFA Act

The PFA Act seeks to prevent adulteration, protect public health, and ensure fair trade practices through defined standards and penalties Advocate. Enforcement is carried out by Food Safety Officers who may inspect manufacturing sites, collect food samples, and seize adulterated goods. These officers can function with the same authority as law enforcement personnel under India's CrPC. Samples are analyzed in accredited laboratories using chemical, microbiological, physical, and nutritional testing methods to determine authenticity and safety. Legal action is taken based on lab reports; magistrates can impose fines or imprisonment up to six years depending on severity.

Role of Consumers & Real-world Enforcement: The PFA Act empowers consumers to report suspected adulteration cases and get food samples tested under Section 40 of the FSS Act, continuing the principle found in the original PFA Act In Rajasthan, for instance, over 3,400 inspections conducted recently led to 489 convictions against



adulterators in just one quarter, reflecting strong enforcement efforts. Yet, many cases remain pending, highlighting enforcement gaps.

Case Examples & Preventive Measures: Adulteration in spices remains a serious issue. In Delhi, raids uncovered 15 tons of fake spices made from sawdust, rotten grains, and chemicals sold at regular prices—posing extreme health hazards. Similarly, ghee adulteration is commonly detected through specialized tests (e.g., mineral oil assays, melting point analysis) to identify imitation vanaspati or artificial colors.

Central regulatory authorities like FSSAI, operating under the Food Safety and Standards Act, 2006, now enforce national food safety standards. The PFA Act is subsumed under FSSAI's regulatory framework, which includes updated sampling protocols, lab accreditation, and civic awareness initiatives. community awareness, these efforts can significantly reduce adulteration and protect food safety in India.

3.1.3. Adulterants in commonly consumed food items

Adulterants are undesirable or harmful substances added to food items deliberately or unintentionally to increase quantity, improve appearance, or reduce production costs. These substances reduce food quality, endanger health, and are a serious violation under the Food Safety and Standards Act (FSSA), 2006.

Adulterants can be broadly categorized into:

- a. Intentional Adulterants – added knowingly to increase profit. Examples: chalk powder in flour, water in milk, starch in ghee.
- b. Incidental Adulterants – due to negligence or poor hygiene. Examples: pesticide residues, rodent droppings, metal particles.
- c. Metallic Contaminants – harmful metals introduced via processing equipment or environment. Examples: arsenic, lead, mercury, tin.

Table.3.1. Common Adulterants in Everyday Food Items

Food Item	Adulterant	Purpose	Health Hazards
Milk	Water, starch, detergent	Increase volume or thickness	Gastrointestinal issues, infections



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Tea leaves	Iron fillings, used tea dust	Imitate fresh tea	Digestive problems, kidney damage
Sugar	Washing soda	Whitening	Stomach disorders, ulcers
Salt	White powdered stone	Increase weight	Kidney stones, hypertension
Turmeric powder	Lead chromate	Enhance colour	Cancer risk, anaemia, brain damage
Red chili powder	Brick powder, salt powder	Increase bulk/colour	Stomach ulcers, liver damage
Coriander powder	Sawdust	Increase weight	Digestive tract damage
Mustard seeds	Argemone seeds	Mixed for cost cutting	Dropsy
Edible oils	Mineral oil, castor oil	Increase volume	Heart and liver toxicity
Ghee/Butter	Vanaspati, starch	Falsify purity	Cardiac issues, poor digestion
Ice cubes	Non-potable water	No cost for clean water	Waterborne diseases (typhoid)
Honey	Glucose or sugar syrup	Increase sweetness	Diabetes risk, impurity
Wheat flour	Chalk powder	Increase weight/whiteness	Digestive system damage
Pulses (masoor)	Polished with stones/color	Appearance improvement	Indigestion, toxicity
Green vegetables	Malachite green	Color enhancement	Carcinogenic, affects liver and kidney
Fruits vegetables	Wax, calcium carbide	Artificial ripening	Cancer risk, nervous system damage

Health Effects of Food Adulteration

- Short-term: Vomiting, diarrhoea, abdominal pain, dizziness.
- Long-term: Cancer, kidney and liver failure, heart disease, reproductive issues, neurotoxicity, and weakened immunity.
- Children and pregnant women are especially vulnerable.

Table.3.2. Simple Detection Tests at Home (Examples)

Adulterant	Test
Water in milk	Drop of milk on smooth surface – if flows, it's diluted
Starch in milk/ghee	Add iodine – blue colour indicates starch



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Chalk in flour	Add vinegar – effervescence (fizz) indicates chalk
Lead in turmeric	Add water and shake – yellow colour settles with foam on top
Brick powder in chili	Mix in water – brick settles at the bottom
Argemone in mustard	Use microscope – argemone seed has different structure

Prevention & Control Measures:

1. Buy from trusted sources – branded, certified, sealed packets.
 2. Check FSSAI logo – ensures regulatory compliance.
 3. Avoid roadside/open food items – particularly dairy, oils, and juices.
 4. Look for unnatural color or texture – overly shiny or bright foods may be adulterated.
 5. Spread awareness – among families, communities, and schools.
 6. Report to authorities – Food Safety Department or via FSSAI's Food Safety Connect App.
- #### Legal Provisions
- a. Governed under the Food Safety and Standards Act (FSSA), 2006.
 - b. Adulteration is a punishable offense, with imprisonment and fines.
 - c. FSSAI (Food Safety and Standards Authority of India) oversees safety standards, quality checks, and enforcement actions.

Food adulteration is a widespread public health concern that involves the deliberate addition of inferior, harmful, or non-edible substances to food items to increase quantity or enhance appearance, often at the cost of safety and nutrition. One of the most commonly adulterated foods is milk, which may contain water, detergent, starch, or even urea—all of which compromise its nutritional value and may cause gastrointestinal or kidney issues.

Similarly, grains and cereals may be adulterated with sand, stones, husks, particles to make them weightier, causing choking and gastrointestinal issues. Pulses are usually polished using dangerous dyes such as lead chromate or blended with Kesari dal, the latter



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associated with a crippling condition known as lathyrism. Spices, particularly powdered ones, are regularly contaminated with harmful chemicals such as methanal yellow in turmeric, brick powder in chili powder, and sawdust in coriander, all of which carry cancer and stomach-related hazards. Not even tea and coffee are exempted—used leaves colored and added with iron filings in tea or tamarind seed powder in coffee decrease their quality and cause gastrointestinal problems. Vegetables and fruits might look artificially fresh because during the process of ripening, chemical dyes such as malachite green or ripening chemicals such as calcium carbide, both of which are poisonous and contribute to ulcers and cancer, are used. Sugar and salt can be adulterated with chalk powder or borax, which are poisonous when consumed in the long run. For honey, adulteration with jaggery syrup or sugar syrup lowers its medicinal value and creates dangers for diabetic patients. Ghee and oils commonly find their adulterants in vanaspati, animal fat, or mineral oils, which harm the liver and increase cholesterol. Ice cream and aerated drinks might contain non-food articles like washing powder or colors, causing ulcers, throat infections, and poisoning.

The health impact of eating contaminated food can be dramatic, ranging from food poisoning, organ damage, and neurological disorders to cancer, hormonal imbalance, and impaired immunity. In order to defend oneself, the consumer needs to remain vigilant, employ simple home tests to identify adulterants, opt for certified products, and shun suspiciously cheap or suspect foodstuffs. Government laws, strict enforcement of food safety, and public awareness are essential to fight against the pernicious practice of food adulteration and provide all access to safe and nutritious food.

