

# 1. Introduction to Food Technology and Nutrition

Food Technology and Nutrition together form a broad, interdisciplinary field that connects **science**, **engineering**, and **health**.

**Food Technology** deals with converting raw materials into safe, nutritious, and shelf-stable food products.

**Nutrition** studies how food affects the human body, growth, health, and disease prevention.

Both fields aim to ensure that people get **safe, affordable, nutritious**, and **high-quality** food every day. As populations grow and lifestyles change, these fields are becoming increasingly important worldwide.

*Example:*

Transforming wheat grains into bread involves milling, dough preparation, fermentation, baking, and packaging — all steps of food technology. Understanding how bread provides carbohydrates, B-vitamins, and energy belongs to nutrition.

## 2. Historical Development of Food Technology

Food technology has ancient roots but modern scientific development only began in the 19th and 20th centuries.

### Early History

Drying, salting, smoking, and fermentation were early food-preservation methods. Ancient civilizations used pickling (India: pickles, Korea: kimchi).

### Industrial Age

In the 1800s, **canning** was invented to feed armies. Refrigeration and cold storage revolutionized food transportation.

### Modern Era

Pasteurization by Louis Pasteur.  
Freezing technology and freeze-drying.  
Food packaging innovations (Tetra Pak).  
Ready-to-eat (RTE) foods and instant foods.

*Example:*

Milk that spoils in one day can last for several months after **UHT (Ultra High Temperature)** processing.

### 3. Fundamentals of Nutrition

Nutrition focuses on the nutrients in food and how the body uses them.

#### Major Nutrients

**Carbohydrates** – energy (rice, bread, potatoes)

**Proteins** – growth and repair (pulses, eggs, chicken)

**Fats** – energy storage, insulation (nuts, oils, milk)

**Vitamins** – metabolic functions (vitamin C in citrus, vitamin D from sunlight)

**Minerals** – bones, blood, nerves (iron, calcium, sodium)

**Water** – hydration and digestion

**Dietary Fibre** – digestion (oats, vegetables)

#### Nutrition Science Studies

Digestion and absorption

Balanced diet

Malnutrition and lifestyle diseases

Nutritional needs of children, adults, pregnant women, elders

*Example:*

Iron deficiency leads to anemia; nutritionists recommend spinach, ragi, jaggery, and supplements.

### 4. Relationship Between Food Technology and Human Health

Food technology ensures **safety** and **quality**, while nutrition ensures **health benefits**. Together, they prevent diseases such as:

Obesity

Diabetes

Heart disease

Vitamin and mineral deficiencies

Modern food industries design foods that enhance health, e.g., fortified milk (vitamin D), fortified flour (iron, folic acid), and low-fat dairy.

*Example:*

Flour fortified with iron has helped reduce anemia in many developing countries.

## 5. Food Processing and Preservation Techniques

Food processing improves shelf life, safety, and convenience.

### Common Preservation Methods

**Thermal:** pasteurization, sterilization, dehydration

**Chemical:** preservatives, antioxidants

**Biological:** fermentation, probiotics

**Physical:** refrigeration, freezing, irradiation

### Primary vs. Secondary Processing

*Primary:* cleaning, sorting, milling

*Secondary:* baking, frying, canning

*Tertiary:* ready-to-eat and instant foods

*Example:*

Potatoes → washed → peeled → sliced → fried → flavored → packaged = potato chips.

## 6. Food Microbiology

Microorganisms are central to both food spoilage and food production.

### Important Microbes

**Beneficial:** Lactobacillus in curd

**Spoilage:** molds on bread

**Pathogenic:** Salmonella, E. coli

### Role in Industry

Dairy fermentation

Alcohol and beverage industries  
Probiotic development

*Example:*

Curd forms when bacteria convert lactose into lactic acid, giving it a sour taste and thick texture.

## 7. Food Chemistry

Food chemistry studies composition and molecular changes during processing.

### Key Areas

Carbohydrates (gelatinization in rice/pasta)  
Proteins (denaturation in boiling eggs)  
Fats and oils (rancidity)  
Enzymes (browning in apples)  
Flavor and color compounds

*Example:*

The golden brown color of fried foods is due to the **Maillard reaction** between sugars and proteins.

## 8. Food Quality and Safety

Ensuring safety is one of the most important responsibilities in food technology.

### Food Safety Concerns

Contamination (biological, chemical, physical)  
Adulteration  
Spoilage  
Packaging hazards  
Allergens

### Standards and Regulations

FSSAI (India)  
Codex Alimentarius  
HACCP (Hazard Analysis and Critical Control Points)

*Example:*

FSSAI sets limits on pesticide residues in vegetables to ensure safety.

## 9. Food Packaging and Storage

Packaging protects food from spoilage, damage, insects, and contamination.

### Functions of Packaging

- Protection
- Information (labels, nutrition facts)
- Convenience (resealable pouches)
- Marketing (branding)

### Types of Packaging

- Plastic, glass, metal, paperboard
- Vacuum packaging
- Modified Atmosphere Packaging (MAP)

*Example:*

Chips packets contain nitrogen gas to prevent breakage and rancidity.

## 10. Emerging Technologies in Food Science

Several modern technologies are transforming food production.

### Novel Technologies

- Extrusion technology** – noodles, pasta, breakfast cereals
- Nanotechnology** – smart packaging
- 3D Food Printing** – personalized nutrition
- Plant-based meats** – vegetarian protein alternatives
- Genetically modified crops (GM crops)**
- Cold plasma & pulsed electric fields** – non-thermal preservation

*Example:*

Textured vegetable protein (TVP) gives the feel of meat using only soy or pea protein.

## 11. Role of Nutrition in Public Health

Public health nutrition aims to improve the diet of entire populations.

### Key Areas

- Prevention of malnutrition
- School mid-day meals
- Vitamin supplementation programs
- Lifestyle disease management
- Diet planning and awareness campaigns

*Example:*

Iodized salt reduced goitre in millions of people globally.

## 12. Scope of Food Technology & Nutrition

The field has vast academic, research, and industry opportunities.

### Higher Studies

- M.Sc. Food Technology
- M.Sc. Nutrition & Dietetics
- Food Safety & Quality Management
- Dairy Science
- Food Engineering
- Clinical Nutrition

### Careers

- Food technologist
- Dietitian / clinical nutritionist
- Quality control officer
- Food safety auditor
- R&D scientist
- Product developer
- Regulatory officer
- Public health nutritionist

## 13. Industry Domains and Applications

Food Technology & Nutrition influence almost every food-related industry.

### Major Domains

**Dairy Industry** – milk, curd, cheese, ice cream

**Bakery & Confectionery** – breads, cakes, cookies, chocolates

**Meat, Fish & Poultry**

**Fruits & Vegetable Processing** – juices, jams, pickles, frozen products

**Beverage Industry** – soft drinks, coffee, tea, probiotic drinks

**Cereal & Pulses Technology** – flour mills, breakfast cereals

**Edible Oil Industry**

**Spices & Condiments**

**Nutraceuticals** – fortified foods, supplements

**Functional Foods** – probiotics, omega-3 foods

**Food Packaging Industry**

*Example:*

Amul uses advanced pasteurization and packaging to deliver milk to millions every day.

## 14. Economic and Social Relevance

The food sector is one of the largest industries in the world.

### Economic Benefits

Provides employment

Drives agriculture and manufacturing

Supports export markets

Encourages food startups

### Social Importance

Ensures food security

Reduces hunger

Improves quality of life

Supports health and wellbeing

*Example:*

Ready-to-cook idli/dosa batter industry supports working families with time-saving nutritious meals.

## 15. Future Prospects and Challenges

### Future Trends

- Personalized nutrition based on DNA
- Sustainable food production
- Zero-waste processing
- Lab-grown meat
- Climate-resilient crops
- AI in food inspection

### Major Challenges

- Ensuring food safety in a globalized supply chain
- Reducing food fraud
- Balancing taste, cost, nutrition, and sustainability
- Managing food waste
- Meeting dietary needs of growing populations

*Example:*

AI-powered cameras are used in factories to detect defects in fruits and vegetables.

## Conclusion

Food Technology and Nutrition play a crucial role in shaping human health, economic growth, and food security. By combining scientific knowledge, engineering skills, and nutritional understanding, this field works to ensure that food is **safe, nutritious, sustainable, affordable**, and available to all.

# Classification of Foods: Raw, Minimally Processed, Processed, and Ultra-Processed

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## 1. Introduction to Food Classification

Food classification helps us understand how foods change from their natural form by different processing methods. Processing is not always bad; some level of processing is essential for:

- Safety
- Convenience
- Shelf life
- Nutrition preservation

Foods are broadly divided into four categories:

1. **Raw foods**
2. **Minimally processed foods**
3. **Processed foods**
4. **Ultra-processed foods (UPFs)**

This classification is widely used in food science, public health nutrition, and modern food policy studies.

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## 2. Why Classification Matters

Understanding these categories helps us evaluate:

- Nutritional value
- Health impact
- Food safety

- Industrial processing levels
- Dietary recommendations

For example, raw fruits are healthier than ultra-processed snacks, but minimally processed items like pasteurized milk are still nutritious and safe.

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# RAW FOODS

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## 3. Definition of Raw Foods

**Raw foods** are those consumed in their natural state without any industrial or significant physical, chemical, or biological processing. They undergo only cleaning, cutting, or grading.

### Key Characteristics

- No heat treatment
- No preservatives
- No addition of sugar, salt, oil, or chemicals
- Minimal or no modification of nutrient structure

### Common Raw Foods

- Fresh fruits (banana, apple)
- Fresh vegetables (carrot, tomato)
- Raw nuts (peanuts, almonds)
- Whole grains before milling (wheat, rice)
- Raw meat, milk, eggs (though risky without proper handling)

*Example:*

A mango plucked from a tree and sold in a market after washing is a raw food.

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## 4. Nutritional and Safety Aspects of Raw Foods

### Nutritional Advantages

- Rich in vitamins, minerals, enzymes
- No added sugar or fat
- High in natural fiber
- Low energy density (healthy for weight control)

### Safety Concerns

- Contamination risk (bacteria, pesticides)
- Spoilage due to moisture
- Perishability (short shelf life)

*Example:*

Raw spinach has high vitamin C but spoils quickly and needs proper washing.

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## MINIMALLY PROCESSED FOODS

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### 5. Definition and Meaning

Minimally processed foods undergo slight changes to improve shelf life or safety **without altering their natural nutrient profile significantly.**

### Examples of Minimal Processing

- Washing
- Cutting or peeling
- Blanching
- Pasteurization
- Refrigeration or freezing
- Vacuum packing
- Drying grains or removing husks

## **Common Minimally Processed Foods**

- Packaged salads
- Pasteurized milk
- Refrigerated fruits and vegetables
- Polished rice
- Roasted nuts
- Chilled coconut water
- Frozen vegetables

*Example:*

Milk heated to destroy harmful microbes is still milk; it remains minimally processed.

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## **6. Benefits and Limitations of Minimally Processed Foods**

### **Benefits**

- Maintains natural taste and nutrition
- Improves safety (removes microbes)
- Increases shelf life
- Reduces preparation time

### **Limitations**

- Still requires refrigeration
- Some vitamin loss (especially vitamin C)
- Does not drastically improve flavor or convenience

*Example:*

Cut pineapple sold in a packet is safer and cleaner but slightly loses vitamin C.

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# PROCESSED FOODS

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## 7. Definition of Processed Foods

Processed foods undergo **moderate industrial processing** where additional ingredients such as **salt, sugar, oil, preservatives, or flavoring agents** may be added.

