



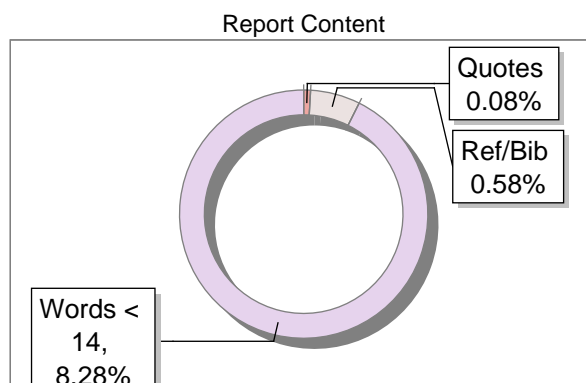
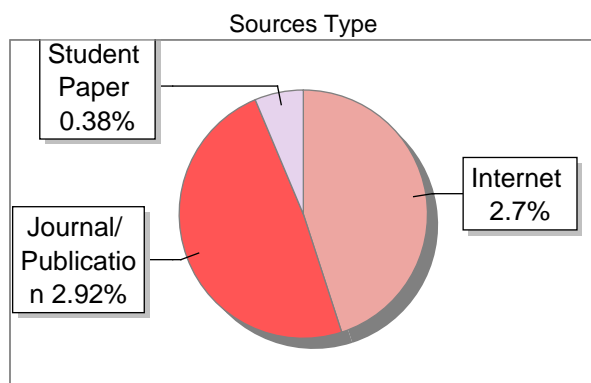
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4

Bachelor of Science

Semester - 1



Nutrition for Health

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Nutrition for Health

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MODULE INTRODUCTION

Course has four modules. Under this theme we have covered the following topics:

S. No.	Module No.	Unit No.
01	Module 01	4 BASIC CONCEPTS IN FOOD AND NUTRITION
02	Module 02	NUTRIENTS
03	Module 03	FOOD ADULTERATION
04	Module 04	NUTRITIONAL PROBLEMS, AND RELATED NUTRITION PROGRAMMES

1 These themes of the Book discuss about Nutrition for health, explored concepts like food, nutrients, health, nutrients related diseases, and health programs. This book is designed to help you think about the topic of the particular CHAPTER.

We suggest you do all the activities in the CHAPTERs, even those which you find relatively easy. This will reinforce your earlier learning.



Unit -I

Introduction to ⁴Basic 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 analysing diets, planning nutritional interventions, and understanding how food affects the human body.

Concepts and Definitions

Food:

Any substance—solid or liquid—which when consumed, provides the body with nutrients and energy required for growth, maintenance, and repair. Food ²⁷also plays a role in cultural and social practices.

Nutrition:

Nutrition is the scientific study of how food and its components affect the body's health, growth, disease prevention and development. It encompasses the entire process of eating, digesting, absorbing, metabolizing, and utilizing nutrients to maintain bodily functions and promote overall health. A fundamental concept in nutrition is the idea of nutrients—chemical ¹⁹substances that are essential for the body to function properly. It involves understanding nutrients, how they are digested, absorbed, and utilized.

Nutrients:

Chemical substances in food that the body needs to function properly. They are classified into:

- **Macronutrients:** Carbohydrates, proteins, water and fats (needed in large amounts), all of which are required in large quantities to provide energy and build body tissues
- **Micronutrients:** 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.
- **Water:** An essential nutrient ¹that supports all bodily functions.

Balanced Diet:



A diet that includes all essential nutrients in the right proportions to maintain health, vitality, and well-being. A balanced diet is one that provides all the essential nutrients in appropriate proportions to sustain life and promote well-being. It typically includes a variety of food groups such as grains, fruits, vegetables, dairy, protein sources (like meat, legumes, or nuts), and a controlled amount of fats and sugars. An imbalance in dietary intake can lead to malnutrition, which includes both undernutrition and overnutrition.

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 (e.g., 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 and heart disease.

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



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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 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. The food we consume can be grouped into basic food groups such as cereals, dairy, meat and alternatives, fruits, vegetables, fats, and sugars, each contributing unique nutrients to the diet.

Within the category of micronutrients, vitamins and minerals play indispensable roles. For instance, vitamin C boosts the immune system, vitamin A supports vision, and minerals like calcium and iron are essential for bone health and blood function. Some of these nutrients also act as antioxidants, helping to neutralize free radicals and reduce the risk of chronic diseases such as cancer and heart disease. Food fortification is a public health strategy that involves adding essential vitamins or minerals to commonly consumed foods to prevent widespread deficiencies. Examples include iodized salt, fortified milk with vitamin D, and iron-fortified cereals.

Water:



Water is another crucial yet often overlooked nutrient. Hydration is essential for regulating body temperature, aiding digestion, transporting nutrients, and eliminating waste. Alongside water, dietary fiber—the indigestible part of plant foods—plays a vital role in maintaining digestive health, preventing constipation, and helping control blood sugar and cholesterol levels. Fiber is found in whole grains, fruits, vegetables, and legumes, and is a key part of any healthy diet.

A critical concern in global nutrition is food security, which refers to having consistent access to safe, nutritious, and affordable food. The opposite, food insecurity, can lead to hunger, poor nutrition, and adverse health outcomes. To combat nutritional deficiencies and promote health, many countries use Recommended Dietary Allowances (RDAs), which provide daily intake recommendations for essential nutrients based on age, gender, and activity level. These serve as a benchmark for meal planning and nutrition labelling. Lastly, the modern food industry has introduced the concept of functional foods, which are foods that provide additional health benefits beyond basic nutrition. These include items like probiotic yogurts, omega-3 enriched eggs, and cholesterol-lowering spreads. As science continues to uncover the complex relationship between food and health, understanding these basic terms is essential for making informed dietary choices and promoting lifelong wellness.

4

Understanding Relationship Between Food, Nutrition and Health

Food, nutrition, and health are deeply interconnected aspects of human life. Understanding their relationship is essential for promoting well-being, preventing disease, and ensuring a high quality of life. Food is the primary source of energy and nutrients for the body, while nutrition refers to how the body utilizes those nutrients. Health, in turn, is the outcome of optimal nutrition and appropriate food choices. When the right food is consumed in the right quantities, it supports physical, mental, and emotional health.

Food: The Foundation of Nutrition

Food is any substance consumed to provide nutritional support to the body. It typically contains essential nutrients like carbohydrates, proteins, fats, vitamins, minerals, and water. These nutrients are necessary for growth, energy, repair of body tissues, and regulation of bodily processes. Foods can

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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:

1. **Energy provision** – through carbohydrates and fats, which fuel physical and metabolic activities.
2. **Body-building** – via proteins, which are crucial for cell repair and growth.
3. **Protective and regulatory roles** – through vitamins and minerals, which support immune function and maintain internal balance.

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.

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 ²¹nutrients 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.

Conclusion

A strong foundation in basic food and nutrition terms is crucial for understanding how to achieve and maintain optimal health. These concepts are not only vital for students and health professionals but also empower individuals to make informed dietary choices for themselves and their communities. The relationship between food, nutrition, and health is complex and vital. Food provides the raw materials for nutrition, and good nutrition fosters health. Health, in turn, enhances the body's ability to digest and benefit from food, creating a continuous loop. Recognizing this interdependence helps individuals make informed dietary choices, and encourages society to promote nutrition education, food security, and health services. Ultimately, a well-nourished population is not only healthier but also more productive and resilient, forming the foundation of a strong and thriving society.

Balanced diet:

A balanced diet is a meal plan that includes a variety of foods in the right proportions to supply the body with all essential 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



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metabolic processes, a balanced diet helps prevent nutrient deficiencies and lowers the risk of chronic diseases like diabetes and heart disease. A balanced diet incorporates the right proportion of both macro and micronutrients to promote good health and prevent malnutrition. For instance, a typical healthy day's meal might include: Breakfast of vegetable upma with milk and a banana (carbs, proteins, vitamins), Lunch of rice, dal, spinach curry, curd, and salad (fiber, calcium, iron, protein), and Dinner of chapati, paneer curry, mixed vegetables, and papaya (vitamins, fiber, protein). Healthy snacks like roasted chana, coconut water, or boiled eggs can provide nutrients between meals.