3.1.4. Accidental Food Contamination

Accidental food contamination refers to the unintentional presence of harmful biological or chemical agents in food, which can cause illness when consumed. Unlike intentional adulteration, which is driven by economic motives or deception, accidental contamination often arises from environmental factors, mishandled food, poor hygiene, or



inadequate storage and processing. Three of the most serious and well-documented forms of accidental food contamination include botulism, staphylococcal food poisoning, and aflatoxin intoxication. Each involves distinct pathogens or toxins with unique mechanisms of action, clinical presentations, and prevention strategies. This write-up explores each in depth—covering etiology, contamination sources, pathophysiology, symptoms, diagnostics, treatment, prevention, and public health implications.

3.1.4.1. Botulism: The Silent Killer

Etiology and Toxin: Botulism is caused by toxins produced by the bacterium *Clostridium botulinum*, a spore-forming anaerobe commonly found in soil and aquatic environments. Under low-oxygen, low-acid, and room-temperature conditions, especially within improperly canned or packaged foods (e.g., home-canned vegetables, fish, and cured meats), the spores germinate and produce neurotoxin types A, B, E, or F.

Mechanism of Action: The toxin blocks the release of acetylcholine at neuromuscular junctions, leading to flaccid paralysis. This toxin is among the most potent in nature—it takes only nanogram quantities to cause severe harm.

Clinical Presentation: Symptoms manifest typically 12–36 hours post-consumption and include blurred vision, drooping eyelids, dry mouth, difficulty swallowing, and generalized muscle weakness. If untreated, paralysis can progress to respiratory failure. Infant botulism presents with lethargy, poor feeding, constipation, and "floppy baby" syndrome.

Diagnosis and Treatment: Diagnosis relies on clinical signs and detection of toxin in serum, stool, or food samples. Immediate administration of antitoxin is critical for neutralizing circulating toxin. Supportive care, especially via mechanical ventilation, may be required. Recovery takes weeks to months, and although rare, mortality can be high if not treated promptly.

Prevention: Safe canning practices—proper sterilization and acidity control—are essential. Foods susceptible to botulism must be



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refrigerated or boiled before consumption. Public education about home food preservation methods significantly reduces risk.

3.1.4.2. Staphylococcal intoxication

This condition is caused by ingestion of pre-formed enterotoxins produced by *Staphylococcus aureus*. The bacterium originates from human carriers—often on the skin, nasal passages, or in infected cuts. When food is contaminated and left at room temperature, the bacteria proliferate and produce heat-stable toxins. Foods Involved: Common culprits include dairy products, egg-based salads, meats, poultry, cream-filled pastries, and other perishable items that are handled extensively and stored improperly.

Clinical Features: The onset of symptoms is rapid—typically 1–6 hours post-ingestion—and includes intense nausea, abdominal cramps, vomiting, and sometimes diarrhea. Fever is uncommon. Although the illness is generally self-limiting (lasting 24–48 hours), symptoms can be severe and uncomfortable.

Diagnosis and Management: Diagnosis is clinical, supported by detection of enterotoxin in leftover food. Treatment is primarily supportive—replenishing fluids and electrolytes. Antibiotics are not indicated unless there is a secondary infection.

Prevention: Preventive strategies include maintaining strict food hygiene, proper refrigeration, avoiding handling food when ill, and educating food handlers about cross-contamination. The heat-stable nature of the toxin means that cooking contaminated food will not make it safe.

3.1.4.3. Aflatoxin Intoxication

Source and Organism: Aflatoxins are potent mycotoxins produced by *Aspergillus flavus* and *Aspergillus parasiticus*, which are common fungi in warm, damp climates. They thrive on improperly stored grains, peanuts, and tree nuts.

Types and Risk: Aflatoxin B₁ is the most toxic and is classified by the IARC as a Group 1 human carcinogen. It can also contaminate animal feed, leading to accumulation in the tissues, milk, and eggs of livestock—a pathway to human exposure.



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Mechanism of Toxicity: Toxicity of aflatoxin mechanism involves liver damage leading to acute toxicity with hemorrhage, edema, fatty change, and necrosis. There is a strong association of chronic exposure with hepatocellular carcinoma. Aflatoxin exerts its action through the formation of DNA adducts and mutations in tumor suppressor genes such as p53.

Clinical Presentations: Acute aflatoxin toxicity (aflatoxicosis) is rare and has a presentation of liver failure, jaundice, vomiting, and severe abdominal pain with high mortality. Chronic exposure can result in liver damage, immune suppression, growth retardation in children, and cancer risk.

Diagnosis and Management: It can be done by testing food/feed samples and biomarkers like aflatoxin-albumin adducts in serum or aflatoxin M₁ in urine. Treatment is mostly supportive; in chronic cases, participation in early cancer detection and liver care is important.

Prevention: It is centered on minimizing fungal development through proper drying, storage, and handling of crops to ensure moisture control. Strict application of good agricultural practices, including timely harvesting, grain cleaning, application of fungicidal agents or biocontrol measures, is critical. Enforcement of aflatoxin levels in food products by regulatory bodies and public awareness efforts assist in minimizing health risks.

Surveillance and Outbreak Response: Surveillance mechanisms of the public health system need to be strong enough to detect and respond to outbreaks of botulism, staphylococcal poisoning, and aflatoxin contamination. Confirmation testing, early reporting, and trace-back studies are essential for preventing outbreaks from spreading and causing maximum harm.

Education and Training: Awareness among food handlers, farmers, and consumers about safe food handling, proper storage, and early detection of contamination is essential. Training schemes and drives are necessary for minimizing the occurrence of accidental contamination.



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Government agencies enforce standards for food safety—such as HACCP, GMP, and Good Storage and Collection Practices (GSCP). They also publish maximum permitted levels of toxins and require testing and certification for high-risk commodities.

Global Health Initiatives: International collaborations through organizations like the WHO and FAO support harmonized standards, capacity building, and resource sharing. These efforts are crucial in controlling mycotoxin contamination in vulnerable regions.

3.1.5. Importance of food labels in processed foods and nutritional labelling

In today's fast-paced world, where processed and packaged foods have become a staple in many households, food labels serve as a crucial tool for consumers to make informed dietary choices. Food labels are legally mandated displays on packaging that provide information about the product's ingredients, nutritional value, origin, manufacturing details, and storage instructions. These labels help consumers identify the quality, safety, and nutritional content of the food they are purchasing, thus enabling better health decisions. With the rise of diet-related diseases like obesity, diabetes, hypertension, and heart disease, the importance of food labelling—especially nutritional labelling—has grown significantly in both public health and consumer behavior.

3.1.6. Purpose and Components of Food Labels: It serve several essential purposes. Primarily, they offer transparency between food manufacturers and consumers. The front and back of a food package typically include key components such as the product name, net weight, manufacturing and expiry dates, batch number, ingredient list, allergen information, and nutritional facts. Additional information may include usage instructions, storage guidelines, and certifications like FSSAI (in India), FDA (in the U.S.), organic or vegan labelling, and vegetarian/non-vegetarian symbols.

One of the most critical elements of food labelling is the ingredient list, which is presented in descending order by weight. This helps consumers identify what is primarily present in the product and detect the presence of additives, preservatives, or potential allergens like



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peanuts, gluten, or soy. Expiry and “Best Before” dates ensure the food is consumed within its safe usage period, helping to prevent foodborne illnesses.