### Typical Processing Methods

- Canning
- Bottling
- Fermentation
- Drying
- Addition of stabilizers or preservatives
- Fortification (adding vitamins/minerals)

### Common Examples

- Cheese
- Bread
- Jams and jellies
- Pickles
- Salted peanuts
- Packaged chapati dough
- Breakfast cereals (mildly processed)
- Canned beans
- Tomato sauce

#### *Example:*

Bread made from flour, yeast, salt, and water is a processed food because ingredients and chemistry (fermentation + baking) change the natural form of wheat.

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## 8. Advantages and Concerns of Processed Foods

### Advantages

- Longer shelf life
- Greater convenience
- Enhanced safety (heating kills bacteria)
- Improved digestibility (fermented foods)
- Nutrient fortification possible

### Concerns

- Higher sodium and sugar content
- Potential use of preservatives
- Some loss of natural nutrition
- May encourage overeating due to taste enhancement

*Example:*

Pickles last months because of brine, vinegar, and spices, but they also have high salt.

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## ULTRA-PROCESSED FOODS (UPFs)

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### 9. Definition of Ultra-Processed Foods

Ultra-processed foods undergo **extensive industrial processing** and contain ingredients that **do not exist in traditional home kitchens**, such as:

- Emulsifiers
- Artificial sweeteners
- Flavour enhancers
- Color additives
- Hydrogenated oils
- Anti-caking agents
- Isolated proteins

- Industrial starches

They are designed to be **hyper-palatable** (tasty, addictive), long-lasting, and convenient.

This category is central to modern nutrition research because it is strongly linked with lifestyle diseases.

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## 10. Features of Ultra-Processed Foods

### Characteristics

- Highly modified structure
- Multiple manufacturing steps
- Often low in natural fiber
- High in calories, sugar, fats, and salt
- Attractive packaging
- Ready-to-eat or ready-to-heat
- Shelf stable for months

### Examples

- Chips and namkeens
- Biscuits and cookies
- Instant noodles
- Soft drinks and energy drinks
- Burgers, pizzas, nuggets (frozen)
- Flavored yogurt
- Packaged cakes
- Chocolate bars
- Artificial juices
- Breakfast cereals with high sugar

#### *Example:*

Instant noodles contain refined flour, emulsifiers, taste enhancers (MSG), colorants, and preservatives – making them ultra-processed.

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# 11. Health Impacts of Ultra-Processed Foods

UPFs are associated with:

- Obesity
- Diabetes
- Hypertension
- Heart diseases
- Fatty liver
- Childhood obesity
- Digestive issues (due to lack of fiber)
- Addictive eating patterns

## Why They Are Risky

- High calorie density
  - Highly palatable → overeating
  - Refined ingredients → rapid sugar spikes
  - Additives → long-term health uncertainty
  - Displacement of natural foods in the diet
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# COMPARATIVE ANALYSIS

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## 12. Nutritional Comparison Between the Four Categories

Category	Processing Level	Nutrition Quality	Additives	Shelf Life
Raw	None	Excellent	None	Short
Minimally Processed	Very Low	Very High	Minimal	Moderate
Processed	Medium	Good to moderate	Some	Long
Ultra-Processed	High	Poor	Many	Very long

*Real Example:*

- Raw corn is nutritious.
- Frozen corn is minimally processed.
- Canned corn (with salt) is processed.
- Corn chips are ultra-processed.

## **13. Food Industry Perspective**

### **Why industries use processing**

- Safety and hygiene
- Transport convenience
- Extended shelf life
- Consumer demand for ready-made foods
- Cost efficiency
- Attractive flavors and variety

Industrially, the shift toward **ultra-processed foods** is driven by:

- High profitability
- Long shelf life
- Large-scale distribution
- Strong consumer taste response

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# **PRACTICAL DIMENSIONS**

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## **14. How Consumers Can Make Healthier Choices**

### **Preferred Choices**

- Raw fruits and vegetables
- Minimally processed milk, curd, paneer

- Natural nuts and seeds
- Fresh cooked homemade meals

### **Consume in moderation**

- Pickles
- Bread
- Cheese
- Jaggery sweets
- Fermented foods

### **Limit or avoid**

- Packaged snacks
- Sugary beverages
- Instant foods
- Deep-fried UPFs
- Ready-to-eat frozen meals

*Simple Rule:*

“The longer the ingredient list, the more processed the product usually is.”

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## **15. Summary and Conclusion**

Food classification into **raw**, **minimally processed**, **processed**, and **ultra-processed** helps us understand how food moves from nature to the plate.

- **Raw foods** → best for nutrition
- **Minimally processed foods** → safe, convenient, still healthy
- **Processed foods** → have added ingredients and moderate changes
- **Ultra-processed foods** → convenient but high health risks

Knowing these categories helps students, consumers, and professionals make informed choices. For a healthier lifestyle, the goal is to **maximize fresh and minimally processed foods** and **minimize consumption of industrial, ultra-processed foods**.

# BASIC FOOD COMPOSITION

## What is Food?

Food is any substance that provides nourishment to the body. It supplies energy, helps in growth, repairs body tissues, and protects against diseases.

## Need for Food

Food is required to:

- Maintain life
- Produce energy for physical and mental activities
- Support growth and development
- Repair worn-out tissues
- Maintain body temperature and health

## Definition of Food Composition

**Food composition** refers to the various nutrients present in food and the proportion in which they occur, which are essential for normal growth and proper functioning of the human body.

Every food item contains more than one nutrient, but usually one nutrient is present in higher quantity.

## 2. Basic Components of Food

Food is composed of **six basic nutrients**:

1. Carbohydrates
2. Proteins
3. Fats
4. Vitamins
5. Minerals

6. Water

## 3. Carbohydrates

### Meaning

Carbohydrates are the **primary energy-giving nutrients** required by the human body.

### Energy Value

- 1 gram of carbohydrate provides **4 kilocalories (kcal)**

### Functions

- Provide energy for daily activities
- Essential for brain and nervous system function
- Prevent protein from being used as an energy source

### Types of Carbohydrates

#### *a) Simple Carbohydrates*

- Easily digestible
- Give quick energy

**Examples:** Sugar, honey, glucose, fruits

#### *b) Complex Carbohydrates*

- Digested slowly
- Provide sustained energy

**Examples:** Rice, wheat, millets, potatoes, pulses

### Sources

- Cereals

- Roots and tubers
- Fruits and vegetables

## 4. Proteins

### Meaning

Proteins are **body-building nutrients** essential for growth and repair of body tissues.

### Energy Value

- 1 gram of protein provides **4 kcal**

### Functions

- Growth and development of body cells
- Repair and maintenance of tissues
- Formation of enzymes, hormones, and antibodies
- Strengthen muscles and immunity

### Types of Proteins

#### *a) Animal Proteins*

- Contain all essential amino acids

**Examples:** Milk, eggs, fish, meat

#### *b) Plant Proteins*

- Deficient in one or more essential amino acids

**Examples:** Pulses, soybeans, nuts, lentils

### Protein Complementation

Combining cereals with pulses (e.g., rice and dal) provides complete protein.

## Protein Deficiency Diseases

- Kwashiorkor
- Marasmus

## 5. Fats

### Meaning

Fats are **concentrated sources of energy**.

### Energy Value

- 1 gram of fat provides **9 kcal**

### Functions

- Provide stored energy
- Protect internal organs
- Help absorb fat-soluble vitamins (A, D, E, K)
- Regulate body temperature

### Types of Fats

#### *a) Saturated Fats*

- Solid at room temperature
- Excess intake is harmful

**Examples:** Butter, ghee

#### *b) Unsaturated Fats*

- Liquid at room temperature
- Beneficial for heart health

**Examples:** Vegetable oils, nuts, seeds

## 6. Vitamins

### Meaning

Vitamins are **protective nutrients** required in very small quantities.

### Functions

- Regulate body processes
- Protect against diseases
- Maintain normal metabolism

### Classification of Vitamins

#### *Fat-Soluble Vitamins*

- Vitamins A, D, E, K
- Stored in the body

#### *Water-Soluble Vitamins*

- Vitamin B-complex, Vitamin C
- Not stored; need daily intake

### Important Vitamins and Deficiency Diseases

- Vitamin A – Vision – Night blindness
- Vitamin B – Energy metabolism – Beriberi
- Vitamin C – Immunity and wound healing – Scurvy
- Vitamin D – Bone formation – Rickets
- Vitamin K – Blood clotting – Excessive bleeding

## 7. Minerals

### Meaning

Minerals are **inorganic nutrients** needed for body structure and regulation.

### Important Minerals and Functions

#### *Calcium*

- Formation of bones and teeth
- Source: Milk, ragi, leafy vegetables

#### *Iron*

- Formation of hemoglobin
- Source: Green leafy vegetables, jaggery

#### *Iodine*

- Normal thyroid function
- Source: Iodized salt

### Mineral Deficiency Diseases

- Iron deficiency – Anemia
- Calcium deficiency – Weak bones
- Iodine deficiency – Goiter

## 8. Water

### Meaning

Water is the **most essential component of food**.

## Functions

- Regulates body temperature
- Aids digestion and absorption
- Removes waste through urine and sweat
- Acts as a medium for chemical reactions

## Daily Requirement

- About 2–3 liters per day, depending on climate and activity level

## 9. Balanced Diet

### Definition

A **balanced diet** is a diet that contains all nutrients in required amounts and proper proportions.

### Example of Balanced Indian Diet

- Rice/Chapati – Carbohydrates
- Dal/Egg – Proteins
- Vegetables – Vitamins and minerals
- Oils – Fats
- Water – Hydration

## 10. Conclusion

- Each nutrient plays a specific role in maintaining health
- Deficiency or excess intake of nutrients leads to health problems
- Understanding food composition helps in planning a balanced diet
- Balanced nutrition ensures growth, energy, and disease protection



# INTRODUCTION TO MACRONUTRIENTS AND MICRONUTRIENTS

## 1. Introduction

### What are nutrients?

Nutrients are chemical substances present in food that are essential for growth, energy, body functioning, and overall health.

### Why nutrients matter?

- They support body functions like breathing, digestion, circulation.
- They help build the body (muscles, bones, tissues).
- They protect against diseases.
- They give energy to carry out daily activities.

### Classification of Nutrients

Nutrients are broadly divided into two major groups:

1. **Macronutrients** – Required in **large amounts**. Provide energy and support growth.
2. **Micronutrients** – Required in **very small amounts**. Do not give energy but are essential for body functioning

## PART 1 — MACRONUTRIENTS

Macronutrients are nutrients required by our body in large quantities. They include:

1. **Carbohydrates**
2. **Proteins**
3. **Fats**
4. **Water (although not an energy nutrient, it is considered a macro due to quantity needed)**

## 1. Carbohydrates

### Definition

Carbohydrates are the body's primary source of energy. They break down into glucose, which fuels all body activities.

### Functions of Carbohydrates

- Provide energy to the brain, muscles, and nervous system.
- Prevents protein breakdown by supplying easy energy.

- Helps in fat metabolism (fat needs carbs to burn properly).
- Source of dietary fiber which helps digestion.

## Types of Carbohydrates

### 1. Simple Carbohydrates:

- Easily digested and give quick energy.
- Examples: sugar, honey, fruits, milk.

### 2. Complex Carbohydrates:

- Take longer to digest and provide sustained energy.
- Examples: rice, wheat, millets, oats, corn, potatoes.

### 3. Dietary Fiber:

- Cannot be digested by the human body.
- Aids bowel movement, prevents constipation, lowers cholesterol.
- Found in vegetables, fruits, whole grains, pulses.
- **Sources of Carbohydrates**
- Rice, wheat, millet, bread, chapati, potatoes, sweet potatoes, fruits, sugar, jaggery, cereals.

## Daily Requirement

- Around **45–65% of total daily calories** should come from carbs.

## 2. Proteins

### Definition

Proteins are the building blocks of the body. They are made up of amino acids and help in growth, repair, and maintenance of tissues.