Nutrients are 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.

Macronutrients: Definition, Types, and Importance

Macronutrients are nutrients that the body requires in large quantities. They are primarily responsible for providing energy and are fundamental for the structure and function of our cells and tissues. The three major macronutrients are carbohydrates, proteins, and fats, and two additional components—water and dietary fiber—are also considered vital macronutrients even though they do not provide energy. Macronutrients, which are needed in large amounts, include carbohydrates (the primary energy source providing 4 kcal per gram), proteins (critical for building and repairing tissues), fats (important for energy storage, organ protection, and vitamin absorption), and water (vital for regulating temperature and transporting nutrients).

Carbohydrates are the body's main source of energy, providing 4 kcal per gram. They are found in foods such as rice, wheat, potatoes, sugar, bread, and fruits. Carbohydrates can be simple (like glucose, sugar, honey) or complex (such as whole grains and starchy vegetables), with complex carbs being more nutritious and providing longer-lasting energy.

Proteins play a critical role in building and repairing body tissues, forming enzymes and hormones, and supporting immune function. Good sources



include eggs, dairy products, legumes (dal), soybeans, chicken, and fish. Proteins are 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.

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. Fiber is found in fruits, vegetables, whole grains, and legumes.

Micronutrients: Definition, Types, and Importance

Micronutrients, required in smaller amounts, include vitamins and minerals essential for immune function, bone health, wound healing, metabolic regulation and brain activity. Vitamins are divided into fat-soluble (A, D, E, K) and water-soluble (B-complex and C), each with specific roles such as vitamin A for vision and immunity, vitamin D for calcium absorption, and vitamin C for healing and immune defense. Micronutrients are nutrients required in small quantities—measured in milligrams or micrograms—They do not provide energy, but their absence can lead to serious health issues.

Micronutrients are classified into two main groups:

1. Vitamins

2. Minerals.

1. **Vitamins** are organic compounds necessary for various biochemical processes. Vitamin A supports vision and immunity and is found in carrots, mangoes, and spinach; its deficiency can cause night blindness. Vitamin B12, found in animal products, is essential for red blood cell formation and nerve function. Folic acid is critical during pregnancy to prevent neural tube defects and is found in leafy greens and citrus fruits. Vitamin C, known for boosting



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immunity and aiding iron absorption, is abundant in amla, oranges, and guava, while Vitamin D, synthesized through sunlight exposure, aids calcium absorption. ²³ Deficiency of Vitamin D can lead to rickets in children and osteomalacia in adults. Vitamin E (from nuts and oils) supports skin health, and Vitamin K (from leafy greens) helps in blood clotting.

2. Minerals are inorganic elements vital for body structure and regulation. **Iron** helps form hemoglobin and prevent anemia and is found in red meat, spinach, and jaggery. **Calcium** is important for bone and teeth health and is abundant in dairy products and sesame seeds. **Iodine**, found in iodized salt and seafood, regulates thyroid function and prevents goiter. **Zinc**, **magnesium**, and **selenium** are involved in immunity, muscle function, and antioxidant activity, and are found in seeds, nuts, green vegetables, and fish.

Summary, Differences, and Balanced Nutrition

While both macronutrients and micronutrients are essential, they serve different roles. Macronutrients are needed in larger amounts and directly provide energy and body mass. Micronutrients, although required in smaller quantities, are just as crucial as they regulate key physiological functions. Deficiency in macronutrients can lead to fatigue, weight loss, and muscle wasting, while a lack of micronutrients results in specific disorders such as anemia (iron), rickets (vitamin D/calcium), scurvy (vitamin C), and goiter (iodine).

Conclusion

In conclusion, **macronutrients and micronutrients** are both indispensable to human health. Macronutrients provide the body's energy and structural support, while micronutrients act as catalysts and regulators of physiological processes. Deficiencies in either can lead to malnutrition, affecting physical and cognitive development. Ensuring a diet rich in diverse, seasonal, and locally available foods is the best way to meet nutritional needs. For lifelong wellness, it is essential to understand and apply the principles of balanced nutrition in daily life. Minerals like calcium, iron, and iodine serve structural and regulatory roles in the body. Together, balanced intake of macro- and micronutrients ensures optimal physical health, energy, mental function, and disease prevention.

Table: Minerals & Their Functions:



Notes

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

Conclusion

A balanced diet that includes the right mix of macronutrients and micronutrients is essential for maintaining health and preventing diseases. Macronutrients provide the energy and building blocks required by the body, while micronutrients ensure all physiological processes run smoothly. Education and awareness about healthy food choices are the first steps toward achieving long-term wellness.

Functions of food -Physiological, psychological and social

Introduction to Functions of Food

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



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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, certain foods support mental health; omega-3 fatty acids can reduce depression symptoms, B vitamins enhance brain function, and minerals like magnesium and zinc help regulate mood and anxiety. Socially, food is central to cultural identity and community bonding. Shared meals foster connection, conversation, and emotional closeness, as seen in family lunches or festive gatherings. Food also symbolizes cultural heritage and plays a crucial role in rituals and celebrations, such as biryani at Indian weddings or turkey on Thanksgiving. Additionally, offering food expresses hospitality and can reflect social status and generosity, demonstrated in elaborate feasts or business meals. Finally, cultural norms and etiquette around food promote respect and social order, whether through table manners, saying grace, or waiting for elders to start eating. Together, these psychological and social functions highlight food's profound impact on human experience beyond physical health.

Broadly, the functions of food can be divided into these categories: physiological functions related to the body's biological needs, psychological functions linked to emotional and mental well-being, and social functions that pertain to culture, tradition, and societal relationships. Each of these aspects contributes to the overall harmony and health of individuals and communities, illustrating the complexity and importance of food in human life. Understanding these dimensions is crucial for students of nutrition, public health, psychology, and social sciences.

Food performs three broad categories of functions:

1. Physiological Functions:

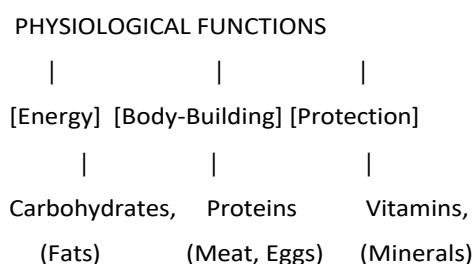
Physiologically, food serves as the primary source of energy required for all bodily activities, including involuntary processes such as breathing, blood circulation, and digestion. This energy primarily comes from carbohydrates and fats, with proteins also contributing when necessary. Carbohydrates and



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proteins each provide approximately 4 kilocalories per gram, whereas fats provide a more concentrated 9 kilocalories per gram, making lipids the most energy-dense macronutrient. Common energy-giving foods include staples like rice, bread, oils, butter, sugar, and cereals. Beyond energy, food plays a vital body-building function by supplying proteins necessary for the growth, repair, and maintenance of tissues, muscles, organs, and immune cells. This function is critical during periods of growth, illness recovery, and injury healing, with sources such as milk, meat, eggs, pulses, and soybeans being rich in high-quality proteins. Additionally, food contains various micronutrients—vitamins and minerals—that provide protective and regulatory roles. 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.

Figure: Physiological Functions of Food



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



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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 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.