3.1.7. Nutritional Labelling: It is a standardized declaration of the energy content and key nutrients per serving or per 100 grams/milliliters of a food product. It typically includes values for calories (energy), protein, total fats, saturated fats, trans fats, carbohydrates, sugars, dietary fiber, sodium, and sometimes cholesterol, vitamins, and minerals. This information is especially important for people managing specific health conditions such as diabetes (needing sugar content), hypertension (concerned about sodium levels), or high cholesterol (watching saturated and trans fats).

Nutritional labels help individuals compare products and select those that align with their dietary needs. For instance, someone looking to lose weight might look for low-calorie or high-fiber options, while an athlete might prefer higher protein content. Labels also assist vegetarians or those on restricted diets (such as low-sodium or gluten-free diets) in making safe choices.

Health Benefits and Consumer Empowerment: One of the key benefits of food labelling is consumer empowerment. Knowledge of what is in a product allows consumers to avoid harmful additives, reduce intake of unhealthy ingredients, and make healthier choices. For instance, a consumer may avoid a snack with high trans-fat or sugar by simply comparing two similar items on the shelf. It also encourages portion control, as serving size information helps in managing calorie intake.

Furthermore, nutritional labelling supports public health initiatives by creating awareness of dietary risks and promoting healthier eating habits. Countries that enforce front-of-pack (FOP) labelling systems—such as color-coded traffic light labels or health star ratings—report better consumer understanding and improved dietary behaviours. Labels can influence reformulation of products by manufacturers who reduce salt, sugar, or fat to meet nutritional standards or gain consumer trust.



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3.1.8. Legal and Regulatory Aspects: Most countries have regulatory authorities that set standards for food labelling. In India, the Food Safety and Standards Authority of India (FSSAI) mandates clear labelling under the Food Safety and Standards (Packaging and Labelling) Regulations. In the United States, the Food and Drug Administration (FDA) oversees food labelling, while in Europe, it's governed by the European Food Safety Authority (EFSA). These organizations define labelling requirements to ensure consistency, accuracy, and consumer protection.

Misleading or false labelling is a serious offense and can result in fines, product recalls, or bans. For example, falsely advertising a food as “sugar-free” or “low-fat” without meeting criteria is considered deceptive. Regulatory oversight is essential to ensure labels remain truthful, standardized, and beneficial to consumers.

Challenges and Limitations: Despite their usefulness, food labels face several challenges. Not all consumers understand or read nutritional labels due to lack of awareness, literacy, or interest. Misleading marketing claims—like “natural,” “light,” or “immune-boosting”—can distract or misguide buyers if not backed by factual nutritional information. Moreover, font sizes, scientific terms, or overly complex formats can hinder easy interpretation, especially among older adults or people with visual impairments.

There is also the issue of serving size manipulation, where a manufacturer may list nutrition facts based on unrealistically small portions to make the product seem healthier. Ongoing efforts are needed to improve label design and increase consumer education on interpreting food labels accurately.

3.1.9. Summary

Food adulteration refers to the deliberate or accidental addition of harmful or inferior substances to food, compromising its quality and endangering health. Common forms include intentional adulteration for economic gain, incidental due to poor hygiene, and metallic contamination. Health impacts range from digestive issues to cancer. The PFA Act (1954) and FSSAI under the FSSA (2006) regulate and



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enforce food safety standards. Consumers can report adulteration and perform simple home tests to detect contaminants like starch, chalk, or dyes. Accidental food contamination, including botulism, staphylococcal poisoning, and aflatoxin toxicity, also poses serious health threats. Food labelling, including ingredient lists and nutritional information, plays a vital role in empowering consumers to make informed dietary choices. Regulatory authorities like FSSAI, FDA, and EFSA ensure truthful, accurate labelling to promote public health and prevent misleading claims.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

1.Which of the following is an intentional adulterant?

- a) Pesticide residue
- b) Lead from processing machinery
- c) Water added to milk
- d) Insect larvae in grains

2.Botulism is caused by which organism?

- a) Staphylococcus aureus
- b) Clostridium botulinum
- c) Aspergillus flavus
- d) Escherichia coli

3.Which food item is commonly adulterated with Argemone seeds?

- a) Tea
- b) Mustard seeds
- c) Sugar
- d. Wheat flour

4.Which of the following is NOT typically found on a food label?

- a) Batch number
- b) Manufacturing date
- c) Farmer's name



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d) Nutritional information

5.What is the main health risk associated with aflatoxins?

- a) Heart disease
- b) Neurological disorders
- c) Liver cancer
- d) Diabetes

Answer keys: 1.c) Water added to milk,2. b) Clostridium botulinum,3. b) Mustard seeds,4. c) Farmer's name,5. c) Liver cancer

B. Short Answer Questions

- 1.What is the role of FSSAI in food safety?
2. Name two simple home tests to detect food adulteration.
3. What are the three main types of food adulteration?
- 4.What are the types of accidental food contamination?
- 5.Write about the nutritional labelling.

C.Long Answer Questions

- 1.Explain the health hazards of food adulteration and give examples of adulterants with their effects.
2. Discuss the key components and importance of food labelling in promoting consumer health.
3. Describe accidental food contamination with examples and outline its prevention.
- 4.Write short notes on Aflatoxin.
- 5.Define food adulteration with characteristics

Unit-3.2. Food Laws, Regulations, and Standards

3.2.1. Food laws, regulations, and standards: These are essential to ensure the safety, quality, and integrity of food from production to consumption. These legal frameworks protect consumers from unsafe or adulterated food and help maintain fairness in international food trade. They define the rights and responsibilities of food producers, processors, and regulators, and also provide a foundation for food inspection, labeling, and enforcement mechanisms. Two significant pillars in this field are the Codex Alimentarius and the Prevention of Food Adulteration (PFA) Act in India.

The Codex Alimentarius, meaning "Food Code" in Latin, is a collection of internationally recognized standards, guidelines, and codes of practice related to food safety and quality. It was established in 1963 by two United Nations bodies: the Food and Agriculture Organization (FAO) and the World Health Organization (WHO) through the Codex Alimentarius Commission (CAC). Objectives of Codex Alimentarius:

1. Protect consumer health by setting minimum safety standards.
2. Ensure fair practices in international food trade.
3. Promote food quality and hygiene standards globally.
4. Provide a reference for countries in formulating national food standards.

Scope of Codex Standards are Codex covers a wide range of areas including:

- Maximum residue limits (MRLs) for pesticides and veterinary drugs
- Food labelling and packaging requirements
- Hygiene and food safety practices (e.g., HACCP)
- Contaminant limits (like heavy metals, aflatoxins)
- Food additives and preservatives
- Nutrition and health claims

These standards are voluntary, but they hold major legal weight under the World Trade Organization (WTO) agreement on Sanitary and Phytosanitary (SPS) Measures. Many countries, including India, use



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Codex standards as a benchmark for domestic regulations and to resolve trade disputes.

3.2.2. Prevention of Food Adulteration (PFA) Act, 1954 – India

The Prevention of Food Adulteration (PFA) Act, 1954, was India's pioneering legislation designed to combat food adulteration by defining adulteration, prescribing standards, and enforcing penalties. It broadly defined adulteration as the addition of inferior or harmful substances, mislabeling of ingredients, or omission of requisite elements, all aimed at deceiving consumers or harming public health. The Act banned unsafe additives and colorants, set hygiene norms, and required labs to test for adulterants. Empowered food inspectors and public analysts had authority to seize suspected products and conduct prosecutions in specialized food courts. Penalties included hefty fines and imprisonment for contaminants posing health risks. While the PFA was a critical step in regulating food purity and was enforced variably across states, it faced limitations such as fragmented jurisdiction, outdated standards, and weak penalties. Its eventual merger into the Food Safety and Standards Act (FSSA), 2006 under the newly established Food Safety and Standards Authority of India (FSSAI) enabled modernization with a unified regulatory framework, risk-based inspections, and national-level standardization.