### Functions of Proteins

- Build muscles, bones, skin, nails, hair.
- Repair damaged tissues.
- Produce enzymes, hormones, antibodies.
- Maintain fluid balance in the body.
- Provide energy when carbs and fats are insufficient.

## Types of Proteins

### 1. Complete Proteins (contain all essential amino acids):

- Animal sources: eggs, milk, cheese, fish, chicken.
- Some plant sources: soy, quinoa.

### 2. Incomplete Proteins (missing one or more essential amino acids):

- Plant sources: pulses, grains, nuts, seeds.
- Combining two incomplete proteins can make a complete protein—for example:
  - Rice + Dal
  - Chapati + Milk
  - Peanut + Jaggery

## Sources of Proteins

- Dal, beans, peas, chickpeas, milk, curd, paneer, chicken, fish, eggs, nuts.

## Daily Requirement

- **0.8–1.0 grams per kg body weight** (more for athletes).

## 3. Fats

### Definition

Fats are a concentrated source of energy. They are needed for cell structure, hormone production, and nutrient absorption.

### Functions of Fats

- Supply concentrated energy (9 kcal per gram).
- Protect organs and maintain body temperature.
- Help absorption of fat-soluble vitamins (A, D, E, K).
- Essential for brain development and nerve function.

### Types of Fats

#### 1. Saturated Fats (limit intake):

Found in butter, ghee, red meat, coconut oil.

#### 2. Unsaturated Fats (healthy fats):

- Monounsaturated: groundnut oil, olive oil, nuts.

- Polyunsaturated: sunflower oil, fish oil, soybean oil.

### 3. Trans Fats (avoid):

Found in bakery items, deep-fried snacks, vanaspati.

## Sources of Fats

Butter, ghee, oils, nuts, seeds, dairy products, meat, fish, avocados.

## Daily Requirement

- Should form **20–35% of total calories**.

## 4. Water

### Importance of Water

Although not an energy nutrient, water is a vital macronutrient.

### Functions

- Regulates body temperature.
- Helps digestion and nutrient absorption.
- Removes toxins through urine and sweat.
- Maintains cell and blood volume.
- Lubricates joints.

### Daily Requirement

- Average **2–3 liters** per day (varies by climate & physical activity).

## PART 2 — MICRONUTRIENTS

Micronutrients are nutrients needed in very small quantities but are crucial for survival.

They include:

1. **Vitamins**
2. **Minerals**

# 1. Vitamins

## Definition

Vitamins are organic compounds required for regulating body processes, preventing deficiencies, and supporting immunity.

## Classification of Vitamins

### A. Fat-Soluble Vitamins (stored in liver):

1. **Vitamin A** – Vision, skin health.
2. **Vitamin D** – Bone health, calcium absorption.
3. **Vitamin E** – Antioxidant, protects cells.
4. **Vitamin K** – Blood clotting.

### B. Water-Soluble Vitamins (not stored in body):

1. **Vitamin C** – Immunity, wound healing.
2. **Vitamin B-Complex** (B1, B2, B3, B6, B12, folate) – Energy production, nerve system, red blood cells.

## Examples of Vitamin Sources

- Vitamin A: carrot, spinach, papaya.
- Vitamin C: oranges, lemon, amla.
- Vitamin D: sunlight, egg yolk, fortified milk.
- Vitamin E: nuts, seeds, vegetable oils.
- Vitamin K: green leafy vegetables.
- B-Complex: whole grains, eggs, meat, legumes.

## Deficiency Examples

- Vitamin A: night blindness.
- Vitamin D: rickets, bone weakness.
- Vitamin C: scurvy.
- Vitamin B12: anemia, nerve problems.

# 2. Minerals

## Definition

Minerals are inorganic elements required for structural and regulatory functions in the body.

## Types of Minerals

### A. Major Minerals (required in larger amounts):

- **Calcium** – bones & teeth.
- **Phosphorus** – energy production.
- **Magnesium** – muscle and nerve function.
- **Potassium** – fluid balance, heart function.
- **Sodium** – nerve transmission, fluid balance.

### B. Trace Minerals (needed in small amounts):

- **Iron** – hemoglobin, oxygen transport.
- **Zinc** – immunity, healing.
- **Iodine** – thyroid hormone production.
- **Selenium** – antioxidant.
- **Copper** – iron metabolism.

## Sources of Minerals

- Calcium: milk, curd, ragi, spinach.
- Iron: leafy vegetables, jaggery, meat, beans.
- Zinc: nuts, seeds, meat.
- Potassium: bananas, coconut water, potatoes.
- Iodine: iodized salt, seafood.
- Magnesium: nuts, whole grains, green leaves.

## Deficiency Disorders

- Iron deficiency: anemia.
- Iodine deficiency: goiter.
- Calcium deficiency: osteoporosis.
- Zinc deficiency: poor immunity, hair fall.

# Conclusion

## Key Takeaways

- Macronutrients (carbs, proteins, fats, water) are required in large amounts and give energy.
- Micronutrients (vitamins and minerals) are required in small amounts but essential for body functions.

- Balanced diet = right proportion of both.
- Deficiency or excess of any nutrient can cause health issues.
- Teaching students about nutrients helps them make better food choices.

# MODULE 1

## PRINCIPLES OF NUTRITION AND BALANCED DIET

### 1. Introduction to Nutrition

**Nutrition** is the science that deals with the study of food, nutrients, and their effect on the human body. It explains how food nourishes the body, supports growth, provides energy, and maintains health.

Nutrition is essential because:

- It provides energy for daily activities
- Helps in growth and development
- Repairs worn-out tissues
- Maintains immunity and resistance to diseases
- Supports mental and physical well-being

Poor nutrition can lead to health problems such as malnutrition, obesity, anemia, diabetes, and heart diseases.

### 2. Nutrients – Basic Concept

**Nutrients** are chemical substances present in food that are required by the body to perform various functions.

Nutrients are broadly classified into:

1. **Macronutrients** – required in large amounts
2. **Micronutrients** – required in small amounts

Additionally:

- Water
- Dietary fiber

are also essential components of nutrition.

## 3. Macronutrients

Macronutrients provide **energy** and form the **structural components** of the body.

### 3.1 Carbohydrates

Carbohydrates are the **primary source of energy** for the body.

#### *Functions:*

- Provide quick energy
- Support brain function
- Spare proteins from being used as energy
- Help in proper digestion when fiber is present

#### *Types of Carbohydrates:*

1. **Simple carbohydrates** – sugars (glucose, fructose)
2. **Complex carbohydrates** – starch, dietary fiber

#### *Sources:*

- Rice, wheat, maize
- Bread, cereals
- Fruits and vegetables
- Sugar, jaggery, honey

#### *Energy value:*

- 1 gram carbohydrate = **4 kcal**

Excess intake may lead to obesity and diabetes.

## 3.2 Proteins

Proteins are known as **body-building nutrients**.

### *Functions:*

- Growth and repair of tissues
- Formation of enzymes and hormones
- Support immune system
- Maintenance of muscles

### *Types of Proteins:*

1. **Complete proteins** – contain all essential amino acids (animal sources)
2. **Incomplete proteins** – lack one or more essential amino acids (plant sources)

### *Sources:*

- Milk, eggs, meat, fish
- Pulses, lentils, beans
- Soybean, nuts

### *Energy value:*

- 1 gram protein = **4 kcal**

Protein deficiency can cause **kwashiorkor** and **marasmus**.

## 3.3 Fats

Fats are concentrated sources of energy.

### *Functions:*

- Provide stored energy
- Help absorption of fat-soluble vitamins (A, D, E, K)
- Protect organs
- Maintain body temperature

### ***Types of Fats:***

1. **Saturated fats** – animal fats, butter
2. **Unsaturated fats** – vegetable oils, nuts
3. **Trans fats** – processed and fried foods (harmful)

### ***Sources:***

- Oils, ghee, butter
- Nuts and seeds
- Meat and dairy products

### ***Energy value:***

- 1 gram fat = **9 kcal**

Excess fat intake leads to heart disease and obesity.

## **4. Micronutrients**

Micronutrients do not provide energy but are essential for **metabolic functions**.

### **4.1 Vitamins**

Vitamins are organic compounds required in small amounts.

#### ***Fat-soluble vitamins:***

- **Vitamin A** – vision, immunity
- **Vitamin D** – bone health
- **Vitamin E** – antioxidant
- **Vitamin K** – blood clotting

#### ***Water-soluble vitamins:***

- **Vitamin B-complex** – energy metabolism
- **Vitamin C** – immunity, wound healing

#### ***Deficiency diseases:***

- Vitamin A – night blindness

- Vitamin D – rickets
- Vitamin C – scurvy

## 4.2 Minerals

Minerals are inorganic elements essential for body structure and function.

### ***Major minerals:***

- Calcium – bones and teeth
- Phosphorus – energy metabolism
- Sodium and Potassium – fluid balance

### ***Trace minerals:***

- Iron – hemoglobin formation
- Iodine – thyroid function
- Zinc – immunity

### ***Deficiency problems:***

- Iron – anemia
- Iodine – goiter

## 5. Water and Dietary Fiber

### **Water:**

- Regulates body temperature
- Helps digestion and absorption
- Removes waste products

### **Dietary Fiber:**

- Improves digestion
- Prevents constipation
- Reduces risk of heart disease

Sources: fruits, vegetables, whole grains

## 6. Principles of Nutrition

The **principles of nutrition** are guidelines that help maintain good health.

### 1. Adequacy

Diet should provide all essential nutrients.

### 2. Balance

Proper proportion of carbohydrates, proteins, fats, vitamins, and minerals.

### 3. Calorie Control

Energy intake should match energy expenditure.

### 4. Variety

Include different types of foods to avoid deficiencies.

### 5. Moderation

Avoid excess intake of sugar, salt, and fats.

### 6. Nutrient Density

Choose foods rich in nutrients rather than empty calories.

## 7. Balanced Diet

A **balanced diet** is a diet that contains all nutrients in the right quantities and proportions according to age, sex, and activity level.

### Components of a Balanced Diet:

- Cereals and grains
- Pulses and legumes
- Milk and animal foods

- Fruits and vegetables
- Fats and oils

### **Characteristics:**

- Meets energy needs
- Prevents nutrient deficiencies
- Promotes growth and health

### **Importance:**

- Improves immunity
- Enhances work efficiency
- Prevents lifestyle diseases

# **DIETARY GUIDELINES (ICMR & WHO)**

## **1. Introduction to Dietary Guidelines**

Dietary guidelines are **scientifically developed recommendations** that help people choose healthy foods and eating patterns to maintain health, prevent nutrient deficiencies, and reduce the risk of diseases.

Two major organizations that provide dietary guidelines are:

- **ICMR (Indian Council of Medical Research)** – for Indian population
- **WHO (World Health Organization)** – global health guidance

These guidelines are based on age, sex, physical activity, physiological condition, and cultural food habits.

## 2. Objectives of Dietary Guidelines

The main objectives are:

- To promote overall health and well-being
- To prevent malnutrition (undernutrition and overnutrition)
- To reduce lifestyle diseases like diabetes, obesity, heart disease
- To guide people in selecting a balanced and nutritious diet
- To improve immunity and quality of life

## 3. ICMR Dietary Guidelines for Indians

The **ICMR–NIN (National Institute of Nutrition)** provides dietary guidelines suitable for Indian food habits.

### 3.1 Eat a Variety of Foods

No single food provides all nutrients.