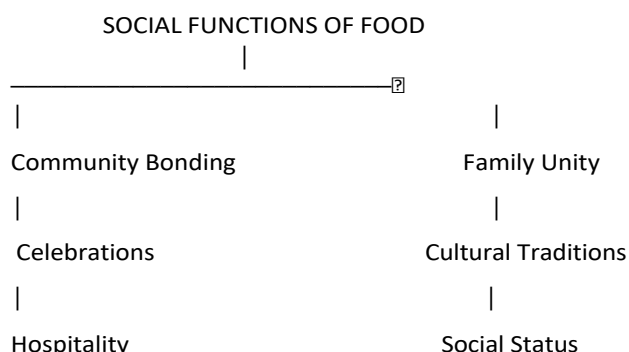
3.Social Functions -

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 Thanksgiving in the United States, or dates during Ramadan are emblematic of cultural values and communal identity. Offering food is a universal sign of hospitality, and 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, ² all of which underscore the role of food in social structure.

Figure: Social Functions of Food



Conclusion

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 behaviour, and appreciate the broader significance of food in society.

SELF ASSESSMENT QUESTIONS

A. Multiple Choice Questions (MCQs)

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

- A. Carbohydrates
- B. Proteins
- C. Fiber



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D. Fats

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. According to WHO, health is defined as:

- A. Freedom from disease
- B. Absence of infection
- C. Physical, mental, and social well-being
- D. Absence of pain

7. Which of the following supports bone health along with calcium?

- A. Vitamin C
- B. Vitamin D
- C. Vitamin K
- D. Vitamin E

8. Which of the following is NOT a macronutrient?

- A. Fats
- B. Proteins



- C. Water
- D. Vitamins

9. Omega-3 fatty acids and B-vitamins are especially linked to:

- A. Skin health
- B. Cognitive function and mood regulation
- C. Eye health
- D. Muscle growth

10. Which factor does NOT directly affect the cycle of food, nutrition, and health?

- A. Cultural practices
- B. Education
- C. Political affiliation
- D. Socioeconomic status

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.

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.
2. Define and differentiate between macronutrients and micronutrients. Describe their types, sources, and specific roles in maintaining health, and explain the consequences of their deficiencies.
3. Discuss the concept of a balanced diet. What are its components, and how does it help prevent malnutrition and chronic diseases? Illustrate with examples of a balanced day's meal.
5. Explain the continuous cycle of food, nutrition, and health.



UNIT-II

Functions¹² dietary, sources and clinical manifestations of deficiency of nutrients Carbohydrates

Introduction

Carbohydrates are one of the three⁸ 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 classified into simple carbohydrates, such as sugars (monosaccharides and disaccharides), and complex carbohydrates, such as starches and dietary fiber (polysaccharides). Their primary function is to provide readily available energy. During digestion, carbohydrates are broken down into glucose, which circulates in the blood and fuels cellular processes. Each gram of carbohydrate provides 4 kcal of energy, making them the most efficient energy source for the body. For instance, glucose is the primary fuel for brain activity and muscle contractions during physical exertion.

Beyond energy production, carbohydrates have a protein-sparing effect, meaning that when carbohydrate intake is sufficient, proteins can be used for their primary roles—such as building tissues and producing enzymes—instead of being diverted for energy. Additionally, carbohydrates assist in the complete metabolism of fats. Without enough carbohydrates, the body breaks down fat incompletely, leading to the accumulation of ketone bodies, a condition known as ketosis, which can cause fatigue, nausea, and bad breath. Another vital function of complex carbohydrates is their fiber content. Though indigestible, fiber plays a crucial role in digestive health, aiding bowel movements, regulating blood sugar, reducing cholesterol, and enhancing the feeling of fullness. Foods like whole grains, fruits, and



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vegetables help prevent constipation and reduce the risk of chronic diseases such as heart disease and type 2 diabetes.

Carbohydrates are abundant in the diet and found predominantly in plant-based foods. Simple carbohydrates, which digest quickly and provide rapid energy, are found in table sugar (sucrose), honey, fruits (fructose), milk (lactose), and processed foods like candies and soft drinks. While they can be a quick source of fuel, overconsumption may lead to blood sugar spikes and weight gain. On the other hand, complex carbohydrates are made up of longer sugar chains that digest more slowly, offering sustained energy. These include whole grains (like brown rice, oats, and wheat), legumes (like lentils and beans), starchy vegetables (like potatoes and corn), and fiber-rich fruits and vegetables (such as apples, spinach, and broccoli). Millets like ragi, jowar, and bajra are also excellent complex carb sources, rich in fiber, minerals, and antioxidants. Compared to simple carbs, complex carbohydrates have higher nutritional value and contribute to digestive health and metabolic balance. Carbohydrate deficiency is relatively rare in people with a balanced diet, but it can occur in individuals following extreme low-carb or ketogenic diets, those with eating disorders, or people suffering from chronic illnesses. A lack of adequate carbohydrates can result in low energy levels, physical and mental fatigue, and reduced endurance. One of the earliest effects of carbohydrate deficiency is the onset of ketosis, where the body begins to burn fat for energy. While this may initially result in weight loss, it can also cause headaches, nausea, bad breath, and even ketoacidosis in unmanaged diabetics, which is potentially life-threatening. In prolonged deficiency, the body may start using muscle protein as an energy source, leading to muscle wasting and weight loss, a condition observed in starvation or severe malnutrition.

Additionally, insufficient dietary fiber, a component of complex carbohydrates, can lead to constipation, irregular bowel movements, and increase the risk of colon-related disorders. The brain, which relies heavily on glucose for functioning, may suffer in cases of deficiency, causing cognitive issues such as poor concentration, irritability, dizziness, and memory impairment. 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.

In conclusion, carbohydrates are a critical part of a healthy diet, providing not just energy but also contributing to protein conservation, fat metabolism, and gut health. Including a variety of complex carbohydrates from whole, unprocessed foods ensures a steady energy supply, supports organ function, and reduces the risk of chronic diseases. Therefore, rather than eliminating carbohydrates, the focus should be on choosing high-quality, nutrient-dense sources while moderating the intake of refined and sugary foods.

Carbohydrates are essential nutrients that serve critical functions in the body, including providing energy, preserving protein stores, and regulating fat metabolism. They are widely available in foods, especially plant-based sources like grains, legumes, fruits, and vegetables. While deficiency is uncommon in normal diets, it can lead to energy depletion, digestive problems, and cognitive impairment. Thus, consuming the right type and amount of carbohydrates is vital for good health and well-being.

Functions, Dietary, sources and clinical manifestations of deficiency of the Following nutrients Lipid

Lipids, commonly known as fats and oils, are a diverse group of hydrophobic molecules that include triglycerides, phospholipids, and sterols such as cholesterol. As a vital class of macronutrients, lipids play essential roles in various biological processes, contributing to energy production, structural integrity of cells, hormone synthesis, and more. One of the primary functions of lipids is to act as a dense energy source, providing 9 kilocalories per gram, which is more than double the energy provided by carbohydrates or proteins. Excess energy is stored in the body as triglycerides in adipose tissue, which serves as a reservoir that can be mobilized during periods of fasting, illness, or prolonged physical activity. For example, during extended exercise or food deprivation, the body breaks down stored fat into fatty acids to meet energy demands.



regulating the entry and exit of substances while maintaining membrane fluidity and stability. This is especially critical in nerve cells, as the human brain is composed of nearly 60% fat, underlining the essential role of lipids in neurological function. Beyond energy and structure, lipids provide insulation and protection for the body. Subcutaneous fat acts as thermal insulation, helping to maintain body temperature, while fat surrounding organs such as the kidneys serves as a cushion against physical impact.

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 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.

In terms of **dietary sources**, lipids are found in both animal and plant-based foods and exist in several forms. Saturated fats, which are typically solid at room temperature, are mainly found in animal products such as butter, ghee, cheese, red meat, and full-fat dairy. Excessive intake of saturated fats has been associated with increased LDL (bad) cholesterol and cardiovascular risk. In contrast, unsaturated fats—which are usually liquid oils—are considered healthier and come in two types: monounsaturated fats (MUFA) found in olive oil, avocados, and nuts, and polyunsaturated fats (PUFA) found in soybean oil, sunflower seeds, flaxseeds, and fatty fish. PUFAs include essential fatty acids like omega-3 and omega-6, which the body cannot synthesize and must be obtained through the diet. Finally, trans fats, which are artificially created through hydrogenation, are found in many processed and fried foods. These fats are known to significantly raise heart disease risk and should be avoided altogether.