The Prevention of Food Adulteration (PFA) Act, 1954, was India's primary food safety law before the establishment of the Food Safety and Standards Act (FSSA), 2006. It aimed to protect consumers from unsafe and impure food by prohibiting the manufacture, sale, and distribution of adulterated or misbranded food. Key Features of the PFA Act:

1. **Definition of Adulteration:** The act clearly defined what constituted adulterated food, including mixing inferior substances, using unsafe additives, or selling decomposed or contaminated food.
2. **Standards for Food Products:** The PFA established minimum quality standards for various foods to ensure safety and prevent fraud.

3. **Enforcement:** The Act empowered food inspectors and public analysts to take samples, conduct laboratory testing, and prosecute offenders in food courts.
4. **Penalties:** Violation of the Act could lead to fines, product seizures, or imprisonment, especially in cases of harmful adulteration.
5. **Labelling and Hygiene Regulations:** The PFA required proper food labelling and set rules for cleanliness in food manufacturing and selling practices. Despite its strong intentions, the PFA Act had several limitations:
 - It was fragmented and outdated, with multiple amendments and overlaps with other food laws.
 - Enforcement varied across states, leading to inconsistent implementation.
 - It did not integrate modern scientific approaches like risk-based inspection or international harmonization.

Because of these challenges, the Food Safety and Standards Act (FSSA), 2006, was introduced to consolidate various food laws and establish the Food Safety and Standards Authority of India (FSSAI) as the central authority for food regulation.

Table.3.2. Codex vs. PFA: A Comparison

Feature	Codex Alimentarius	PFA Act (India)
Origin	International (FAO & WHO)	National (India)
Focus	Global food safety and trade	Prevention of food adulteration in India
Nature	Voluntary (but referenced in trade)	Mandatory law
Enforcement	Not enforced directly; advisory in nature	Enforced through legal provisions in India
Replaced By	Still active globally	Replaced by FSSA, 2006 in India

3.2.3. Agmark (Agricultural Marketing Act, 1937)

Agmark, under the Agricultural Produce (Grading and Marking) Act of 1937, is India's premier certification system for agricultural produce, administered by the Directorate of Marketing and Inspection (DMI)



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under the Ministry of Agriculture. It sets quality benchmarks in fields such as pulses, cereals, oils, spices, milk products, honey, and vermicelli—benefitting farmers, consumers, and exporters by ensuring consistent product quality and fair pricing. The Agmark label, which is voluntary for most items but mandatory for certain exports, signifies adherence to grading standards based on criteria like moisture content, purity, and permissible levels of contaminants, including pesticide residue and aflatoxin. Certified products are graded—Good, Better, best—helping consumers and traders make informed choices. Agmark labs nationwide conduct chemical, microbiological, and residue testing, fostering transparency in the agricultural supply chain. Although voluntary, Agmark certification enhances marketability and trust, and protection under law ensures misuse of the label can invite penalties.

3.2.4. Fruit Products Order (FPO), 1955

The Fruit Products Order (FPO), instituted under the Essential Commodities Act, 1955, governs the processing, packaging, labeling, and sale of fruit and vegetable products, with the ministry overseeing through the Directorate of Fruit & Vegetable Processing. Mandatory licensing under FPO ensures that units producing jams, jellies, squashes, pickles, dehydrated produce, and bottled juices meet hygiene, equipment, water quality, and processing standards. The FPO label—oval with hanging strips—is required on all products, serving as a guarantee of manufacturing in clean, inspected premises dedicated to food-safe production. It also mandates traceability through batch codes, prohibits misleading claims on health and nutritional superiority, and restricts additives, preservatives, and heavy metal levels to safe thresholds. The FPO is administered by regional offices and the Central Fruit Advisory Committee, which revises standards to align with international norms and facilitate export trade. It was made legally compulsory in 2006, aligning with the FSSAI's integrated regulatory framework.

Together, the PFA Act, Agmark, and FPO form a comprehensive regulatory matrix safeguarding food quality and consumer welfare in India. While the PFA Act laid the foundational groundwork against



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adulteration in all food products and has now been absorbed within a modern framework under FSSAI, Agmark regulates agricultural commodity quality and grading for bulk trade, and the FPO ensures processed fruit products meet stringent safety norms. Each scheme addresses a specific segment: PFA covers general food safety; Agmark promotes agricultural produce standards; FPO ensures processed fruit/vegetable food safety. These regulations, supported by active enforcement through inspections, testing, labeling, and public education, protect consumers from unsafe or misleading food practices. Although voluntary in some areas, certification marks like Agmark and FPO foster consumer trust, trade transparency, and compliance with global trade requirements. In combination, these regulatory systems contribute to robust food safety, equitable markets, and healthier nutritional outcomes in India.

3.2.5. Meat Products Order (MPO)

The Meat Products Order (MPO), 1973, instituted under the Food Safety and Standards Act (formerly under the Essential Commodities Act), regulates the production, storage, distribution, and labelling of meat and meat products in India. It mandates that all meat processing establishments must obtain MPO licenses before operating. These licenses ensure compliance with prescribed hygiene norms, processing practices, and packaging standards. The order covers a variety of processed meats—including sausages, meatloaf, kebabs, and bacon—requiring strict control of slaughtering procedures, chilling, temperature, additives, preservatives, and sanitation. Labels must include product type, ingredients, weight, and manufacturer details, ensuring transparency and traceability. The MPO aims to protect consumers from unsafe meat products, reduce foodborne illnesses, and support the meat industry's compliance with quality standards.

3.2.6. Bureau of Indian Standards (BIS)

The Bureau of Indian Standards (BIS), established by the BIS Act, 2016, serves as India's national standards body for a wide range of products, including select food items and inputs used in food



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production. BIS issues voluntary ISI quality marks for packaged food products, such as milk powders, infant formula, and packaged drinking water, under mandates like the Food Safety and Standards (Prohibition and Restriction on Sales) Regulations, 2011. BIS also serves as an FSSAI-recognized auditing agency for food processing facilities, assessing compliance with Good Manufacturing Practice and Hazard Analysis Critical Control Point (HACCP) schemes. Effective BIS certification offers assurance of product quality, building consumer trust, and meets regulatory requirements in both domestic and export markets.

3.2.7. Meat and Meat Products Order (MMPO)

The Meat and Meat Products Order (MMPO), introduced in 1973 under the Essential Commodities Act, 1955 and now governed by the Food Safety and Standards Act (FSSA), 2006, is a key regulatory framework aimed at ensuring the safety, hygiene, and quality of meat and meat products in India. MMPO applies to all meat processing units, including those producing sausages, kebabs, bacon, salami, meatloaf, and frozen or ready-to-eat items. Its primary objectives include standardizing meat production, ensuring public health through regulated hygiene and slaughter practices, mandating licenses for all meat processors, and enforcing proper labelling and packaging. The order covers critical aspects such as slaughtering standards, chilling and freezing temperatures (0–7°C for chilled meat and –18°C or lower for frozen), and permissible use of food additives within limits set by FSSAI. Facilities must source meat from healthy animals, maintain strict sanitation protocols, and ensure personal hygiene of workers.