- Combine cereals, pulses, vegetables, fruits, milk, and oils
- Variety ensures adequacy of all nutrients

### 3.2 Maintain Ideal Body Weight

- Balance between energy intake and energy expenditure
- Regular physical activity is essential
- Prevents obesity and undernutrition

### **3.3 Choose Cereals, Millets, and Whole Grains**

- Prefer whole grains over refined grains
- Millets like ragi, jowar, bajra are rich in fiber and minerals
- Provide sustained energy

### **3.4 Include Pulses, Legumes, and Animal Foods**

- Pulses are major protein sources for vegetarians
- Animal foods provide high-quality proteins and micronutrients
- Combination improves protein quality

### **3.5 Eat Plenty of Vegetables and Fruits**

- Green leafy vegetables provide iron and folic acid
- Fruits provide vitamins, minerals, and antioxidants
- Helps prevent micronutrient deficiencies

### **3.6 Consume Milk and Milk Products Adequately**

- Important source of calcium and protein
- Essential for bone and teeth health
- Especially important for children, adolescents, pregnant women

### **3.7 Limit Fat, Sugar, and Salt Intake**

- Excess fat leads to obesity and heart disease
- High sugar intake causes diabetes and dental caries
- Excess salt increases blood pressure

### **3.8 Use Oils and Fats Judiciously**

- Prefer vegetable oils
- Avoid repeated heating of oils
- Limit fried and processed foods

### **3.9 Drink Safe and Adequate Water**

- Prevents dehydration
- Maintains digestion and metabolism
- Safe water prevents water-borne diseases

### **3.10 Ensure Food Safety and Hygiene**

- Wash hands before eating
- Proper cooking and storage of food
- Prevents food-borne illnesses

## **4. WHO Dietary Guidelines**

WHO provides global dietary recommendations to prevent non-communicable diseases.

### **4.1 Achieve Energy Balance**

- Balance calorie intake with physical activity
- Prevents overweight and obesity

### **4.2 Increase Intake of Fruits and Vegetables**

- At least 400 grams per day

- Reduces risk of heart disease, cancer

### **4.3 Reduce Fat Intake**

- Limit total fat intake
- Avoid trans fats
- Prefer unsaturated fats

### **4.4 Limit Free Sugars**

- Free sugars should be less than 10% of total energy
- Reduces obesity and dental problems

### **4.5 Reduce Salt Intake**

- Less than 5 grams per day
- Prevents hypertension and stroke

### **4.6 Choose Healthy Protein Sources**

- Lean meats, fish, pulses, nuts
- Supports growth and repair

## **5. Comparison of ICMR and WHO Guidelines**

- ICMR focuses on Indian dietary patterns
- WHO provides global recommendations
- Both emphasize balanced diet, variety, moderation, and physical activity

## 6. Importance of Following Dietary Guidelines

- Prevents malnutrition
- Reduces lifestyle diseases
- Improves immunity
- Enhances physical and mental performance

# ENERGY REQUIREMENTS

## Basics of BMR and TDEE

### 1. Introduction to Energy Requirements

#### What is Energy?

- **Energy** is the capacity of the body to do work.
- In nutrition, energy is required for:
  - Breathing
  - Heartbeat
  - Digestion
  - Physical activity
  - Growth and repair
  - Maintaining body temperature

#### Source of Energy

- Energy comes from **food**, mainly:
  - **Carbohydrates**
  - **Fats**
  - **Proteins** (secondary source)

## Units of Energy

- **Kilocalorie (kcal)** – commonly used in nutrition
- **Calorie** – small unit (1 kcal = 1000 calories)

## Why Do We Study Energy Requirements?

- To:
  - Plan balanced diets
  - Prevent undernutrition and overnutrition
  - Maintain healthy body weight
  - Improve physical performance
  - Prevent lifestyle diseases like obesity and diabetes

## 2. Basal Metabolic Rate (BMR)

### Definition of BMR

**Basal Metabolic Rate (BMR)** is the **minimum amount of energy required by the body at complete rest** to maintain vital functions.

👉 In simple words:

**Energy needed just to stay alive**

### Functions Supported by BMR

BMR energy is used for:

- Breathing
- Blood circulation

- Heart function
- Brain activity
- Kidney and liver function
- Maintaining body temperature

⚠ BMR does **not** include:

- Physical activity
- Digestion
- Exercise

## Conditions for Measuring BMR

BMR is measured under strict conditions:

- Early morning
- After 8–12 hours fasting
- Complete physical and mental rest
- Comfortable temperature
- Awake but relaxed state

## Factors Affecting BMR

### 1. Age

- BMR is **high in children**
- Decreases with age due to loss of muscle mass

## **2. Gender**

- Males usually have higher BMR than females
- Due to greater muscle mass

## **3. Body Size and Composition**

- More muscle = higher BMR
- Fat tissue requires less energy than muscle

## **4. Growth**

- Infants, children, adolescents → higher BMR

## **5. Hormones**

- Thyroid hormones increase BMR
- Hypothyroidism decreases BMR

## **6. Climate**

- Cold climate → higher BMR
- Hot climate → lower BMR

## **7. Health Status**

- Fever, infections → increase BMR
- Malnutrition → decreases BMR

## **Importance of BMR**

- Forms the **largest part of daily energy expenditure**
- Helps in:

- Calculating total calorie needs
- Weight management
- Diet planning
- Clinical nutrition

### 3. Total Daily Energy Expenditure (TDEE)

#### Definition of TDEE

**Total Daily Energy Expenditure (TDEE)** is the **total amount of energy used by the body in one day.**

👉 It includes:

1. BMR
2. Physical activity
3. Thermic effect of food

#### Components of TDEE

##### 3.1 Basal Metabolic Rate (BMR)

- Accounts for **60–70%** of total energy expenditure
- Energy needed for vital body functions

## 3.2 Physical Activity Energy Expenditure (PAEE)

### Definition

Energy spent during:

- Daily activities
- Work
- Exercise
- Household chores

### Examples

- Walking
- Standing
- Climbing stairs
- Manual work
- Sports

### Percentage Contribution

- **15–30%** of TDEE (varies widely)

### Activity Levels

- Sedentary: office work, sitting
- Moderate: walking, teaching, light exercise
- Heavy: farming, construction, athletes

### 3.3 Thermic Effect of Food (TEF)

#### Definition

Energy required for:

- Digestion
- Absorption
- Metabolism of food

#### Contribution

- About **10% of total energy intake**

#### Effect of Macronutrients

- Protein → highest TEF
- Carbohydrates → moderate
- Fat → lowest

### 4. Relationship Between BMR and TDEE

Aspect	BMR	TDEE
Meaning	Energy at rest	Total daily energy
Includes activity	No	Yes
Includes digestion	No	Yes
Use	Base calculation	Final calorie need

👉 **TDEE = BMR + Physical Activity + Thermic Effect of Food**

## 5. Importance of TDEE in Nutrition

### Why TDEE is Important

- Helps in:
  - Weight maintenance
  - Weight loss
  - Weight gain
  - Personalized diet planning

### Weight Balance Concept

- Energy intake = Energy expenditure → weight maintenance
- Intake > expenditure → weight gain
- Intake < expenditure → weight loss

# NUTRIENT DENSITY vs CALORIE DENSITY

## 1. Introduction

### Why Study Food Quality, Not Just Quantity?

- People often focus only on **how many calories** they eat.
- But **where those calories come from** is equally important.
- Two foods may provide the same calories but very different health benefits.

👉 This leads to the concepts of:

- **Nutrient Density**
- **Calorie Density**

## 2. Nutrient Density

### Definition of Nutrient Density

**Nutrient density** refers to the **amount of essential nutrients present in a food relative to its calorie content.**

👉 In simple words:

**More nutrients for fewer calories**

### What Are Essential Nutrients?

- Vitamins
- Minerals
- Proteins
- Dietary fiber
- Essential fatty acids

### Characteristics of Nutrient-Dense Foods

- High in vitamins and minerals
- Rich in fiber
- Moderate or low in calories

- Low in added sugars and unhealthy fats

## **Examples of Nutrient-Dense Foods**

- Green leafy vegetables (spinach, fenugreek)
- Fruits (guava, orange, apple)
- Whole grains (brown rice, millets)
- Pulses and legumes (dal, chickpeas)
- Milk, curd
- Eggs
- Nuts and seeds (in moderate amounts)

## **Benefits of Nutrient-Dense Foods**

- Prevent micronutrient deficiencies
- Improve immunity
- Support growth and development
- Promote healthy weight
- Reduce risk of lifestyle diseases

## **Importance in Indian Diet Context**

- Helps address:
  - Anaemia
  - Vitamin A deficiency
  - Calcium deficiency
- Aligns with ICMR dietary guidelines

## 3. Calorie Density

### Definition of Calorie Density

**Calorie density** refers to the **number of calories present per unit weight or volume of food.**

👉 In simple words:

**More calories in a small amount of food**

### Factors Affecting Calorie Density

1. Fat content (fat = 9 kcal/g)
2. Sugar content
3. Water content (more water → lower calorie density)
4. Fiber content

### High Calorie-Dense Foods

- Fried foods
- Fast foods
- Sweets and desserts
- Bakery items
- Sugar-sweetened beverages
- Chips, namkeen

### Low Calorie-Dense Foods

- Vegetables

- Fruits
- Soups
- Salads
- Whole grains

### Impact of High Calorie-Dense Diet

- Excess calorie intake
- Weight gain and obesity
- Increased risk of diabetes and heart disease
- Poor micronutrient intake

## 4. Comparison: Nutrient Density vs Calorie Density

Aspect	Nutrient Density	Calorie Density
Focus	Nutrients per calorie	Calories per amount
Health value	High	May be low
Common sources	Fruits, vegetables	Fried & processed foods
Effect on weight	Helps control weight	Leads to weight gain
Diet quality	Improves	May reduce

## 5. Real-Life Examples

### Example 1

- 100 kcal from vegetables → many vitamins & fiber

- 100 kcal from chips → fat and salt, few nutrients

## **Example 2**

- Apple vs sweet biscuit  
Both provide calories, but apple is more nutrient-dense.

## **6. Importance in Diet Planning**

### **For Weight Management**

- Choose low calorie-dense but nutrient-dense foods
- Eat larger portions without excess calories

### **For Children and Adolescents**

- Ensure growth with quality nutrients

### **For Elderly**

- Prevent deficiencies with limited calorie needs

### **For Athletes**

- Balance nutrient density with higher calorie needs

# FOOD GROUPS AND PLATE MODELS

## 1. Introduction to Food Groups

### What Are Food Groups?

**Food groups** are categories of foods that provide **similar nutrients** and perform **similar functions** in the body.

### Why Do We Classify Foods?

- To understand nutrient contribution
- To plan balanced meals
- To avoid deficiencies
- To improve overall health

👉 No single food provides all nutrients; therefore, **variety is essential**.

## 2. Basic Food Groups

Food groups may be classified in different ways. The most commonly used system includes **five major food groups**.

### 2.1 Cereals and Millets (Energy-Giving Group)

#### Examples

- Rice, wheat, maize

- Millets: ragi, jowar, bajra
- Bread, chapati, dosa

### **Major Nutrients**

- Carbohydrates
- Some protein
- B-complex vitamins
- Dietary fiber (whole grains)

### **Functions**

- Provide energy
- Support brain and muscle function

## **2.2 Pulses, Legumes, Nuts & Seeds (Body-Building Group)**

### **Examples**

- Bengal gram, green gram, black gram
- Lentils, peas
- Groundnuts, almonds, sesame seeds

### **Major Nutrients**

- Proteins
- Iron
- B-vitamins
- Healthy fats (nuts and seeds)

## Functions

- Growth and repair of tissues
- Muscle development
- Blood formation

## 2.3 Milk and Animal Foods (Body-Building Group)

### Examples

- Milk, curd, paneer
- Eggs
- Fish, meat, poultry

### Major Nutrients

- High-quality protein
- Calcium
- Vitamin B12
- Iron (especially in meat)

### Functions

- Strong bones and teeth
- Muscle building
- Growth and immunity

## 2.4 Vegetables and Fruits (Protective Group)

### Vegetables

- Green leafy vegetables (spinach, amaranth)
- Other vegetables (carrot, pumpkin, tomato)

### Fruits

- Citrus fruits, banana, apple, papaya

### Major Nutrients

- Vitamins (A, C, folate)
- Minerals
- Dietary fiber
- Antioxidants

### Functions

- Protect against infections
- Improve digestion
- Prevent micronutrient deficiencies

## 2.5 Fats, Oils, Sugar (Energy-Dense Group)

### Examples

- Ghee, butter, oils
- Sugar, jaggery, honey

## Major Nutrients

- Fats
- Simple carbohydrates

## Functions

- Concentrated energy source
- Helps absorption of fat-soluble vitamins

⚠️ Should be consumed **in moderation**.