Overall, lipids are indispensable to human health. A **balanced diet should include adequate** healthy fats, especially unsaturated fats and essential fatty



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acids, while limiting saturated and trans fats. This helps maintain optimal energy levels, supports cellular functions, and promotes long-term well-being.

Table-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. 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 fatty acids are essential for multiple bodily functions, including brain development, anti-inflammatory responses, and the maintenance of cardiovascular health. Omega-3s are particularly important during pregnancy and early childhood, as they contribute to neurological and visual development, while omega-6 fatty acids help regulate immune function and cell growth.

A deficiency in lipids, particularly essential fatty acids, can result in several clinical manifestations. ⁸ One of the most notable effects is impaired growth and development, especially in infants and children. Fat is a major energy source and structural component of cell membranes, and inadequate intake may lead to growth retardation, developmental delays, and neurological impairments. For instance, infants fed on low-fat formulas have shown delayed brain and eye development due to the absence of EFAs. Another common symptom is skin and hair problems, as EFAs help maintain skin barrier integrity and hair health. Deficiency can cause dry, scaly skin, dermatitis, brittle hair, and delayed wound healing.



Lipids also aid in the absorption of fat-soluble vitamins—A, D, E, and K. When fat intake is too low, absorption of these nutrients becomes compromised, leading to further health issues. Vitamin A deficiency may result in night blindness and weakened immunity, while vitamin D deficiency can cause

rickets in children or osteomalacia in adults, both characterized by soft or deformed bones. A lack of vitamin E can contribute to neurological dysfunctions due to oxidative damage in nerve tissues, and vitamin K deficiency can impair blood clotting, resulting in excessive bleeding or bruising. Moreover, lipids are precursors to steroid hormones, including those responsible for reproduction and stress response. Therefore, insufficient fat intake can lead to hormonal imbalances, affecting fertility, menstrual cycles, and the body's ability to cope with stress.

In addition to these issues, insufficient intake of omega-3 fatty acids has been linked to a higher risk of cardiovascular diseases, depression, and cognitive decline in older adults. Research indicates that diets low in omega-3s may contribute to inflammation, elevated cholesterol levels, and the deterioration of brain function over time. Several populations are particularly at risk of lipid deficiency, including those on very low-fat diets, individuals with malabsorption disorders like celiac disease or cystic fibrosis, and premature infants or children with restricted fat intake due to medical conditions.

In conclusion, lipids are essential macronutrients that play critical roles in energy storage, cellular structure, vitamin absorption, and hormone synthesis. While excess intake of unhealthy fats such as trans fats and saturated fats is harmful, a complete avoidance of fats can also be detrimental. A balanced intake that includes healthy fats from nuts, seeds, fatty fish, plant oils, and avocados ensures the body receives adequate essential fatty acids and supports overall well-being. Though lipid deficiency is relatively rare in developed nations, it can have serious consequences when it occurs. Therefore, public health recommendations stress the importance of including beneficial fats in the daily diet while avoiding excessive intake of harmful varieties.

Deficiency, although uncommon in developed countries, can lead to serious clinical issues such as growth retardation, skin disorders, vitamin



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deficiencies, and hormonal problems. Hence, dietary guidelines emphasize the inclusion of healthy fats from varied sources while limiting harmful fats like trans fats.

Following nutrients proteins

Introduction

Proteins are complex organic compounds composed of amino acids, often referred to as the building blocks of life. They are essential macronutrients vital to the structure and function of every cell in the human body of the 20 amino acids required by the body, nine are essential, meaning they must be obtained through the diet because the body cannot synthesize them. Proteins are required in relatively large amounts and are present in all living tissues. The Recommended Dietary Allowance (RDA) for a healthy adult is approximately 0.8 grams per kilogram of body weight per day, although this requirement varies based on age, sex, health status, and activity level.

Proteins serve a wide array of physiological functions. First and foremost, they play a key role in body-building and tissue repair, contributing to the growth and maintenance of muscles and other tissues, and aiding in the healing of wounds and replacement of damaged cells. They also serve enzymatic functions, as many enzymes involved in digestion, energy metabolism, and detoxification—such as amylase and pepsin—are protein-based. In addition, proteins are integral to immune function, helping form antibodies that protect the body against infections. Protein-based hormones like insulin and growth hormone regulate various body functions including metabolism and reproduction. Proteins also support transport and storage, with molecules like haemoglobin transporting oxygen in the blood, and albumin maintaining fluid balance. Although proteins are not the body's primary energy source, they can be used to provide energy (4 kcal/g) when carbohydrates and fats are insufficient.

Dietary proteins are classified based on their amino acid composition. Complete proteins contain all nine essential amino acids in adequate amounts and are typically found in animal-based sources like eggs, milk,



meat, poultry, and fish, as well as in some plant-based sources such as soybeans, quinoa, and chia seeds. On the other hand, incomplete proteins, such as those found in cereals, legumes, nuts, and seeds, lack one or more essential amino acids. However, when consumed in complementary combinations—for example, rice and beans—they can provide the full range of essential amino acids. Therefore, a well-balanced diet that includes a variety of protein sources is crucial for meeting the body's nutritional needs

and maintaining optimal health.

Table: 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)

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



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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. PEM has two major forms: Kwashiorkor and Marasmus. Kwashiorkor results from severe protein deficiency despite an adequate intake of calories, often from starchy foods. 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, 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, protein deficiency has other far-reaching consequences. One such outcome is weakened immune function, as protein is necessary for the synthesis of antibodies and immune cells. Without sufficient protein, the body becomes more prone to frequent infections, and recovery from illnesses is significantly delayed. 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 ²⁵ plays a key role in wound healing, as it supports the formation of new tissues. A deficiency slows down recovery from injuries, surgeries, or burns, 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. Infants and young children, especially in low-income or food-insecure regions, are highly vulnerable due to their rapid growth needs and dependence on others for food. 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, ⁶ 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 at risk if they do not properly plan their diets to include complete plant proteins or fortified alternatives.

¹³ In conclusion, protein is essential for maintaining body structure and function, and its deficiency can lead to a wide array of health complications. Preventing these outcomes requires awareness, dietary education, and accessible nutrition, especially for vulnerable populations. Simple strategies such as combining plant proteins, including dairy or soy-based options, and choosing lean meats or fish can go a long way in ensuring sufficient protein intake. Public health interventions aimed at reducing poverty, increasing food security, and providing nutrition education are crucial for preventing protein deficiency-related disorders globally.

Proteins are fundamental to life, performing structural, functional, regulatory, and immune roles ²⁰ in the body. A balanced diet with adequate protein ensures proper growth, repair, and immunity. While protein-rich foods are available from both animal and plant sources, special attention must be paid to combining plant proteins to meet essential amino acid needs. Protein deficiency, though preventable, ¹³ can have serious health consequences ranging from growth failure to life-threatening conditions like marasmus and kwashiorkor. Hence, ensuring adequate and quality protein intake is crucial for overall health.





Milk and Milk products

Milk is a white, nutrient-rich liquid produced by the mammary glands of mammals. It is considered 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: 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 vital role in human nutrition, offering a wide range of health benefits and physiological functions. One of the most well-known advantages of milk is its contribution to bone health, as it is rich in 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 serves as an important source of protein and energy, supporting not only physical growth but also cognitive development. In addition, milk is beneficial for dental health due to its high calcium and phosphorus content, which help in forming and maintaining strong teeth while preventing dental caries. Milk proteins, including casein and whey, also play a crucial role in muscle repair and maintenance, making milk a useful post-exercise recovery drink. Furthermore, the high-water content in milk contributes to hydration, assisting in maintaining the body's fluid balance. There are various types of milk available to suit different dietary needs and preferences. Whole milk contains about 3.5–4% fat and is energy-rich, whereas toned or reduced-fat milk offers a lower fat content of around 1.5–3%, making it suitable for those managing fat intake. Skimmed milk, with less



than 0.5% fat, is ideal for individuals seeking low-calorie, low-fat options without compromising on protein and calcium. Additionally, plant-based milk alternatives such as soy milk, almond milk, and oat milk have gained popularity among those who are lactose intolerant, allergic to milk proteins, or following vegan diets.