Labelling is mandatory and must include product name, ingredients, net weight, manufacturing and expiry dates, storage and cooking instructions, and manufacturer details to ensure traceability. Regulatory oversight is provided by FSSAI, along with state food safety departments, and MMPO licensing is integrated within FSSAI's Food Business Operator system. Non-compliance can result in suspension of licenses, product seizures, legal penalties, or bans on sales and exports. For export markets, MMPO aligns with international standards like



Codex Alimentarius and OIE to ensure global quality benchmarks are met. Overall, MMPO plays a vital role in protecting consumer rights, supporting meat industry regulation, and ensuring that meat products are safe, hygienic, and correctly labelled throughout the supply chain.

3.2.8. Food Safety and Standards Authority of India (FSSAI)

The Food Safety and Standards Authority of India (FSSAI), established under the Food Safety and Standards Act, 2006, serves as the central regulator for all food categories, including meat products, MPO/MMPO, and BIS-certified food items. It sets uniform national standards—covering food additives, packaging, labelling, contaminants, and processing guidelines—through regulations such as the Food Products Standards and Food Additives Regulations, 2011. FSSAI enforces licensing and registration of all food businesses, including meat processors, granting MPO/MMPO license as part of an integrated framework under FSSAI and UPSC news. It mandates scientific risk-based standards, accredits food testing laboratories, promotes capacity-building, and conducts surveillance to ensure food safety across the supply chain

Under the overarching framework of FSSAI, the Meat Products Order and Meat and Meat Products Order ensure meat safety and standardization, while BIS offers certification and auditing for product quality and food facility compliance. This synergistic approach helps uphold food safety, protect consumer health, and instill confidence in both domestic and global markets.

3.3. Summary

At last accidental contamination from botulism, staphylococcal toxins, and aflatoxins represents significant global food safety challenges. Each type of contamination arises from different sources and mechanistic pathways, causing distinct illnesses ranging from acute poisoning to chronic liver disease and cancer. Prevention through knowledge, safe food practices, effective regulation, and rapid public health response is essential for mitigating risk. Ensuring food safety remains a cornerstone of public health—only with coordinated efforts



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at the individual, community, and regulatory levels can we protect populations from the hazards of accidental food contamination.

Food labels, especially nutritional labelling, are indispensable tools for promoting health, safety, and informed decision-making in the modern food landscape. As consumers face an overwhelming array of processed and packaged foods, labels offer vital guidance on what goes into their bodies. With rising concerns about lifestyle diseases, the ability to understand and use food labels effectively can lead to improved nutrition, better health outcomes, and reduced healthcare costs. It is therefore imperative that both consumers and producers prioritize transparency and education in food labelling practices. Strengthening regulatory frameworks, simplifying label design, and spreading public awareness are key strategies to maximize the benefits of food labels and build a healthier society.

Food adulteration undermines trust, endangers health, and exploits consumers. The PFA Act provides clear legal definitions and enforcement mechanisms to combat this issue. However, effective action requires adequate manpower, modern testing labs, public education, and swift legal adjudication. Empowering consumers via reporting rights and incorporating whistle-blower recognition are further steps to reinforce prevention. Public awareness, regular food testing, strong laws, and responsible consumer behavior are key to eliminating adulteration and ensuring food safety in our everyday lives. Choosing branded and certified products, avoiding suspiciously low-priced goods, and staying informed are effective ways to safeguard one's health from the dangers of food adulteration.

Food laws and standards like the Codex Alimentarius and the PFA Act have played critical roles in shaping safe food systems globally and nationally. While the Codex provides a universal framework for food quality and safety, the PFA Act was India's pioneering step toward consumer protection against food adulteration. Although the PFA has now been replaced by a more integrated law (FSSA), its historical importance and contribution to food safety regulation remain significant. With growing concerns around food fraud, chemical



contamination, and international food trade, robust laws and harmonized standards are more important than ever to ensure public health, build consumer trust, and support sustainable food systems.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

1. Which regulatory framework currently governs the Meat and Meat Products Order (MMPO)?

- a) Essential Commodities Act, 1955
- b) Prevention of Food Adulteration Act, 1954
- c) Food Safety and Standards Act, 2006
- d) Agricultural Produce (Grading and Marking) Act, 1937

2. Which of the following is a common adulterant in turmeric powder?

- a) Brick powder
- b) Lead chromate
- c) Urea
- d) Methanal yellow

3. The term "floppy baby syndrome" is associated with which foodborne illness?

- a) Staphylococcal food poisoning
- b) Botulism
- c) Aflatoxicosis
- d) Salmonellosis

4. What is the primary certification authority for agricultural produce in India?

- a) FSSAI
- b) BIS
- c) DMI (Agmark)
- d) FDA

5. Which toxin is heat-stable and remains even after cooking?

- a) Botulinum toxin
- b) Aflatoxin B1



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c) Staphylococcal enterotoxin

d) Listeria monocytogenes

6. Which of the following has replaced the Prevention of Food Adulteration (PFA) Act in India?

a) Agmark

b) Fruit Products Order (FPO)

c) Food Safety and Standards Act (FSSA), 2006

d) Bureau of Indian Standards (BIS) Act, 2016

7. What does the Agmark certification primarily apply to?

a) Processed fruit products

b) Agricultural produce like grains, oils, and spices

c) Packaged meat products

d) Bottled drinking water

8. Which international organization is responsible for Codex Alimentarius standards?

a) WTO and UNDP

b) WHO and FAO

c) WHO and UNICEF

d) FAO and UNEP

9. What is a key limitation of the PFA Act mentioned in the document?

a) It lacked penalties for adulteration

b) It had strong scientific backing

c) It enforced international standards

d) It was fragmented and outdated

10. The FPO mark is mandatory for which type of food products?

a) Dairy products

b) Bottled water

c) Fruit and vegetable-based processed foods like jams and pickles

d) Wheat and rice grains

Answer keys: 1. c) Food Safety and Standards Act, 2006, 2.b) Lead chromate, 3. b) Botulism, 4. c) DMI (Agmark), 5.c) Staphylococcal enterotoxin, 6. c) Food Safety and Standards Act (FSSA), 2006, 7. b) Agricultural produce like grains, oils, and spices, 8.b) WHO and FAO, 9.



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d) It was fragmented and outdated 10. c) Fruit and vegetable-based processed foods like jams and pickles

B. Short Answer Questions

1. What are the key labelling requirements under the MMPO for meat products?
2. Name two common adulterants found in milk and their associated health risks.
3. What are the public health implications of consuming aflatoxin-contaminated food?
4. State two preventive measures against accidental food contamination.
5. Write the full form of MMPO and FSSA.

C. Long Answer Questions

1. Discuss the objectives, key features, and limitations of the Prevention of Food Adulteration (PFA) Act, 1954.
2. Explain the roles of Agmark and the Fruit Products Order (FPO), 1955 in ensuring food quality and consumer safety in India.
3. Evaluate the significance of the Meat Products Order (MPO) and Meat and Meat Products Order (MMPO) in regulating India's meat industry.
4. Describe the role of the Bureau of Indian Standards (BIS) in food quality assurance.
5. Write short notes of MMPO and FPO.



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Module-4 Nutritional problems and related nutrition programs

Objectives

Nutritional Problems are the primary goal is to reduce malnutrition—including undernutrition, micronutrient deficiencies, and stunting—across vulnerable groups such as children, pregnant women, and adolescents, while also ensuring equitable access to a balanced, adequate diet that supports growth, development, and overall health.