## 3. Concept of Balanced Diet

A **balanced diet** includes foods from **all food groups** in appropriate proportions to meet daily nutrient needs.

Key Principles:

- Variety
- Moderation
- Proportion

## 4. Plate Models – Visual Guide to Balanced Eating

### What Is a Plate Model?

A **plate model** is a **visual representation** showing the **proportion of different food groups** on a plate for a balanced meal.

👉 It simplifies nutrition education.

## 4.1 Indian Balanced Plate (ICMR / My Plate Concept)

### Plate Division (General Concept)

- **½ plate** – Vegetables and fruits
- **¼ plate** – Cereals / whole grains
- **¼ plate** – Protein foods (pulses, eggs, meat)
- Small amount of fats and oils
- Milk or curd on the side

### Advantages

- Easy to understand
- Culturally adaptable
- Promotes nutrient-dense foods

## 4.2 MyPlate Model (International Concept)

### Plate Composition

- Vegetables
- Fruits
- Grains
- Protein
- Dairy (on the side)

## **Key Message**

**“Make half your plate fruits and vegetables”**

## **4.3 Traditional Indian Thali as Plate Model**

### **Components**

- Rice or roti
- Dal
- Vegetable curry
- Curd
- Small amount of oil or ghee

### **Significance**

- Naturally balanced
- Culturally acceptable
- Sustainable diet model

## **5. Importance of Food Groups and Plate Models**

### **Health Benefits**

- Prevent malnutrition
- Control body weight
- Reduce lifestyle diseases
- Improve digestion and immunity

## **For Different Age Groups**

- Children – growth and development
- Adults – productivity and health
- Elderly – disease prevention

# MODULE- 3

## DIGESTIVE SYSTEM – OVERVIEW

### 1. Introduction to the Digestive System

#### What is Digestion?

**Digestion** is the process by which food is:

- Broken down into simpler substances
- Absorbed into the body
- Used for energy, growth, and repair

#### Why is Digestion Important?

- Nutrients in food are not usable in their original form
- Digestion converts food into absorbable forms
- Without digestion, nutrition is not possible

### 2. Major Functions of the Digestive System

The digestive system performs the following functions:

1. **Ingestion** – taking food into the mouth
2. **Digestion** – mechanical and chemical breakdown of food
3. **Absorption** – passage of nutrients into blood and lymph
4. **Assimilation** – use of nutrients by body cells
5. **Egestion** – removal of undigested waste

### 3. Parts of the Digestive System

The digestive system consists of:

- **Alimentary canal**
- **Accessory digestive organs**

## **3.1 Alimentary Canal (Digestive Tract)**

### **3.1.1 Mouth (Oral Cavity)**

- Entry point of food
- Teeth help in chewing (mechanical digestion)
- Saliva contains **salivary amylase**
- Begins digestion of carbohydrates

### **3.1.2 Pharynx**

- Common passage for food and air
- Helps in swallowing

### **3.1.3 Oesophagus**

- Muscular tube connecting mouth to stomach
- Moves food by **peristalsis**

### **3.1.4 Stomach**

- J-shaped muscular organ
- Stores food temporarily
- Secretes gastric juice:
  - Hydrochloric acid (HCl)
  - Pepsin enzyme

## Functions

- Protein digestion begins
- Kills harmful bacteria
- Converts food into semi-liquid form (chyme)

### 3.1.5 Small Intestine

- Longest part of digestive tract
- Divided into:
  - Duodenum
  - Jejunum
  - Ileum

## Functions

- Complete digestion of carbohydrates, proteins, and fats
- Major site of **absorption**

## Special Feature

- Villi and microvilli increase surface area for absorption

### 3.1.6 Large Intestine

- Includes caecum, colon, rectum
- Absorbs water and electrolytes
- Forms and stores feces

### 3.1.7 Anus

- Final opening
- Expels waste from the body

## **3.2 Accessory Digestive Organs**

### **3.2.1 Salivary Glands**

- Produce saliva
- Help in lubrication and carbohydrate digestion

### **3.2.2 Liver**

- Largest gland in the body
- Produces bile
- Bile helps in fat digestion and absorption

### **3.2.3 Gall Bladder**

- Stores and concentrates bile
- Releases bile into small intestine

### **3.2.4 Pancreas**

- Secretes pancreatic juice
- Contains enzymes for:
  - Carbohydrates
  - Proteins
  - Fats

## 4. Digestion of Major Nutrients

### Carbohydrates

- Begins in mouth
- Completed in small intestine
- Final product: Glucose

### Proteins

- Begins in stomach
- Completed in small intestine
- Final product: Amino acids

### Fats

- Digested mainly in small intestine
- Bile emulsifies fats
- Final products: Fatty acids and glycerol

## 5. Absorption and Transport of Nutrients

- Absorption mainly occurs in small intestine
- Nutrients enter:
  - Blood (glucose, amino acids)
  - Lymph (fats)
- Transported to body tissues for use

## 6. Importance of Digestive System in Nutrition

- Determines nutrient availability

- Influences nutritional status
- Poor digestion leads to malnutrition
- Supports growth, energy, and immunity

## 7. Common Digestive Disorders

- Indigestion
- Acid reflux
- Constipation
- Diarrhea

# DIGESTION, ABSORPTION, AND ASSIMILATION

## 1. Introduction

Food provides nutrients, but the body **cannot use food in its original form.**

Therefore, food must pass through three important processes:

1. **Digestion** – breakdown of food
2. **Absorption** – entry of nutrients into blood
3. **Assimilation** – use of nutrients by body cells

👉 These processes together ensure **proper nutrition and health.**

## 2. Digestion

### Definition

**Digestion** is the process by which **complex food substances are broken down into simpler, absorbable forms.**

## Types of Digestion

### 1. Mechanical Digestion

- Physical breakdown of food
- Occurs by:
  - Chewing in the mouth
  - Churning in the stomach

### 2. Chemical Digestion

- Breakdown by digestive enzymes
- Occurs throughout the digestive tract

## Digestion of Carbohydrates

- Begins in the **mouth**
  - Salivary amylase acts on starch
- Continues in the **small intestine**
- End product: **Glucose**

## Digestion of Proteins

- Begins in the **stomach**
  - Pepsin enzyme breaks proteins into peptides
- Completed in the **small intestine**
- End product: **Amino acids**

## Digestion of Fats

- Occurs mainly in the **small intestine**
- Bile emulsifies fats
- Lipase breaks fats into:
  - Fatty acids

- Glycerol

## 3. Absorption

### Definition

**Absorption** is the process by which **digested nutrients pass from the intestine into the blood and lymph.**

### Site of Absorption

- Mainly in the **small intestine**
- Especially in the **jejunum and ileum**

### Special Features for Absorption

- **Villi and microvilli** increase surface area
- Rich blood supply helps transport nutrients

### Absorption of Nutrients

#### *Carbohydrates*

- Absorbed as glucose
- Enter bloodstream directly

#### *Proteins*

- Absorbed as amino acids
- Enter bloodstream

## **Fats**

- Absorbed as fatty acids and glycerol
- Enter lymphatic system first

## **Absorption of Water and Minerals**

- Occurs in:
  - Small intestine
  - Large intestine (mainly water)

# **4. Assimilation**

## **Definition**

**Assimilation** is the process by which **absorbed nutrients are utilized by body cells** for energy, growth, repair, and maintenance.

## **Role of Liver in Assimilation**

- Converts glucose to glycogen
- Regulates blood sugar levels
- Synthesizes proteins
- Stores vitamins and minerals

## **Utilization of Nutrients**

### **Carbohydrates**

- Provide energy
- Excess stored as glycogen or fat

### **Proteins**

- Used for tissue growth and repair
- Formation of enzymes and hormones

### **Fats**

- Provide concentrated energy
- Stored as fat
- Help in absorption of fat-soluble vitamins

### **Importance of Assimilation**

- Supports body functions
- Maintains growth and immunity
- Prevents nutritional deficiencies

## **5. Difference Between Digestion, Absorption, and Assimilation**

<b>Aspect</b>	<b>Digestion</b>	<b>Absorption</b>	<b>Assimilation</b>
Meaning	Breakdown of food	Entry into blood	Use by cells
Site	Digestive tract	Small intestine	Body tissues
Outcome	Simple nutrients	Nutrients in blood	Energy & growth

## **6. Importance in Nutrition and Health**

- Proper digestion ensures nutrient availability
- Absorption defects lead to malnutrition
- Assimilation failure affects growth and immunity
- Balanced diet supports all three processes

# METABOLIC RATE AND THERMIC EFFECT OF FOOD

## 1. Introduction

The human body needs energy continuously to:

- Stay alive
- Perform physical activities
- Digest and utilize food

The rate at which the body uses this energy is called the **metabolic rate**.

One important component of energy expenditure is the **Thermic Effect of Food (TEF)**.

## 2. Metabolism and Metabolic Rate

### What is Metabolism?

**Metabolism** refers to **all chemical reactions occurring in the body** that help maintain life.

These reactions include:

- Breaking down nutrients
- Producing energy
- Building and repairing tissues

### Types of Metabolism

#### 1. *Catabolism*

- Breakdown of complex substances
- Releases energy

- Example: Breakdown of glucose for energy

## 2. Anabolism

- Building of complex substances
- Requires energy
- Example: Protein synthesis

## Definition of Metabolic Rate

**Metabolic rate** is the **amount of energy expended by the body per unit time.**

👉 Usually expressed as kcal/day.

## 3. Types of Metabolic Rate

### 3.1 Basal Metabolic Rate (BMR)

- Energy required at complete rest
- Maintains vital functions:
  - Breathing
  - Heartbeat
  - Body temperature

BMR contributes **60–70%** of total energy expenditure.

### 3.2 Resting Metabolic Rate (RMR)

- Energy expenditure at rest, but less strict conditions than BMR
- Slightly higher than BMR

### 3.3 Total Daily Energy Expenditure (TDEE)

Includes:

- BMR
- Physical activity
- Thermic effect of food

## 4. Factors Affecting Metabolic Rate

- Age (decreases with age)
- Gender (higher in males)
- Body composition (muscle ↑ metabolism)
- Hormones (thyroid hormones)
- Physical activity level
- Climate
- Health and nutritional status

## 5. Thermic Effect of Food (TEF)

### Definition

The **Thermic Effect of Food (TEF)** is the **increase in energy expenditure after eating food**, due to:

- Digestion
- Absorption
- Metabolism of nutrients

👉 Also called **Specific Dynamic Action (SDA)**.