Milk is also the base for a wide array of dairy products, each with unique nutritional properties and culinary uses. Curd or yogurt (dahi) is produced by fermenting milk with lactic acid bacteria, making it rich in probiotics that promote gut health and digestion, along with calcium and protein. Cheese, a concentrated source of milk's fat and protein, is high in calcium, calories, and vitamin B12, though it should be consumed in moderation due to its saturated fat and sodium content. Paneer (cottage cheese), a staple in Indian cuisine, is a fresh, non-aged cheese rich in protein, calcium, and phosphorus, making it excellent for vegetarians seeking muscle-building nutrients. Butter and ghee, made from the fat component of milk or cream, are dense energy sources and contain fat-soluble vitamins (A, D, E, and K). Notably, ghee is highly valued in Ayurvedic medicine for its therapeutic properties. 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.

Understanding food groups, including dairy, is essential for planning a balanced diet. Food groups are classified based on similar nutrient



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: 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 ¹³reducing 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 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.

Conclusion

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 form the foundation of nutritional science and public health nutrition.

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

Type 2 Diabetes: Mellitus (T2DM) is a chronic and progressive metabolic disorder characterized by the body's inability to use insulin effectively, a condition known as insulin resistance, combined with an eventual relative insulin deficiency. This leads to persistent elevation of blood glucose levels, known as hyperglycemia. T2DM is the most common form of diabetes worldwide and generally develops gradually, often remaining undiagnosed for years due to its slow progression and initially mild symptoms. It typically affects adults over the age of 40, though its incidence is increasingly rising among younger populations, including children and adolescents, due to growing rates of obesity and sedentary lifestyles.

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;



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individuals with a family history of diabetes are at a significantly higher risk. Advancing age (especially over 40 years), a personal history of gestational diabetes (diabetes during pregnancy), and certain ethnic backgrounds—such as South Asians, African Americans, and Hispanics—are also important risk factors.

Symptoms of Type 2 diabetes often develop gradually and may be subtle or mistaken for other conditions. Common signs include increased thirst (polydipsia) and frequent urination (polyuria) as the body attempts to flush out excess glucose through the urine. Individuals may experience persistent fatigue, weakness, and blurred vision due to the osmotic effects of high blood sugar levels. 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.

Over time, uncontrolled diabetes can lead to a variety of serious complications. Chronic hyperglycaemia damages blood vessels and organs, significantly increasing the risk of cardiovascular diseases, such as heart attacks and strokes. Kidney damage (diabetic nephropathy) can progress to kidney failure if not managed properly. Nerve damage (diabetic neuropathy) may result in loss of sensation and mobility issues, while eye damage (retinopathy) can eventually lead to blindness if untreated. One of the most concerning outcomes is the development of foot ulcers, which, if infected and left untreated, may require amputation. The severity and progression of these complications are largely influenced by how well blood glucose, blood pressure, and lipid levels are controlled over time.

Fortunately, 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, 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 5–10% 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.

In conclusion, Type 2 Diabetes Mellitus is a serious but manageable condition

in conclusion, type 2 Diabetes mellitus is a serious but manageable condition that demands awareness, early diagnosis, and a commitment to long-term lifestyle changes. By adopting a nutritionally balanced diet, engaging in regular exercise, and seeking appropriate medical care, individuals can not only manage their blood sugar levels effectively but also reduce the risk of debilitating complications. Public health efforts should continue to focus on education, prevention, and accessible care to reduce the global burden of this increasingly prevalent disease.

Hypertension, 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 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 or adrenal gland disorders, or certain medications. Identifying the type of hypertension is essential for choosing the appropriate management strategy.

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



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of hypertension and aging also increase a person's risk. Although hypertension often develops gradually, it can exist for years without symptoms. When symptoms do occur, they may include headaches, dizziness, blurred vision, and in some cases, nosebleeds. However, these symptoms are not exclusive to hypertension and often appear only when blood pressure reaches dangerously high levels.

If left unmanaged, hypertension can lead to serious complications. These include an increased risk of stroke, heart attack, chronic kidney disease,

damage to the eyes (hypertensive retinopathy), and aneurysms—weakened blood vessel walls that can rupture. Long-term elevated blood pressure places constant stress on the cardiovascular system, leading to irreversible organ damage and increased mortality.

Diet and lifestyle changes are critical in both the prevention and management of hypertension. The DASH (Dietary Approaches to Stop Hypertension) diet is highly recommended. It emphasizes a diet low in sodium and rich in ²²fruits, vegetables, whole grains, lean proteins, and low-fat dairy. Avoiding processed and salty foods is crucial, as is ⁶maintaining 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. In cases where lifestyle changes are insufficient, doctors may prescribe antihypertensive medications, including ACE inhibitors, beta-blockers, or diuretics, to help control blood pressure ³⁵and reduce the risk of complications.

In **summary**, hypertension is a manageable but potentially deadly condition. Awareness, early detection through routine blood pressure checks, and a commitment to healthy lifestyle practices are essential in reducing its burden on individuals and public health systems.

Obesity – Causes, Risks, and Management

Obesity is a complex; chronic health condition defined as an abnormal or excessive fat accumulation that may impair health. It is primarily measured using the Body Mass Index (BMI), which is calculated by dividing a person's weight in kilograms by the square of their height in meters. A BMI of 30 kg/m² or higher is classified as obese, while a BMI between 25 and 29.9 kg/m² is considered overweight. While BMI does not account for muscle mass or fat



distribution, it remains a practical screening tool for population studies and clinical use.

The causes of obesity are multifactorial, often involving an interplay of lifestyle, biological, psychological, and environmental factors. The most common cause is an imbalance between energy intake and expenditure, where a person consumes more calories than they burn. Sedentary behavior, such as prolonged screen time or lack of physical activity, exacerbates this condition. 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. Additionally, 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 disturbances.

Obesity is not merely a cosmetic issue—it is associated with a broad range of serious health risks. Most notably, it significantly increases the risk of type 2 diabetes mellitus, due to insulin resistance caused by excess fat, especially around the abdomen. It is also a major risk factor for hypertension, coronary heart disease (CHD), and stroke. Obese individuals are more likely to develop osteoarthritis, particularly in weight-bearing joints like the knees and hips, due to increased mechanical stress. Furthermore, obesity has been linked to certain cancers, including breast, endometrial, and colon cancers. It can also lead to obstructive sleep apnea, where excess fat around the neck narrows the airway and disrupts breathing during sleep. In women, it may cause fertility issues and complications during pregnancy, such as gestational diabetes or preeclampsia.

Preventing and managing obesity requires a long-term, sustainable approach that addresses both lifestyle and behavioural factors. The foundation of weight management lies in adopting a calorie-controlled, nutrient-rich diet that includes adequate protein, vitamins, and minerals. This is best paired with regular physical activity, such as brisk walking, swimming, cycling, or strength training for at least 30 to 60 minutes per day. In cases where emotional or binge eating contributes to weight gain, behavioural therapy or



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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 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 role of nutrition in obesity prevention is central. Diets rich in high-fiber foods, such as fruits, vegetables, legumes, and whole grains, improve satiety and support gut health, which may aid in long-term weight regulation. Consuming healthy fats in moderation, such as olive oil, nuts, and avocados

Consuming healthy fats in moderation, such as olive oil, nuts, and avocados, can promote cardiovascular health without contributing to excessive calorie intake. It is essential to avoid trans fats, which are found in fried and packaged foods and have been linked to both weight gain and heart disease. Refined sugars and sugary drinks should be minimized, as they contribute to rapid blood sugar spikes and unnecessary calories. Practicing mindful eating—such as eating slowly, avoiding distractions during meals, and recognizing true hunger signals—can also help control portions and prevent overeating.