Nutrition Programs are key programs like ICDS, the Mid-Day Meal Scheme, and Poshan Abhiyaan aim to deliver supplementary nutrition, strengthen early childhood development, and improve maternal and child health outcomes through integrated service delivery, education, and intersectoral coordination.

UNIT-4.1. Etiology Prevalence, clinical features, preventive strategies of- Undernutrition

4.1.1. Definition of Etiology: Etiology refers to the cause or origin of a disease or health condition. In medical and public health contexts, it focuses on identifying the biological, environmental, genetic, or lifestyle factors responsible for the onset of illness eg. The etiology of botulism is the neurotoxin produced by *Clostridium botulinum*, whereas the etiology of food poisoning could be due to bacterial contamination like *Salmonella* or *Staphylococcus aureus*. It identifies various factors that contribute to disease development, including biological agents like bacteria and viruses (e.g., *Salmonella* in food poisoning), chemical agents such as toxins or pollutants (e.g., aflatoxins in moldy grains), physical causes like trauma or radiation, nutritional deficiencies, genetic disorders, and lifestyle-related habits such as smoking, poor hygiene, or consumption of unclean food. For instance, the etiology of botulism is linked to the neurotoxin produced by *Clostridium botulinum* in improperly canned food.

Prevalence, on the other hand, refers to the total number of disease cases—both existing and new—within a specific population at a given time. It helps public health professionals assess the burden of disease in a community and is usually expressed as a percentage or as cases per



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1,000 or 100,000 people. Prevalence is influenced by factors such as the duration of the disease, survival rates, and recovery rates. For example, the prevalence of foodborne illnesses like diarrhea tends to be high in developing countries due to inadequate sanitation and poor food handling practices.

The clinical features describe the signs and symptoms observed in affected individuals, helping in diagnosis and treatment. These features vary depending on the disease but often include fever, vomiting, diarrhoea, fatigue, pain, or inflammation. In the case of foodborne botulism, clinical features may include double vision, dry mouth, muscle weakness, and even respiratory failure. Together, etiology and clinical features guide medical professionals in identifying the disease and planning appropriate prevention and treatment strategies.

Understanding the etiology helps in designing effective preventive strategies at. *Salmonella* or *Clostridium botulinum* can be prevented through proper cooking, hygienic food handling, safe canning practices, and maintaining cold chain storage. Public education, clean water supply, personal hygiene, regular health inspections, and food safety regulations are crucial preventive measures that target the root causes identified through etiology, ultimately reducing disease burden and improving population health.

4.1.2. Undernutrition occurs when the body does not receive sufficient calories, protein, or essential micronutrients needed for growth and maintenance. It is driven by a complex interplay of dietary, biological, environmental, and socioeconomic factors. Poverty is the single most important determinant—families with low income, limited education, and food insecurity often lack access to nutrient-rich foods. In infants and young children, inadequate breastfeeding, delayed complementary feeding, and poor maternal nutrition during pregnancy contribute significantly to early growth faltering (IYCF gaps). Frequent infections like diarrhoea, respiratory illnesses, and intestinal worms worsen nutrient losses and impair absorption, creating a vicious cycle that exacerbates undernutrition. Environmental enteropathy, caused by



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chronic exposure to unsanitary conditions, also hinders gut function and nutrient uptake in young children. Additional risk factors include low maternal weight and anemia, short birth intervals, large family size, and social inequality reflected in gender, caste, or literacy disparities.

Prevalence of Undernutrition: Undernutrition remains widespread, particularly among children under five. Globally, 149 million children are stunted (too short for age), and 45 million are wasted (too thin for height). India shoulders one of the heaviest burdens—approximately one-third of global undernourished children reside there. National surveys report stunting at ~35%, underweight at ~33%, and wasting at ~17% among under-five children, although these figures vary regionally. Some states, particularly in Bihar, Uttar Pradesh, Jharkhand, and Madhya Pradesh, show even higher stunting (>45%), while southern states like Kerala and Goa have relatively lower rates (~20%). In urban slum contexts, stunting (~31%), underweight (~25%), and wasting (~9%) remain stark, and anemia affects over 76% of children—especially boys and those with recent illness or low birth weight.

Undernutrition manifests in distinct clinical forms:

Acute/Pem Disorders: Marasmus: Severe energy deficiency, characterized by extreme wasting, loss of muscle and fat, prominent ribs, and skin wrinkles. Children with marasmus appear emaciated and lethargic.

Kwashiorkor: Protein deprivation despite calorie intake leads to edema, abdominal distension, hepatomegaly, skin depigmentation, and irritability. Laboratory findings include hypoalbuminemia and elevated liver enzymes.

Chronic Forms: Stunting (height-for-age <-2 Z-score): Represents chronic undernutrition and is associated with poor cognition, delayed development, and increased morbidity.

Wasting (weight-for-height <-2 Z-score): Indicates acute weight loss and high risk of mortality.

Underweight (weight-for-age deficit) combines aspects of both chronic and acute undernutrition.



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Children often present multiple forms simultaneously. Behavioral symptoms include apathy, slow speech development, learning difficulties, and immune dysfunction—leading to frequent infections. In infants, the absence of exclusive breastfeeding and early feeding of pre lacteal increases vulnerability.

4.1.3. Maternal Nutrition and IYCF

Improving women's nutritional status before and during pregnancy is critical, as is promoting exclusive breast feeding for six months and timely, safe complementary feeding thereafter avoidance of pre lacteal feeding and appropriate complementary feeding foods lower infection and malnutrition risk.

Healthcare & Infection Control: Regular immunization, deworming, and treatment of infections reduce nutrient loss. Improved Water, Sanitation, and Hygiene (WASH) practices mitigate the impact of environmental enteropathy, supporting nutrient absorption and growth. **Nutritional Supplementation & Food Security:** Food fortification (e.g., iodized salt, iron-fortified grains) and micronutrient powders help address deficiencies at scale. Community-based supplementation for high-risk groups like pregnant women and young children, combined with safety nets like public distribution systems, supports food access in low-income settings.

Education & Social Interventions: Women's education—particularly maternal literacy—strongly correlates with better child nutrition outcomes. Behaviour change communication on feeding practices, hygiene, and nutrition empowers families to make informed decisions. Community engagement, antenatal care attendance, and female empowerment also contribute to improved birth outcomes and reduced malnutrition risks.

Policy & Public Health Measures: National programs promoting the first 1,000 days of life, integrated child development, and rural nutrition initiatives (like India's ICDS) form essential infrastructure. Surveillance, growth monitoring, and early interventions for children



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with moderate acute malnutrition further prevent progression to severe forms.

4.1.4. Summary

Undernutrition is a major global public health issue characterized by inadequate intake of calories, proteins, and essential nutrients, leading to conditions such as stunting, wasting, underweight, marasmus, and kwashiorkor. Its etiology is multifactorial, involving poverty, food insecurity, maternal undernutrition, infections, and poor infant and young child feeding (IYCF) practices. It predominantly affects children under five, especially in low- and middle-income countries like India, where the burden is exceptionally high. Clinical manifestations vary from acute conditions like marasmus and kwashiorkor to chronic forms such as stunting and wasting, often accompanied by developmental delays and increased susceptibility to infections. Preventive strategies include improving maternal nutrition, promoting exclusive breastfeeding, ensuring safe complementary feeding, infection control, WASH practices, food fortification, and public health interventions like the Integrated Child Development Services (ICDS) and nutrition surveillance programs.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

1.What is the most common determinant of undernutrition?