### Contribution to Energy Expenditure

- Accounts for about **10% of total daily energy expenditure**

## TEF of Macronutrients

Nutrient	Thermic Effect
Protein	Highest (20–30%)
Carbohydrate	Moderate (5–10%)
Fat	Lowest (0–5%)

## Why Protein Has High TEF?

- Requires more energy for digestion
- Complex metabolic pathways

## 6. Importance of TEF

- Influences total calorie needs
- Helps in weight management
- High-protein diets slightly increase energy expenditure
- Supports metabolic efficiency

## 7. Relationship Between Metabolic Rate and TEF

- TEF is a **component of total metabolism**
- Metabolic rate increases temporarily after meals
- Balanced diet ensures optimal metabolic functioning

## 8. Practical Application in Nutrition

- Frequent balanced meals maintain metabolism
- Adequate protein intake improves satiety
- Avoid long fasting periods to prevent metabolic slowdown

# GLYCEMIC INDEX AND GLYCEMIC LOAD

## 1. Introduction

Carbohydrates are the main source of energy, but **not all carbohydrates affect blood glucose in the same way.**

To understand how different foods influence blood sugar levels, we use the concepts of:

- **Glycemic Index (GI)**
- **Glycemic Load (GL)**

These concepts are important in **diabetes management, weight control, and overall metabolic health.**

## 2. Glycemic Index (GI)

### Definition

The **Glycemic Index (GI)** is a measure that ranks carbohydrate-containing foods based on **how quickly they raise blood glucose levels after eating.**

- Pure glucose is taken as the reference food and assigned a GI value of **100.**
- Other foods are compared with glucose.

👉 In simple words:

**GI tells us the quality of carbohydrates.**

### Classification of GI Values

GI Range	Category
< 55	Low GI
56–69	Medium GI
≥ 70	High GI

## Examples of Foods by GI

### Low GI foods

- Whole grains
- Pulses and legumes
- Fruits like apple, guava
- Milk and yogurt

### Medium GI foods

- Brown rice
- Sweet corn
- Banana

### High GI foods

- White bread
- White rice
- Potatoes
- Sugar and sweets

## Factors Affecting GI

- Type of carbohydrate
- Fiber content (high fiber → low GI)
- Fat and protein content
- Food processing (refining increases GI)
- Cooking method (overcooking increases GI)

## Importance of Glycemic Index

- Helps control blood sugar levels
- Reduces risk of diabetes and heart disease
- Provides sustained energy
- Improves satiety

### 3. Limitations of Glycemic Index

- GI does not consider **portion size**
- Eating multiple foods together alters GI effect
- Individual response may vary

👉 This leads to the concept of **Glycemic Load**.

### 4. Glycemic Load (GL)

#### Definition

**Glycemic Load (GL)** considers **both the quality (GI) and quantity of carbohydrates** in a serving of food.

👉 In simple words:

**GL tells us the actual blood sugar impact of a food portion.**

#### Classification of GL Values

GL Value	Category
< 10	Low GL
11–19	Medium GL
≥ 20	High GL

#### Example (Conceptual)

- A food may have high GI but low carbohydrate content → low GL
- A food with moderate GI eaten in large quantity → high GL

## Importance of Glycemic Load

- More accurate than GI for meal planning
- Useful for diabetes management
- Helps prevent blood sugar spikes
- Aids weight control

## 5. Difference Between GI and GL

Aspect	Glycemic Index	Glycemic Load
Focus	Quality of carbohydrate	Quality + quantity
Considers portion size	No	Yes
Practical use	Limited	More practical
Use in diet planning	General guide	Meal-specific guide

## 6. Practical Applications

### For Diabetes

- Prefer low GI and low GL foods
- Combine carbohydrates with protein and fiber

### For Weight Management

- Low GI foods increase satiety
- Reduce frequent hunger and overeating

### For General Health

- Maintain stable energy levels
- Reduce risk of metabolic disorders

## 7. Tips to Lower Glycemic Response

- Choose whole grains instead of refined grains
- Increase fiber intake
- Avoid overcooking
- Combine carbs with protein and fat
- Eat fruits whole, not as juice

# MODULE-4

## CARBOHYDRATES: TYPES AND FUNCTIONS

### 1. Introduction to Carbohydrates

**Carbohydrates** are the **primary source of energy** in the human diet.

They are found mainly in **plant foods** and supply energy required for daily activities.

- Provide **4 kcal per gram**
- Essential for brain and nervous system function
- Should form the major part of a balanced diet

### 2. Definition of Carbohydrates

Carbohydrates are **organic compounds composed of carbon, hydrogen, and oxygen**, usually in the ratio **1:2:1**.

👉 General formula:



### 3. Classification of Carbohydrates

Carbohydrates are classified based on **number of sugar units**.

#### 3.1 Simple Carbohydrates

##### Definition

Simple carbohydrates are **quickly digestible sugars** that provide **instant energy**.

## **Types of Simple Carbohydrates**

### **3.1.1 Monosaccharides**

- Single sugar unit
- Cannot be broken down further

#### **Examples**

- Glucose – blood sugar
- Fructose – fruit sugar
- Galactose – part of milk sugar

### **3.1.2 Disaccharides**

- Two monosaccharides joined together

#### **Examples**

- Sucrose (glucose + fructose) – table sugar
- Lactose (glucose + galactose) – milk sugar
- Maltose (glucose + glucose)

## **Sources**

- Sugar
- Honey
- Fruits
- Milk
- Sweets and soft drinks

## Characteristics

- Sweet in taste
- Rapidly increase blood glucose
- Excess intake may cause weight gain

## 3.2 Complex Carbohydrates (Polysaccharides)

### Definition

Complex carbohydrates consist of **many sugar units** and are **digested slowly**.

### Types of Complex Carbohydrates

#### 3.2.1 Starch

- Storage form of carbohydrate in plants

#### Sources

- Rice
- Wheat
- Potatoes
- Maize
- Millets

#### 3.2.2 Glycogen

- Storage form of carbohydrate in animals
- Stored in **liver and muscles**

### **3.2.3 Dietary Fiber**

- Indigestible carbohydrate
- Includes:
  - Cellulose
  - Hemicellulose
  - Pectin

#### **Sources**

- Whole grains
- Fruits
- Vegetables
- Pulses

#### **Characteristics**

- Not sweet
- Provide sustained energy
- Improve digestive health

## **4. Functions of Carbohydrates**

### **4.1 Energy Supply**

- Main source of energy
- Essential for physical activity
- Brain depends mainly on glucose

### **4.2 Protein Sparing Action**

- Adequate carbohydrates prevent protein breakdown

- Proteins are saved for growth and repair

### **4.3 Fat Metabolism**

- Carbohydrates help in proper fat oxidation
- Prevent formation of ketone bodies

### **4.4 Storage of Energy**

- Stored as glycogen in liver and muscles
- Used during fasting or exercise

### **4.5 Role of Dietary Fiber**

- Improves bowel movement
- Prevents constipation
- Lowers cholesterol
- Helps control blood sugar

### **4.6 Sweetening and Palatability**

- Improve taste of food
- Increase acceptability of diet

## **5. Carbohydrates and Health**

### **Excess Intake**

- Obesity
- Dental caries
- Diabetes risk

## Deficiency

- Fatigue
- Weakness
- Ketosis

## 6. Recommended Intake (Brief)

- Carbohydrates should provide **50–60% of total energy**
- Emphasis on **complex carbohydrates and fiber**
- Limit refined sugars

# PROTEINS: AMINO ACIDS, BIOLOGICAL VALUE & PDCAAS

## 1. Introduction to Proteins

**Proteins** are essential **body-building nutrients** required for:

- Growth and repair of tissues
- Formation of enzymes, hormones, and antibodies
- Maintenance of body structure
- Provide **4 kcal per gram**
- Present in both animal and plant foods

## 2. Amino Acids – Building Blocks of Proteins

### Definition

**Amino acids** are the **basic units of proteins**.

Proteins are formed when many amino acids join together by **peptide bonds**.

## Classification of Amino Acids

### 2.1 Essential Amino Acids (EAA)

**Definition:**

Amino acids that **cannot be synthesized by the body** and must be obtained from the diet.

**List (Adults):**

- Histidine
- Isoleucine
- Leucine
- Lysine
- Methionine
- Phenylalanine
- Threonine
- Tryptophan
- Valine

**Importance:**

- Required for growth
- Tissue repair
- Maintenance of nitrogen balance

### 2.2 Non-Essential Amino Acids (NEAA)

**Definition:**

Amino acids that **can be synthesized by the body**.

**Examples:**

- Alanine
- Glycine
- Serine
- Glutamic acid

## 2.3 Conditionally Essential Amino Acids

Required during:

- Childhood
- Illness
- Stress

**Examples:**

- Arginine
- Cysteine
- Tyrosine

## 3. Quality of Protein

Not all proteins have the same nutritional quality.

**Protein quality** depends on:

- Amino acid composition
- Digestibility
- Ability to support growth and maintenance

This leads to concepts like **Biological Value** and **PDCAAS**.

## 4. Biological Value (BV) of Proteins

### Definition

**Biological Value (BV)** is a measure of **how efficiently absorbed protein is utilized by the body** for tissue synthesis.

👉 In simple words:

**How well the body uses the protein eaten**

## Factors Affecting BV

- Presence of essential amino acids
- Digestibility
- Limiting amino acid

## Examples of BV

Food	BV (Approx.)
Egg	~100
Milk	85–90
Meat/Fish	70–80
Pulses	60–65
Cereals	50–60

## Limiting Amino Acid

The **essential amino acid present in the least amount** compared to body needs.

- Cereals → Lysine limiting
- Pulses → Methionine limiting

👉 Combining cereals + pulses improves protein quality.

## 5. PDCAAS (Protein Digestibility-Corrected Amino Acid Score)

### Definition

**PDCAAS** is a method to evaluate protein quality based on:

- Amino acid requirements of humans

- Digestibility of protein

👉 It is the **most widely accepted method** internationally.

## PDCAAS Scale

- Maximum score = **1.0**
- Higher score = better protein quality

## Examples of PDCAAS Values

Protein Source	PDCAAS
Egg	1.0
Milk	1.0
Soy protein	1.0
Meat/Fish	~0.9
Pulses	~0.6–0.7
Cereals	~0.4–0.5

## Importance of PDCAAS

- Used by WHO/FAO
- Helps compare plant and animal proteins
- Useful in diet planning and food labeling

## 6. Comparison: BV vs PDCAAS

Aspect	Biological Value	PDCAAS
Measures	Protein utilization	Digestibility + AA profile
Scale	No fixed max	Max = 1.0

Considers digestibility	Partly	Fully
Used by	Traditional method	International standard

## 7. Importance of High-Quality Protein

- Supports growth and muscle development
- Maintains immune function
- Prevents protein-energy malnutrition
- Essential for children, pregnant women, and elderly

# LIPIDS: SATURATED, UNSATURATED, TRANS FATS & OMEGA BALANCE

## 1. Introduction to Lipids

**Lipids (fats)** are essential nutrients that:

- Provide concentrated energy (**9 kcal/g**)
- Support absorption of fat-soluble vitamins (A, D, E, K)
- Protect organs and maintain body temperature
- Form cell membranes and hormones

👉 Though often misunderstood, **fats are essential when consumed wisely.**

## 2. Classification of Lipids

Dietary fats are classified based on their **chemical structure**:

- Saturated fats
- Unsaturated fats
  - Monounsaturated fats (MUFA)

- Polyunsaturated fats (PUFA)
- Trans fats

## 3. Saturated Fats

### Definition

**Saturated fats** are fats in which **fatty acid chains are fully saturated with hydrogen**.

### Characteristics

- Solid at room temperature
- More stable
- Increase LDL (“bad”) cholesterol when consumed in excess

### Sources

- Ghee, butter
- Cream, cheese
- Coconut oil, palm oil
- Fatty cuts of meat

### Health Effects

- Excess intake → heart disease risk
- Should be **limited**, not completely avoided

## 4. Unsaturated Fats

### Definition

**Unsaturated fats** contain **one or more double bonds** in their structure.

### 4.1 Monounsaturated Fats (MUFA)

#### *Sources*

- Groundnut oil
- Olive oil
- Mustard oil
- Nuts and seeds

#### *Benefits*

- Reduce LDL cholesterol
- Support heart health
- Improve insulin sensitivity

### 4.2 Polyunsaturated Fats (PUFA)

#### *Types*

- Omega-6 fatty acids
- Omega-3 fatty acids

#### *Sources*

- Sunflower oil, safflower oil (omega-6)
- Flaxseed, walnuts, fatty fish (omega-3)

#### *Benefits*

- Essential fats (cannot be made by body)

- Important for brain and heart health

## 5. Trans Fats

### Definition

**Trans fats** are **artificially produced fats** formed during hydrogenation of oils.

### Sources

- Vanaspati
- Bakery items
- Fried fast foods
- Packaged snacks

### Health Effects

- Increase LDL cholesterol
- Decrease HDL (“good”) cholesterol
- Increase risk of heart disease and diabetes

👉 WHO recommends **elimination of trans fats** from diet.