In **conclusion**, obesity is a preventable and manageable condition that requires a comprehensive approach involving dietary modifications, physical activity, behavioral support, and sometimes medical intervention. Its prevention is not only crucial for individual health but also for reducing the burden of related diseases like diabetes, hypertension, and heart disease on the healthcare system. Education, early intervention, and lifestyle changes are key strategies to combat this global health epidemic.

20 **Coronary Heart Disease (CHD)**, 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 common symptoms of CHD include chest pain or discomfort (commonly referred to as angina), shortness of breath, fatigue, palpitations, and, in severe cases, a heart attack (myocardial infarction). In many people, CHD may remain asymptomatic until it progresses to a more dangerous stage, which is why regular screening and early diagnosis are essential.

Complications arising from CHD can be life-threatening. These include heart attacks, heart failure (when the heart cannot pump blood efficiently), arrhythmias (irregular heart rhythms), and sudden cardiac arrest. The diagnosis of CHD typically involves a range of tests such as electrocardiograms (ECG), stress tests, echocardiograms, angiography, and blood tests to assess lipid profiles and other cardiovascular markers.

Effective prevention and management of CHD require a multi-faceted approach. A heart-healthy diet that is low in saturated fat and rich in fiber, fruits, and vegetables plays a foundational role. Regular physical activity, such as brisk walking or aerobic exercises, helps maintain cardiovascular fitness and manage weight. Controlling blood sugar levels in diabetics and blood pressure in hypertensive patients is also essential. Smoking cessation and moderation of alcohol consumption significantly reduce risk. In many cases, medications like statins, beta-blockers, or aspirin are prescribed to manage symptoms or prevent progression. In more advanced cases, surgical procedures like angioplasty (to open narrowed arteries) or coronary artery bypass surgery may be necessary.

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 fish like salmon or mackerel. It is advisable to avoid red and processed meats, reduce intake of salt, sugar, and alcohol, and consume



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more soluble fiber from foods like oats, legumes, fruits, and vegetables, which help lower cholesterol.

In **conclusion**, non-communicable diseases such as Type 2 Diabetes, Hypertension, Obesity, and CHD are closely linked and largely preventable through informed lifestyle and dietary choices. Since these conditions often occur together, addressing one can have a positive impact on the others. 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.

Fat-soluble vitamins—A, D, E, and K—are organic compounds that dissolve in fats and oils. Unlike water-soluble vitamins, they require dietary fat for absorption and are stored to varying extents in the liver and adipose tissue. **11** These vitamins play critical roles in vision, bone development, immune response, antioxidant protection, and blood coagulation. However, excessive intake can lead to toxicity due to their accumulation in body tissues. This write-up explores the functions, dietary sources, deficiencies, and toxicity risks associated with each of these essential nutrients.

Vitamin A

Vitamin A exists in two forms: preformed vitamin A (retinol and retinyl esters) found in animal products, and provitamin A (beta-carotene) derived from plant-based sources. **16** It plays a pivotal role in vision, particularly night vision, by forming part of rhodopsin in the retina. Vitamin A is also essential for cell differentiation, immune function, and skin integrity, contributing to epithelial tissue maintenance.

Dietary sources include liver, egg yolk, full-fat dairy, carrots, sweet potatoes, spinach, and mangoes. A deficiency can cause night blindness, xerophthalmia (dry-eye syndrome), increased susceptibility to infections, and impaired growth in children. On the other hand, excessive intake—especially from animal sources or supplements—can lead to hypervitaminosis A, with symptoms such as headache, skin irritation, hair loss, and liver damage. Pregnant women should avoid mega doses due to risk of fatal malformations.

Vitamin D



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Vitamin D is unique as it can be synthesized in the skin upon exposure to sunlight (UVB radiation), in addition to being obtained from dietary sources. It is vital for calcium and phosphorus homeostasis, facilitating intestinal calcium absorption, promoting bone mineralization, and preventing rickets in children or osteomalacia in adults. It also influences immune function and has been linked to benefits in mood regulation.

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.

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, anaemia, 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, and 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



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antibiotics. Fortunately, toxicity is rare, though excess vitamin K can interfere with anticoagulant medications.

Conclusion

11 Fat-soluble **11** vitamins A, D, E, and K are essential for many physiological processes including vision, bone health, antioxidant protection, and blood coagulation. Their fat-dependent absorption and tissue storage call for a mindful approach to both deficiency prevention and toxicity avoidance. A well-balanced diet—including animal-based and plant-based foods—along with sensible sun exposure and occasional supplementation, can help provide adequate levels of these vital nutrients. Monitoring intake through diet and healthcare guidance is crucial to maintain optimal health and prevent complications related to both deficiency and excess.

5 **Water-soluble 5** **vitamins are essential nutrients that** dissolve in water and are not stored in large quantities within the human body. Unlike fat-soluble vitamins, which are stored in fat tissues, water-soluble vitamins are excreted through urine if consumed in excess, making regular dietary intake necessary.

11 **These 11** **vitamins play critical roles in** energy production, cellular metabolism, growth, immunity, and the repair of tissues. Deficiencies, even though less likely to cause toxicity, can lead to significant health complications if not addressed promptly. 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).

16 **Thiamine (Vitamin B₁) 16** **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 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) functions 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. ¹⁶ 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) is essential for the formation of coenzymes NAD and NADP, which are central to metabolism, DNA repair, and antioxidant functions. Rich dietary ³¹ sources include meats, poultry, fish, legumes, whole grains, and fortified cereals. A deficiency of niacin leads to pellagra, historically prevalent in populations dependent on maize-based diets. Pellagra is classically characterized by the "three Ds": dermatitis, diarrhoea, and dementia. If left untreated, it can eventually result in death due to widespread dysfunction ¹⁵ in cellular energy production. The amino acid tryptophan can be converted into niacin, which adds a protective dietary factor if adequate protein is consumed.

Pyridoxine, also known as Vitamin B₆, is a water-soluble B-complex vitamin essential for numerous metabolic functions in the human body. It ¹⁴ plays a critical role in amino acid metabolism, neurotransmitter synthesis (including serotonin, dopamine, and GABA), haemoglobin formation, immune function, and hormonal regulation. The active coenzyme form, pyridoxal 5'-phosphate (PLP), is involved in over 100 enzyme 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



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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) 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) 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 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, 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.

In **conclusion**, 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. Because the body does not store these vitamins extensively, it is important to consume them regularly through a balanced and diverse diet. Deficiencies in these vitamins can lead to a variety of health disorders—some of which are life-threatening if not addressed. Public health initiatives such as dietary education, food fortification, and nutritional supplementation are essential tools in preventing vitamin deficiencies and promoting overall well-being across populations.

Minerals: Calcium, Iron, Iodine and Zinc

Minerals are inorganic nutrients that are essential for various physiological processes in the human body. Unlike vitamins, which are organic compounds, minerals do not contain carbon and are naturally occurring elements. They are broadly classified into two groups based on the quantity required by the body: microminerals (needed in larger amounts) and trace minerals (needed in smaller amounts). Macro minerals include calcium, phosphorus, magnesium, sodium, potassium, chloride, and sulphur. These are vital for building bones and teeth, maintaining fluid balance, nerve function, and muscle contraction. Trace minerals such as iron, iodine, zinc, selenium, copper, manganese, fluoride, and chromium play critical roles in oxygen



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transport, enzyme activity, immune response, thyroid function, and antioxidant protection. For example, calcium is essential for bone health, iron is necessary for haemoglobin production, iodine regulates thyroid hormones, and zinc supports immunity and wound healing. Dietary sources of minerals vary: dairy products, leafy greens, nuts, meat, seafood, legumes, and whole grains are all rich in different minerals. Both deficiencies and excesses can lead to health problems—calcium deficiency may cause osteoporosis, iron deficiency leads to anemia, and iodine deficiency can result in goiter. Conversely, excessive mineral intake, often through supplements, can cause toxicity symptoms like kidney stones (from too much calcium) or gastrointestinal distress (from too much zinc). Thus, a balanced diet that includes a variety of whole foods is the best way to ensure adequate and safe mineral intake, supporting overall health and disease prevention.