- a) Genetics
- b) Poverty
- c) Climate
- d) Pollution

2.Which of the following clinical features is most characteristic of kwashiorkor?

- a) Wasting
- b) Edema and abdominal distension
- c) Hyperpigmentation
- d) Skin elasticity

3.Stunting in children is defined as:

- a) Weight-for-age below -2 Z-score



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- b) Height-for-age below -2 Z-score
- c) Weight-for-height below -3 Z-score
- d) BMI-for-age above -2 Z-score

4. Which of the following is a preventive strategy against environmental enteropathy?

- a) Exclusive formula feeding
- b) Antibiotic use
- c) Improved WASH (Water, Sanitation, and Hygiene) practices
- d) High-protein diet

5. Marasmus is primarily caused by:

- a) Iron deficiency
- b) Severe energy (calorie) deficiency
- c) Vitamin A deficiency
- d) Protein toxicity

Answer keys: 1.b) Poverty, 2.b) Edema and abdominal distension, 3.b) Height-for-age below -2 Z-score, 4.c) Improved WASH practices, 5. b) Severe energy (calorie) deficiency

B. Short Answer Questions

1. Define undernutrition and mention two of its main clinical forms.
2. List any three risk factors that contribute to undernutrition in children.
3. How does poor maternal nutrition affect child health outcomes?
4. What role does exclusive breastfeeding play in preventing undernutrition?
5. Explain the difference between stunting and wasting.

C. Long Answer Questions

1. Describe the etiology of undernutrition with reference to biological, environmental, and socio-economic factors.
2. Explain the clinical features of marasmus and kwashiorkor. How can they be differentiated?
3. Discuss the prevalence of undernutrition globally and in India. Highlight regional disparities.



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4. Outline comprehensive strategies for the prevention and management of undernutrition in children under five.
5. Explain the significance of maternal nutrition and Infant and Young Child Feeding (IYCF) practices in combating undernutrition. Include key interventions.



Unit-4.2. National Nutrition Policy and Programs

4.2.1. National Nutrition Policy: India's National Nutrition Policy (NNP) provides a comprehensive roadmap to combat malnutrition by integrating both direct and indirect nutritional interventions across multiple sectors. Envisioned to address pervasive deficiencies among women, children, and vulnerable groups, it calls for multi-sectoral collaboration involving health, agriculture, education, rural development, water and sanitation, and food systems. The policy outlines direct interventions such as the ICDS scheme, micronutrient supplementation (iron, folic acid, vitamin A), growth monitoring, nutrition rehabilitation centres, and the Mid-Day Meal scheme. Simultaneously, its indirect strategies include strengthening the Public Distribution System, promoting livelihood programs, enhancing dietary diversity through agricultural policies, improving WASH (Water, Sanitation, and Hygiene), and empowering women to foster sustainable nutritional behaviours. The NNP emphasizes governance through institutional mechanisms like the National Nutrition Council and district-level nutrition coordination bodies to ensure action across domains aligns with national targets such as reducing stunting, undernutrition, and anaemia each by 2–3% per year.

4.2.2. Integrated Child Development Services (ICDS)

Origins and Reach Launched on 2nd October 1975 in 33 blocks, ICDS has grown into one of the world's largest community-based early childhood care and development programs, now covering over 1.3 million Anganwadi centres across urban and rural India. It targets children under 6 years, pregnant and lactating women, and adolescent girls, aiming to improve health, nutrition, and KAP (Knowledge-Attitude-Practice) indicators in low-income communities. Despite its scale, ICDS has faced implementation challenges—such as inconsistent service delivery, food supply disruptions, low community participation, and inadequate reach in underserved states—diluting the impact on reducing malnutrition in the poorest regions. Core Components of ICDS Scheme



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ICDS delivers six integrated services via Anganwadi Centres:

- **Supplementary Nutrition:** Children aged 6 months–6 years, and pregnant/lactating mothers receive daily nutrition supplements—hot cooked meals at centres for 3–6 years, and take-home rations for younger children and mothers. Special nutrition is provided to severely malnourished children.
- **Immunization:** In coordination with the health system, beneficiaries receive vaccines against key childhood diseases—DPT, measles, tuberculosis, polio, and maternal tetanus immunization.
- **Health Check-up & Referral Services:** Regular anthropometric monitoring, antenatal check-ups, deworming, and referrals are organized via linkages with primary health centres.
- **Non-formal Pre-School Education:** For children aged 3–6 years, Anganwadi Centres provide a play-based learning environment to foster early cognitive and motor development and readiness for formal schooling.
- **Nutrition & Health Education:** Anganwadi Workers counsel mothers on breastfeeding, complementary feeding, hygiene, and adolescent nutrition, aiming for long-term behavioural change.
- **Referral Services:** Children and women identified with growth faltering, illness, or disability are guided towards healthcare or specialized support facilities.

Governance, Funding, and Systems Support: ICDS falls under the Ministry of Women & Child Development, with central funding shared with states: 60:40 ratio for most services and 50:50 (or 90:10 for North-East states) for the Supplementary Nutrition Programme. The scheme employs Anganwadi Workers (AWWs) and Helpers (AWHs) to deliver grassroots services, with each Anganwadi covering about 400–800 individuals, supervised at block and district levels via project officers. Recent enhancements include adoption of digital platforms like Poshan Tracker to ensure accurate beneficiary tracking, monitor attendance and nutrition delivery, and minimize leakages.



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Impact, Challenges & Reforms: ICDS is recognized for improvements in child survival, nutritional status, birth weight, and school readiness in operational areas, outperforming non-ICDS regions in evaluations. States like Uttar Pradesh have witnessed outreach to over 1.8 crore children and 13.5 lakh pregnant women, contributing to reduced infant mortality and improved nutrition outcomes. Yet, challenges persist: service gaps in urban slums, data gaps with migrant children, and uneven quality across regions—especially in high-burden states like Bihar and Jharkhand. ICDS is now integrated under the government's Poshan 2.0 framework, which consolidates schemes like PMMVY, Kishori Shakti Yojana, and National Creche under a unified umbrella for holistic nutrition and early development priorities at scale.

4.2.3. Mid-Day Meal Programme (PM-POSHAN)

The Mid-Day Meal Scheme, rebranded as Pradhan Mantri Poshan Shakti Nirman (PM-POSHAN), began in 1995 as the National Programme of Nutritional Support to Primary Education (NP-NSPE) to address hunger, boost school enrolment, and enhance nutrition among children in grades I–V. It was expanded to upper primary classes (VI–VIII) by 2007–08, educationally backward areas, and universalized nationwide by 2008. Under legal mandate from the Supreme Court (2001), all government and aided schools must provide a free cooked meal daily to eligible children.

Nutritional standards require each meal to provide 450 kcal and 12 g protein for primary and 700 kcal and 20 g protein for upper primary students, with foodgrain, pulses, vegetables, and oil allocated accordingly. The scheme now covers over 120 million children in more than 1.27 million schools. Intended outcomes include improving nutrition, eradicating classroom hunger, enhancing attendance and enrolment, reducing dropout rates, and empowering women through cook-cum-helper roles. Implementation involves decentralized cooking through Anganwadi centres or self-help groups, with state-level committees (SSMCs) monitoring quality and compliance.