## 6. Omega Fatty Acids and Omega Balance

### Omega-3 Fatty Acids

#### *Types*

- ALA
- EPA

- DHA

### **Sources**

- Flaxseed
- Chia seeds
- Fish oils

### **Benefits**

- Anti-inflammatory
- Heart protective
- Brain development

## **Omega-6 Fatty Acids**

### **Sources**

- Vegetable oils (sunflower, corn oil)
- Nuts and seeds

### **Benefits**

- Essential for growth
- Immune function

## **Omega Balance**

- Ideal omega-6 : omega-3 ratio = **5:1 or lower**
- Modern diets often have **excess omega-6**

👉 Imbalance leads to inflammation and chronic diseases.

## 7. Fat Intake Recommendations

- Total fat intake: **20–30% of total energy**
- Prefer MUFA and PUFA
- Limit saturated fats
- Avoid trans fats completely
- Include omega-3-rich foods regularly

# Macronutrient Metabolism, Balance & Health Implications

## 1. Introduction: Why Macronutrient Balance Matters

- **Energy** (carbohydrates and fats)
- **Structure and repair** (proteins)

However, **excess or deficiency** of any macronutrient affects:

- Metabolic health
- Body weight
- Risk of chronic diseases

👉 Understanding metabolism and balance helps in **practical diet planning**.

## 2. Digestion and Metabolism of Macronutrients

### 2.1 Carbohydrate Metabolism (Brief Overview)

- Digested into **glucose**
- Absorbed into blood
- Used for:
  - Immediate energy
  - Stored as **glycogen**
  - Excess converted to fat

**Hormonal control:** Insulin and glucagon

## 2.2 Protein Metabolism (Brief Overview)

- Digested into **amino acids**
- Used for:
  - Tissue synthesis
  - Enzymes and hormones
- No storage form
- Excess amino acids → energy or fat

👉 Protein intake must be **regular**.

## 2.3 Fat Metabolism (Brief Overview)

- Digested into fatty acids and glycerol
- Used for:
  - Energy
  - Cell membranes
- Stored as adipose tissue

# 3. Macronutrient Distribution and Energy Contribution

## Recommended Energy Distribution (General)

Macronutrient	% of Total Energy
Carbohydrates	50–60%
Proteins	10–15%
Fats	20–30%

👉 Balance is more important than excess intake of any one nutrient.

## 4. Macronutrient Imbalance and Health Effects

### Excess Carbohydrates

- Obesity
- Insulin resistance
- Dental caries

### Protein Deficiency

- Muscle wasting
- Poor immunity
- Growth failure (children)

### Excess Fat Intake

- Obesity
- Heart disease
- Fatty liver

### Poor Fat Quality

- High trans fats → cardiovascular disease
- Omega imbalance → inflammation

## 5. Macronutrients and Lifestyle Diseases

### Diabetes Mellitus

- Role of high GI carbohydrates
- Importance of fiber

## Cardiovascular Diseases

- Saturated and trans fats
- Protective role of omega-3 fats

## Protein-Energy Malnutrition

- Inadequate protein and calories
- Affects children and elderly

# 6. Improving Macronutrient Quality

## Carbohydrates

- Prefer whole grains
- Increase dietary fiber
- Limit refined sugars

## Proteins

- Combine plant proteins
- Include high BV foods
- Adequate intake across meals

## Fats

- Use mixed oils
- Avoid hydrogenated fats
- Maintain omega-6:omega-3 balance

# 7. Practical Application in Diet Planning

- Balanced meals using plate models

- Macronutrient quality over quantity
- Culturally acceptable food choices
- Cost-effective planning

# MODULE-5

## VITAMINS: CLASSIFICATION AND SOURCES

### 1. Introduction to Vitamins

**Vitamins** are **organic micronutrients** required in **small amounts** for:

- Normal growth and development
- Regulation of metabolic processes
- Maintenance of health and immunity

👉 They do **not provide energy**, but are essential for utilizing macronutrients.

### 2. General Characteristics of Vitamins

- Required in minute quantities
- Cannot be synthesized in sufficient amounts by the body
- Must be obtained from diet
- Deficiency leads to specific deficiency diseases
- Excess intake of some vitamins may cause toxicity

### 3. Classification of Vitamins

Vitamins are classified based on **solubility**:

1. **Fat-soluble vitamins**
2. **Water-soluble vitamins**

## 4. Fat-Soluble Vitamins

Fat-soluble vitamins dissolve in fat and are stored in the body.

### Common Features

- Absorbed with dietary fat
- Stored in liver and fatty tissues
- Excess intake may cause toxicity

### 4.1 Vitamin A

#### Sources

- Animal: Liver, egg yolk, milk
- Plant ( $\beta$ -carotene): Carrot, spinach, mango

### 4.2 Vitamin D

#### Sources

- Sunlight (skin synthesis)
- Fish liver oil
- Egg yolk
- Fortified milk

### 4.3 Vitamin E

#### Sources

- Vegetable oils
- Nuts and seeds
- Whole grains

## 4.4 Vitamin K

### Sources

- Green leafy vegetables
- Broccoli
- Intestinal bacteria (partial)

## 5. Water-Soluble Vitamins

Water-soluble vitamins dissolve in water and are **not stored** in large amounts.

### Common Features

- Excess excreted in urine
- Regular intake needed
- Low toxicity risk

### 5.1 Vitamin C (Ascorbic Acid)

#### Sources

- Citrus fruits
- Guava
- Amla
- Tomatoes

### 5.2 B-Complex Vitamins

Includes:

- B1 (Thiamine)
- B2 (Riboflavin)
- B3 (Niacin)

- B6 (Pyridoxine)
- B9 (Folic acid)
- B12 (Cobalamin)

### Sources

- Whole grains
- Pulses
- Milk and eggs
- Green leafy vegetables

## 6. Importance of Classification

- Helps understand absorption and storage
- Guides dietary planning
- Prevents deficiency and toxicity
- Useful in clinical nutrition

# VITAMINS: DEFICIENCY CONDITIONS

## PART A: VITAMIN DEFICIENCY CONDITIONS

### 1. Introduction

Vitamin deficiencies occur when:

- Dietary intake is inadequate
- Absorption is poor
- Requirement is increased
- Loss is excessive

👉 Deficiency leads to **specific deficiency diseases**, many of which are **preventable** through balanced diet and nutrition education.

## 2. Deficiency of Fat-Soluble Vitamins

### 2.1 Vitamin A Deficiency

#### Causes

- Low intake of animal foods
- Poor intake of green leafy vegetables

#### Deficiency Conditions

- Night blindness
- Xerophthalmia (dry eyes)
- Bitot's spots
- Keratomalacia (severe cases)

#### Risk Groups

- Children
- Pregnant women

### 2.2 Vitamin D Deficiency

#### Causes

- Inadequate sunlight exposure
- Low dietary intake

#### Deficiency Conditions

- Rickets (children)
- Osteomalacia (adults)
- Weak bones

## 2.3 Vitamin E Deficiency

### Causes

- Fat malabsorption
- Very low fat intake

### Deficiency Conditions

- Muscle weakness
- Nerve damage (rare)

## 2.4 Vitamin K Deficiency

### Causes

- Poor intake
- Antibiotic use

### Deficiency Conditions

- Delayed blood clotting
- Excessive bleeding

# 3. Deficiency of Water-Soluble Vitamins

## 3.1 Vitamin C Deficiency

### Deficiency Disease: Scurvy

### Symptoms

- Bleeding gums
- Poor wound healing
- Weakness

- Joint pain

### **3.2 Thiamine (Vitamin B1) Deficiency**

**Deficiency Disease: Beriberi**

#### **Symptoms**

- Muscle weakness
- Nerve damage
- Edema
- Heart problems

### **3.3 Riboflavin (Vitamin B2) Deficiency**

#### **Symptoms**

- Cracks at corners of mouth
- Glossitis
- Skin lesions

### **3.4 Niacin (Vitamin B3) Deficiency**

**Deficiency Disease: Pellagra**

#### **Symptoms (3 Ds)**

- Dermatitis
- Diarrhea
- Dementia

### **3.5 Folic Acid Deficiency**

#### **Symptoms**

- Megaloblastic anemia
- Poor growth
- Neural tube defects (during pregnancy)

### **3.6 Vitamin B12 Deficiency**

#### **Symptoms**

- Megaloblastic anemia
- Nerve damage
- Memory problems

## **PART B: ADDITIONAL RELATED CONTENT**

### **Vitamin Losses, Toxicity, and Prevention**

## **4. Vitamin Losses During Cooking and Storage**

#### **Causes of Vitamin Loss**

- Overcooking
- Repeated reheating
- Exposure to air and light
- Washing vegetables after cutting

#### **Most Affected Vitamins**

- Vitamin C
- B-complex vitamins

#### **Prevention**

- Use minimal water

- Cook for shorter duration
- Avoid over-peeling
- Steam instead of boiling

## 5. Hypervitaminosis (Vitamin Toxicity)

### Definition

Excess intake of certain vitamins leading to toxicity.

### Commonly Affected Vitamins

- Vitamin A
- Vitamin D

### Symptoms

- Headache
- Nausea
- Bone pain
- Organ damage (severe cases)

👉 Water-soluble vitamins rarely cause toxicity.

## 6. Prevention of Vitamin Deficiencies

- Balanced diet
- Seasonal fruits and vegetables
- Fortified foods
- Nutrition education
- Supplementation when needed

# MINERALS: MAJOR AND TRACE ELEMENTS

## 1. Introduction to Minerals

**Minerals** are **inorganic micronutrients** required by the body in **small amounts** for:

- Growth and development
- Regulation of body processes
- Formation of body structures

👉 Minerals **do not provide energy**, but they are essential for normal functioning of the body.

## 2. Characteristics of Minerals

- Inorganic substances
- Required in small quantities
- Cannot be destroyed by heat
- Obtained from plant and animal foods
- Deficiency or excess causes health problems

## 3. Classification of Minerals

Minerals are classified based on **daily requirement**:

1. **Major (Macrominerals)**
2. **Trace (Microminerals)**

## 4. Major Minerals (Macrominerals)

Major minerals are required in amounts **greater than 100 mg per day**.

## 4.1 Calcium

### Functions

- Formation of bones and teeth
- Blood clotting
- Muscle contraction

### Sources

- Milk and milk products
- Green leafy vegetables
- Ragi

### Deficiency

- Rickets (children)
- Osteoporosis (adults)

## 4.2 Phosphorus

### Functions

- Bone formation
- Energy metabolism (ATP)

### Sources

- Milk
- Pulses
- Nuts

## 4.3 Magnesium

### Functions

- Enzyme activation

- Muscle and nerve function

### **Sources**

- Nuts
- Whole grains
- Green leafy vegetables

## **4.4 Sodium**

### **Functions**

- Fluid balance
- Nerve impulse transmission

### **Sources**

- Table salt
- Processed foods

### **Deficiency**

- Muscle cramps

#### **Excess**

- Hypertension

## **4.5 Potassium**

### **Functions**

- Muscle function
- Heart rhythm regulation

### **Sources**

- Fruits (banana, orange)
- Vegetables

## 4.6 Chloride

### Functions

- Formation of gastric acid
- Fluid balance

### Sources

- Common salt

## 5. Trace Minerals (Microminerals)

Trace minerals are required in amounts **less than 100 mg per day**.