Calcium

Calcium is the most abundant mineral in the human body, essential for the development and maintenance of strong bones and teeth. About 99% of calcium is stored in the skeletal system, providing structural integrity, while the remaining 1% plays critical roles in muscle contraction, blood clotting, nerve transmission, and hormonal secretion. Important dietary sources include dairy products (milk, yogurt, cheese), green leafy vegetables (spinach, kale), fortified plant-based milks, and tofu made with calcium salts. A deficiency in calcium, often accompanied by insufficient vitamin D, can lead to osteoporosis in adults—characterized by brittle bones and an increased risk of fractures—and rickets in children, which results in bone deformities. Conversely, excessive intake from supplements can cause kidney stones or hypercalcemia, though this is uncommon with balanced dietary intake.

Iron

Iron is vital for oxygen transport, energy metabolism, and immune function. In the bloodstream, it forms part of haemoglobin in red blood cells, enabling oxygen delivery to tissues, and is also a component of myoglobin in muscles. Additionally, iron is required by enzymes involved in energy production and immune defense. There are two types of dietary iron: heme iron, sourced from meat, poultry, and fish, which is well-absorbed, and non-heme iron, found in plant foods, fortified grains, legumes, and dark leafy greens. Non-



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heme iron's absorption is enhanced by consuming it with vitamin C-rich foods. Iron deficiency is the most common micronutrient deficiency worldwide and causes iron-deficiency anemia, with symptoms such as fatigue, pallor, and impaired cognitive performance. On the other hand, excessive iron—usually from supplements—can lead to organ damage due to oxidative stress and is especially risky in individuals with genetic conditions like hemochromatosis.

Iodine

Iodine is a trace mineral crucial for the synthesis of thyroid hormones, which regulate metabolism, growth, and neurodevelopment. The body does not produce iodine, so it must be obtained from the diet. Rich sources include iodized salt, seafood (fish, seaweed, shellfish), dairy products, and some fortified foods. Iodine deficiency can lead to goiter—an enlargement of the thyroid gland—and hypothyroidism, with symptoms such as fatigue, weight gain, and slowed heart rate. In pregnant women, insufficient iodine increases the risk of cretinism, a condition in newborns marked by intellectual disability and growth failure. While iodine toxicity is rare, excessive intake from seaweed or supplements may cause thyroid overactivity or disrupt thyroid hormone balance.

Zinc

Zinc is a critical trace mineral involved in over 300 enzymatic reactions related to immune function, wound healing, DNA synthesis, protein metabolism, and growth and development. It also contributes to taste and smell perception and supports cell division. Dietary sources include oysters, red meat, poultry, beans, nuts, whole grains, and dairy. Zinc absorption can be inhibited by phytates, which are found in whole grains and legumes, but soaking or fermentation techniques can reduce this effect. Zinc deficiency manifests as impaired growth, delayed wound healing, increased susceptibility to infections, loss of appetite, taste disorders, and in severe cases, diarrhea or dermatitis. Conversely, excessive zinc intake—usually via supplements—can cause nausea, immune suppression, and interference with copper absorption.

Conclusion



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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

Multiple Choice Questions (MCQs)

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



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- A. Leafy vegetables
- B. Whole grains
- C. Animal-derived foods
- D. Citrus fruits

6. Which of the following is NOT a symptom of riboflavin (B₂) deficiency?

- A. Glossitis
- B. Cheilosis
- C. Edema
- D. Angular stomatitis

7. Vitamin C enhances the absorption of which mineral from plant-based sources?

- A. Calcium
- B. Zinc
- C. Iron
- D. Magnesium

8. A deficiency of which vitamin during pregnancy can lead to neural tube defects such as spina bifida?

- A. Riboflavin
- B. Vitamin B₉ (Folate)
- C. Vitamin C
- D. Vitamin B₁₂

9. Which water-soluble vitamin is a powerful antioxidant and helps in collagen synthesis?

- A. Thiamine
- B. Niacin
- C. Vitamin C
- D. Vitamin B₁₂

10. What is the condition caused by Vitamin C deficiency?

- A. Beriberi
- B. Pellagra
- C. Scurvy
- D. Anemia

B. Short Answer Questions



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- 1.Explain the two types of beriberi and the systems they affect.
- 2.Why are water-soluble vitamins required daily in the diet?
3. What are the symptoms of megaloblastic anemia caused by folate deficiency?
- 4.Name three good dietary sources of Vitamin C.
- 5.Name five important Vitamins wit examples

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.

UNIT-III

Food adulteration

Introduction

PFA definition of food adulteration

Food adulteration 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



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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.
 - 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.

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. Enforcement is carried out by Food Safety Officers who may inspect manufacturing sites, collect food samples, and seize adulterated goods.



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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 tonnes 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

Conclusion

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. Combined with consistent surveillance, rigorous regulation, and community



awareness, these efforts can significantly reduce adulteration and protect food safety in India.

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.

Types of Adulterants

Adulterants can be broadly categorized into:

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

Common Adulterants in Everyday Food Items

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



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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 (swelling due to fluid retention)
Edible oils	Mineral oil, castor oil	Increase volume	Heart and liver toxicity
Ghee/Butter	Vanaspati, starch	Falsify purity	Cardiac issues, poor digestion
Ice cubes (street)	Non-potable water	No cost for clean water	Waterborne diseases (typhoid, cholera)
Honey	Glucose or sugar syrup	Increase sweetness	Diabetes risk, impurity
Wheat flour (atta)	Chalk powder	Increase weight/whiteness	Digestive system damage
Pulses (masoor, arhar)	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



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- **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.

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
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



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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 can be contaminated with sand, stones, husks, or iron particles to increase weight, posing a choking hazard and digestive problems. Pulses are often polished with harmful dyes like lead chromate or mixed with Kesari dal, the latter linked to a debilitating condition called lathyrism. Spices, especially in powdered form, are frequently adulterated with toxic substances like methanal yellow in turmeric, brick powder in chili powder, and sawdust in coriander, all of which pose cancer and stomach-related risks. Even tea and coffee are not spared—used leaves dyed and mixed with iron filings in tea or tamarind seed powder in coffee lower their quality and can cause digestive issues. Fruits and vegetables may appear artificially fresh due to the use of chemical dyes like malachite green or ripening agents such as calcium carbide, both of which are toxic and linked to ulcers and cancer. Sugar and salt may be bulked up with chalk powder or borax, substances that are harmful when ingested over time. In the case of honey, adulteration with sugar syrup or jaggery syrup reduces its therapeutic value and poses risks to diabetic individuals. Ghee and edible oils are often adulterated with vanaspati, animal fats, or mineral oils, which can damage the liver and raise cholesterol levels. Ice creams and soft drinks may include non-edible substances such as washing powder or artificial colors, potentially leading to ulcers, throat infections, and poisoning. The health effects of consuming adulterated food can be severe, including food poisoning, organ damage, neurological disorders, cancer, hormonal disruption, and compromised immunity. To protect oneself, consumers must stay alert, use simple home tests to detect adulterants, prefer certified products, and avoid overly cheap or suspicious food items. Government regulations, strict food safety enforcement, and public awareness are crucial in combating the harmful practice of food adulteration and ensuring access to safe, nutritious food for all.