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Recent developments include weekly fruit provision and inclusion of regional dishes in school menus (e.g. Rajasthan), along with enhanced coverage and infrastructure support in drought-affected Andhra Pradesh. Budget constraints amid high food inflation have stressed the Programme—many schools face nutritional shortfalls due to stagnant per-child funding despite rising food costs .

4.2.4. National Programs for prevention of Anemia, Vitamin Deficiency & Iodine Deficiency Disorders

India runs targeted nutrition-specific interventions to tackle micronutrient deficiencies:

- Anemia control programs deliver weekly iron and folic acid supplements to children, adolescent girls, pregnant and lactating women through health and education platforms, including convergence with ICDS and schools. Recent state reports (e.g., Tamil Nadu) indicate high prevalence (78%) among children, calling for individualized therapeutic dosing and periodic school-level monitoring
- Vitamin deficiency prevention, particularly vitamin A supplementation, is integrated into Child Health and ICDS outreach, with periodic mega doses for children and postpartum mothers, though gaps remain in fortification and coverage in certain regions.
- Iodine Deficiency Disorders (IDD) are addressed through universal iodization of edible salt, mandated by law. While non-iodized salt sales are banned across India, enforcement remains uneven. Distinguished public health leaders like Dr. Chandrakant Pandav have spear headed mass awareness and community-level interventions to promote iodized salt adoption.

Interlinkages & Convergence with ICDS and Public Health Infrastructure. These micronutrient programs operate synergistically with the ICDS, Mid-Day Meals, and National Health Mission, forming a multi-sectoral nutrition safety net. At Anganwadi centers and schools, children receive supplementary meals, growth monitoring, deworming,



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immunity checks, and micronutrient supplementation in a coordinated manner. The ICDS programme ensures nutritional counselling, monitoring, and targeted referrals which reinforce these national micronutrient efforts.

Impacts, Challenges & Future Directions: These flagship schemes have made substantial inroads—reducing child hunger, improving school attendance, and raising nutrition awareness. However, key challenges persist: service delivery deficits, irregular supplementation, logistical issues, and funding shortfalls—especially amid inflation. Coverage lags in marginalized populations, and nutrient-intensive regions suffer due to inadequate fortification access. Going forward, strengthening joint management at state and community levels, expanding fortified food distribution through school and public programs, and fostering enhanced real-time tracking and auditing are essential to optimize outcomes. Digital mechanisms like the Poshan Tracker help in bridging data gaps and ensuring transparency. Specialized nutrition gardens, community monitoring through SMCs, and increased budgetary allocation aligned with food inflation can bolster Programme resilience.

4.2.5. Summary

At last undernutrition remains a critical global and national public health challenge with long-term consequences on growth, cognition, immunity, and productivity. Causes span poverty, poor maternal and child feeding care, infections, and environmental factors. Clinical presentations vary from wasting and stunting to protein-energy malnutrition. Preventive solutions must be holistic—targeting maternal health, infant feeding, infection control, food security, and education—supported by strong public health systems and policies. Scaling up these interventions during the early childhood window can break the cycle of undernutrition and pave the way for healthier, more productive populations.

The National Nutrition Policy sets the vision and coordination framework, with ICDS serving as its flagship delivery arm for early



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childhood and maternal nutrition. The holistic service package—ranging from nutrition provision to education and health referrals—addresses both immediate and preventive dimensions of malnutrition. While ICDS has made commendable strides, systemic efforts to enhance monitoring, improve quality, expand urban and migrant coverage, and upgrade Anganwadi capacity remain pivotal for realizing its full potential. Strengthening intersectoral collaboration, leveraging digital tools, and keeping nutrition central to governance structures will be vital to meet national goals and transform India’s nutritional landscape.

India’s Mid-Day Meal Scheme alongside its national programs for anemia, vitamin, and iodine deficiency reflect a comprehensive public health strategy to address child nutrition. With integrated outreach through ICDS and school systems, these initiatives deliver critical macro- and micro-nutritional support. While significant progress has been made in reach and impact, addressing systemic implementation gaps, strengthening quality assurance, and ensuring consistent funding are vital to sustaining and enhancing their long-term effectiveness in reducing malnutrition and micronutrient deficiencies nationwide.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

1.The Meat Products Order (MPO), 1973 was originally enacted under which act?

- a) Food Safety and Standards Act
- b)Essential Commodities Act
- c)Prevention of Food Adulteration Act
- d)Livestock Management Act

2.Which organization currently governs the implementation of MPO licenses?

- a)Bureau of Indian Standards (BIS)
- b) Ministry of Agriculture
- c) Food Safety and Standards Authority of India (FSSAI)
- d) Ministry of Consumer Affairs

3.Which of the following is NOT required on a meat product



label under MPO?

- a) Product weight
- b) Manufacturing date
- c) Slaughterhouse license number
- d) Ingredients list

4.The MPO mandates storage of meat products at which of the following temperatures for frozen items?

- a) 0–4 °C
- b) ≤ -18 °C
- c) 5–10 °C
- d) Room temperature

5.Which of the following is permitted in processed meats under MPO/MMPO with limited use?

- a) Formalin
- b) Phosphate salts
- c) Sodium benzoate
- d) Tartrazine

6. What is the primary delivery platform for early childhood nutrition under India's National Nutrition Policy?

- a) National Health Mission (NHM)
- b) Public Distribution System (PDS)
- c) Integrated Child Development Services (ICDS)
- d) Pradhan Mantri POSHAN (Mid Day Meal Scheme)

7. Which of the following is NOT a core service provided by Anganwadi Centres under ICDS?

- a) Immunization
- b) Non-formal Pre-School Education
- c) Employment Guarantee for Mothers
- d) Supplementary Nutrition

8. The Mid Day Meal Scheme, now called PM POSHAN, is legally mandated to provide meals under an order from which institution?



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- a) Parliament of India
- b) Ministry of Women and Child Development
- c) NITI Aayog
- d) Supreme Court of India

9. Which micronutrient deficiency is addressed through universal salt iodisation in India?

- a) Iron
- b) Iodine
- c) Vitamin A
- d) Folic Acid

10. Which digital tool has been adopted to improve tracking and transparency in ICDS service delivery?

- a) Swachh Tracker
- b) Poshan Tracker
- c) Nirogi App
- d) Ayushman Portal

Answer Keys: 1.b) Essential Commodities Act, 2.c) Food Safety and Standards Authority of India (FSSAI), 3.c) Slaughter house license number, 4.b) $\leq -18^{\circ}\text{C}$, 5.b) Phosphate salts, 6.c) Integrated Child Development Services (ICDS), 7.c) Employment Guarantee for Mothers, 8. d) Supreme Court of India 9.b) Iodine, 10.b) Poshan Tracker

B. Short Answer Questions

1. What is the purpose of the MPO license for meat processing establishments?
2. List two labelling requirements under the Meat Products Order (MPO).
3. How does the Meat and Meat Products Order (MMPO) complement the MPO?
4. What role does the Bureau of Indian Standards (BIS) play in meat product regulation?
5. Write about role of BIS.

C. Long Answer Questions

1. Critically examine the structure, implementation, and challenges of the Integrated Child Development Services (ICDS) scheme.



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2. Analyze the objectives, nutritional standards, and implementation mechanisms of the Mid Day Meal Scheme.
3. Discuss the national programs aimed at preventing anemia, vitamin A deficiency, and iodine deficiency disorders in India.
4. Define the term “etiology” in the context of public health and explain its significance in disease prevention and control.
5. Explain about the vitamin A and Iodine deficiency disorder.

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