Conclusion

Food adulteration is a serious health threat and a legal offense. While it is driven by profit motives, its consequences are dangerous, especially for vulnerable populations like children, elderly, and pregnant women. Public



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awareness, regular food testing, strong laws, and responsible consumer behaviour 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.

Introduction to 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.

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.



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

Staphylococcal Food Poisoning

Etiology and Toxin Production: 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.

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.

Mechanism of Toxicity: Aflatoxin exposure damages the liver, causing acute toxicity with haemorrhage, edema, fatty change, and necrosis. Chronic exposure is strongly associated with hepatocellular carcinoma. Aflatoxin acts by forming DNA adducts and causing mutations in tumor suppressor genes like p53.

Clinical Manifestations: Acute aflatoxin poisoning (aflatoxicosis) is relatively rare and presents with liver failure, jaundice, vomiting, abdominal pain, and high mortality. Chronic exposure may lead to liver dysfunction, immune suppression, stunted growth in children, and increased cancer risk.

Diagnosis and Management: Diagnosis involves testing food/feed samples and measuring biomarkers such as aflatoxin-albumin adducts in serum or aflatoxin M₁ in urine. Treatment is largely supportive; in chronic cases, engaging in early cancer detection and liver care is crucial.

Prevention: Prevention focuses on reducing fungal growth via proper drying, storage, and moisture control of crops. Using good agricultural practices, such as timely harvest, cleaning grains, and using fungicidal treatments or biocontrol agents, is key. Regulatory enforcement of aflatoxin limits in food products, alongside public awareness strategies, aid in reducing health risks.

Public Health Implications and Prevention

Surveillance and Outbreak Response: Public health systems must maintain robust surveillance mechanisms to detect and respond to outbreaks of botulism, staphylococcal poisoning, and aflatoxin contamination. Confirmatory testing, prompt reporting, and trace-back investigations are critical for containing outbreaks and minimizing harm.

Education and Training: Raising awareness among food handlers, farmers, and consumers about safe food handling, proper storage, and early signs of contamination is vital. Training programs and campaigns are essential to reducing the incidence of accidental contamination.



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Regulatory Frameworks: 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.

Conclusion

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

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, ²⁴ 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 ²⁴ the rise of diet-related diseases like obesity, diabetes, hypertension, and heart disease, ²⁴ the importance of food labelling—especially nutritional labelling—has grown significantly in both public health and consumer behaviour.

Purpose and Components of Food Labels

Food labels serve several essential purposes. Primarily, they offer transparency between food manufacturers and consumers. The front and



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

Nutritional Labelling:

Nutritional labelling is a standardized declaration of the energy content and key nutrients per serving or per 100 grams/millilitres 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.



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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.

Legal and Regulatory Aspects

Most countries have regulatory authorities that set standards for food labelling. In India, ³ 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.

Conclusion



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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 Laws, Regulations, and Standards

Food laws, regulations, and standards 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.

Codex Alimentarius

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:



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

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, mislabelling 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.

Limitations of the PFA Act

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, ³the 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: 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



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Enforcement	Not enforced directly; advisory in nature	Enforced through legal provisions in India
Replaced By	Still active globally	Replaced by FSSA, 2006 in India

Conclusion

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.

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 ¹⁰ by the Directorate of Marketing and Inspection (DMI) 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.

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



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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.

Comparative Overview & Conclusion

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 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.

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



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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.

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 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.

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.



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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.

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 instil confidence in both domestic and global markets.

SELF ASSESSMENT QUESTIONS

Multiple Choice Questions (MCQs)



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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) Metanil 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
- C) Staphylococcal enterotoxin
- D) Listeria monocytogenes

6. Which chemical is commonly used as an artificial ripening agent for fruits and is considered unsafe?

- A) Borax
- B) Calcium carbide
- C) Lead acetate
- D) Alum



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7. The Codex Alimentarius Commission was established by:

- A) FSSAI and WHO
- B) WHO and FAO
- C) WTO and WHO
- D) BIS and FAO

8. Which of the following temperatures is suitable for storing chilled meat under MMPO guidelines?

- A) -4°C to -10°C
- B) 0°C to 7°C
- C) -18°C or lower
- D) 15°C to 20°C

9. Which food item is commonly adulterated with chalk powder?

- A) Ghee
- B) Salt
- C) Sugar
- D) Honey

10. Which of the following food laws was replaced by the FSSA, 2006 in India?

- A) Codex Alimentarius
- B) PFA Act, 1954
- C) BIS Act, 2016
- D) Agmark Act, 1937

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. What is the significance of Codex Alimentarius in global food safety?

C. Long Answer Questions

1. Discuss the objectives, key features, and limitations of the Prevention of Food Adulteration (PFA) Act, 1954.



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- 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.

UNIT-IV

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.

For

example:

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



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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 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.

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



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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 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.

Clinical Features of Undernutrition

Undernutrition manifests in distinct clinical forms:

Acute/Perm 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



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- 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.

Children often present multiple forms simultaneously. Behavioural 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 prelacteals increases vulnerability.

Preventive Strategies

Undernutrition requires multifaceted prevention.

Key strategies include:

Maternal Nutrition & IYCF

Improving women's nutritional status before and during pregnancy is critical, as is promoting exclusive breastfeeding for six months and timely, safe complementary feeding thereafter. Avoidance of prelacteal 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



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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 with moderate acute malnutrition further prevent progression to severe forms.

Conclusion

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.

National Nutrition Policy: Vision and Framework

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,



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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.

Integrated Child Development Services (ICDS): Origins and Reach

Launched on 2 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

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



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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 (with facial recognition enrolment) to ensure accurate beneficiary tracking, monitor attendance and nutrition delivery, and minimize leakages .

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.

Conclusion

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

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 ¹⁸ 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.

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.



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National Programmes for prevention of Anaemia, Vitamin Deficiency & Iodine Deficiency Disorders

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

- Anaemia control programmes 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 iodisation of edible salt, mandated by law. While non-iodised salt sales are banned across India, enforcement remains uneven. Distinguished public health leaders like Dr. Chandrakant Pandav have spearheaded mass awareness and community-level interventions to promote iodized salt adoption.

Interlinkages & Convergence with ICDS and Public Health Infrastructure

These micronutrient programmes operate synergistically with the ICDS, Mid-Day Meals, and National Health Mission, forming a multi-sectoral nutrition safety net. At Anganwadi centres and schools, children receive supplementary meals, growth monitoring, deworming, 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



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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 programmes, 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.

Conclusion

India's Mid-Day Meal Scheme alongside its national programmes for anaemia, 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

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



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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 objective of the Meat Products Order (MPO)?

- a) Increase meat exports
- b) Subsidize meat industry
- c) Ensure hygiene, safety, and standardization in meat processing
- d) Promote vegetarian diets

7.Which of the following products is covered under MPO regulation?

- a) Raw milk
- b) Sausages
- c) Canned vegetables
- d) Instant noodles

8.Who audits meat processing facilities for quality under BIS standards?

- a) State health departments
- b) Veterinary doctors
- c) Bureau of Indian Standards (BIS)
- d) Agricultural officers

9.Under MPO/MMPO, what is the required temperature range for



chilling (non-frozen) meat?

- a) 10–12 °C
- b) 0–7 °C
- c) –5 to –10 °C
- d) 5–15 °C

10. Which regulation provides uniform standards for food additives, labelling, and contaminants in India, including meat?

- a) Prevention of Food Adulteration Rules
- b) Indian Veterinary Code
- c) Food Products Standards and Food Additives Regulations, 2011
- d) National Animal Welfare Code

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. Why is temperature control critical in meat storage under MPO/MMPO?

C. Long Answer Questions

1. Critically examine the structure, implementation, and challenges of the Integrated Child Development Services (ICDS) scheme.
2. Analyse the objectives, nutritional standards, and implementation mechanisms of the Mid Day Meal Scheme.
3. Discuss the national programmes aimed at preventing anaemia, 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.



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lays 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,

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