### 5.1 Iron

#### Functions

- Hemoglobin formation
- Oxygen transport

#### Sources

- Green leafy vegetables
- Liver
- Pulses

#### Deficiency

- Anemia

## 5.2 Iodine

### Functions

- Thyroid hormone synthesis

### Sources

- Iodized salt
- Seafood

### Deficiency

- Goiter
- Cretinism

## 5.3 Zinc

### Functions

- Growth and immunity
- Wound healing

### Sources

- Whole grains
- Meat
- Nuts

## 5.4 Copper

### Functions

- Iron metabolism
- Enzyme activity

### Sources

- Nuts
- Seeds

## 5.5 Selenium

### Functions

- Antioxidant function

### Sources

- Nuts
- Seafood

## 5.6 Fluoride

### Functions

- Tooth enamel strength

### Sources

- Drinking water

### Deficiency

- Dental caries

#### **Excess**

- Fluorosis

## 6. Importance of Minerals in Nutrition

- Maintain electrolyte balance
- Support skeletal health
- Regulate metabolic reactions
- Prevent deficiency disorders

# PHYTONUTRIENTS AND ANTIOXIDANTS

## 1. Introduction

Modern nutrition not only focuses on **macronutrients and micronutrients**, but also on **protective food components** that promote health and prevent disease.

Two such important components are:

- **Phytonutrients**
- **Antioxidants**

👉 These are mainly found in **plant-based foods** and play a major role in **disease prevention and health promotion**.

## 2. Phytonutrients

### Definition

**Phytonutrients** (also called phytochemicals) are **natural bioactive compounds present in plants** that provide health benefits beyond basic nutrition.

👉 They are **not essential nutrients**, but they improve health and reduce disease risk.

### Major Characteristics

- Found only in plant foods
- Give color, flavor, and aroma to foods
- Act as antioxidants and anti-inflammatory agents
- Work together (synergistic effect)

### Classification of Phytonutrients

## 2.1 Carotenoids

### Functions

- Antioxidant activity
- Some convert to vitamin A

### Examples & Sources

- Beta-carotene – carrot, pumpkin
- Lycopene – tomato, watermelon
- Lutein – green leafy vegetables

## 2.2 Flavonoids

### Functions

- Reduce inflammation
- Improve heart health

### Sources

- Fruits (apple, berries)
- Tea
- Citrus fruits

## 2.3 Polyphenols

### Functions

- Antioxidant
- Protect against chronic diseases

### Sources

- Green tea
- Coffee

- Grapes

## 2.4 Glucosinolates

### Functions

- Cancer-protective compounds

### Sources

- Cabbage
- Broccoli
- Cauliflower

## 2.5 Phytoestrogens

### Functions

- Hormonal balance
- Bone health

### Sources

- Soybean
- Flaxseed

## 3. Antioxidants

### Definition

**Antioxidants** are substances that **protect the body from oxidative damage** caused by free radicals.

## What Are Free Radicals?

- Unstable molecules produced during normal metabolism
- Increased by:
  - Pollution
  - Smoking
  - Stress
  - Radiation

👉 Free radicals damage cells, proteins, and DNA.

## Role of Antioxidants

- Neutralize free radicals
- Prevent cell damage
- Slow aging
- Reduce risk of chronic diseases

## Types of Antioxidants

### 3.1 Enzymatic Antioxidants

- Superoxide dismutase
- Catalase
- Glutathione peroxidase

### 3.2 Non-Enzymatic Antioxidants

#### *Vitamins*

- Vitamin C
- Vitamin E

- Beta-carotene

### ***Minerals***

- Selenium
- Zinc

### ***Phytochemicals***

- Flavonoids
- Polyphenols

## **4. Health Benefits of Phytonutrients and Antioxidants**

- Reduce risk of heart disease
- Protect against cancer
- Improve immunity
- Support eye and brain health
- Delay aging process

## **5. Dietary Sources and Practical Application**

### **Best Sources**

- Fruits and vegetables of different colors
- Whole grains
- Nuts and seeds
- Herbs and spices

### **“Eat the Rainbow” Concept**

- Different colors → different phytonutrients
- Ensures wide range of protective compounds

## 6. Factors Affecting Phytonutrient Content

- Cooking methods
- Storage
- Food processing
- Ripeness

👉 Minimal processing preserves more antioxidants.

## Micronutrient Bioavailability, Interactions, Fortification & Supplementation

### 1. Introduction

Having vitamins and minerals in food **does not guarantee absorption**.

Their **availability, interactions, and losses** decide how much the body can actually use.

👉 This topic explains **why deficiencies occur even with food intake**.

### 2. Bioavailability of Micronutrients

#### What is Bioavailability?

**Bioavailability** refers to the **fraction of a nutrient that is absorbed and utilized by the body**.

#### Factors Affecting Bioavailability

##### 1. Food Matrix

- Animal foods → higher bioavailability
- Plant foods → lower (due to fiber, phytates)

## **2. Nutrient Form**

- Heme iron → better absorbed
- Non-heme iron → less absorbed

## **3. Digestive Health**

- Poor digestion reduces absorption

## **4. Cooking and Processing**

- Excess cooking → vitamin loss

## **Examples**

- Vitamin C improves iron absorption
- Calcium absorption needs vitamin D

# **3. Micronutrient Interactions**

## **Positive Interactions (Synergistic)**

- Vitamin C + iron
- Vitamin D + calcium
- Vitamin A + zinc

## **Negative Interactions (Antagonistic)**

- Excess calcium reduces iron absorption
- Phytates reduce zinc and iron absorption

👉 Balanced intake is more effective than high single-nutrient intake.

## 4. Fortification of Foods

### Definition

**Fortification** is the process of **adding essential micronutrients to commonly consumed foods.**

### Objectives

- Prevent widespread deficiencies
- Improve public health

### Examples in India

- Iodized salt → iodine
- Fortified wheat flour → iron, folic acid
- Fortified milk → vitamin A & D

### Advantages

- Cost-effective
- Reaches large population
- No change in food habits

## 5. Supplementation of Micronutrients

### Definition

**Supplementation** is the **use of pills, syrups, or powders** to provide nutrients.

## When Supplements Are Needed

- Pregnancy and lactation
- Infancy and childhood
- Severe deficiency
- Elderly population

## Examples

- Iron–folic acid tablets
- Vitamin D supplements
- Calcium tablets

⚠️ Excess supplementation may cause toxicity.

## 6. Antioxidants: Food vs Supplements

- Natural food sources are better
- Supplements lack synergistic effects
- Excess antioxidants may be harmful

👉 “Food first” approach is recommended.

## 7. Prevention of Micronutrient Deficiencies

- Balanced diet
- Dietary diversity
- Fortified foods
- Nutrition education
- Regular health screening



# MODULE-6

## WATER ACTIVITY, pH, AND FOOD SPOILAGE

### 1. Introduction

Food quality and safety are strongly influenced by:

- **Water availability**
- **Acidity or alkalinity**
- **Microbial growth**

Two key factors that control food stability are:

- **Water activity (aw)**
- **pH**

👉 Understanding these helps in **preventing food spoilage and food-borne illness.**

### 2. Water Activity (aw)

#### Definition

**Water activity (aw)** is the **measure of free water available in food for microbial growth and chemical reactions.**

- Expressed on a scale of **0 to 1**
- Pure water has **aw = 1.0**

👉 It is **not the same as moisture content.**

## Importance of Water Activity

- Determines microbial growth
- Influences shelf life
- Affects texture and quality

## Water Activity and Microbial Growth

Microorganism	Minimum aw
Bacteria	$\geq 0.91$
Yeasts	$\geq 0.88$
Molds	$\geq 0.80$

👉 Lower aw = less microbial growth.

## Examples of Foods by Water Activity

### High aw foods

- Fresh fruits and vegetables
- Milk
- Meat

### Low aw foods

- Dried fruits
- Cereals
- Nuts
- Sugar

## Methods to Reduce Water Activity

- Drying
- Dehydration
- Adding salt or sugar

- Freezing (indirectly)

### 3. pH of Foods

#### Definition

**pH** is a measure of **acidity or alkalinity** of food.

- pH scale: **0–14**
- $\text{pH} < 7 \rightarrow$  acidic
- $\text{pH} = 7 \rightarrow$  neutral
- $\text{pH} > 7 \rightarrow$  alkaline

#### Importance of pH in Food

- Controls microbial growth
- Affects enzyme activity
- Influences taste and preservation

#### pH and Microbial Growth

- Most bacteria grow best at **neutral pH (6.5–7.5)**
- Acidic foods inhibit bacterial growth

#### Examples of Food pH

Food	pH
Lemon juice	2–3
Tomato	4–4.5
Milk	6.5
Meat	5.5–6.5

## Methods to Control pH

- Fermentation
- Pickling
- Addition of acids (vinegar, lemon)

## 4. Food Spoilage

### Definition

**Food spoilage** is the **deterioration of food quality**, making it unfit or unacceptable for consumption.

### Causes of Food Spoilage

#### *1. Microbial Spoilage*

- Bacteria, yeasts, molds
- Produce off-odors, slime, toxins

#### *2. Enzymatic Spoilage*

- Natural enzymes cause browning and softening

#### *3. Chemical Spoilage*

- Oxidation of fats
- Rancidity

### Role of Water Activity and pH in Spoilage

- High  $a_w$  + neutral pH → rapid spoilage
- Low  $a_w$  or acidic pH → slower spoilage

## Signs of Food Spoilage

- Change in color
- Off smell
- Slimy texture
- Gas formation
- Mold growth

## Prevention of Food Spoilage

- Refrigeration
- Freezing
- Drying
- Fermentation
- Use of preservatives
- Proper packaging

## 5. Relationship Between Water Activity, pH, and Food Preservation

- Both aw and pH control microbial growth
- Used together in food preservation
- Known as **hurdle technology**

# BROWNING REACTIONS

## Maillard Browning and Enzymatic Browning

### 1. Introduction to Browning Reactions

**Browning reactions** are chemical or enzymatic processes that cause **brown color formation in foods**.

#### Importance of Browning

- Affects **color, flavor, aroma, and acceptability**
- Can be **desirable** (baked foods)
- Can be **undesirable** (cut fruits)

👉 Browning plays a major role in food quality.

### 2. Types of Browning Reactions

There are two main types:

1. **Maillard (Non-enzymatic) browning**
2. **Enzymatic browning**

### 3. Maillard Browning (Non-Enzymatic Browning)

#### Definition

**Maillard reaction** is a **chemical reaction between reducing sugars and amino acids**, occurring when food is heated.

👉 Responsible for **brown color and roasted flavor**.

## Conditions Favoring Maillard Browning

- Presence of:
  - Reducing sugars
  - Amino acids/proteins
- Heat
- Low to intermediate moisture
- Slightly alkaline pH

## Examples of Maillard Browning

- Bread crust
- Roasted coffee
- Biscuits
- Fried foods
- Toasted cereals

## Stages of Maillard Reaction (Simplified)

1. Initial stage – sugar + amino acid
2. Intermediate stage – flavor compounds
3. Final stage – brown pigments (melanoidins)

## Effects of Maillard Browning

### *Positive Effects*

- Improved flavor and aroma
- Attractive color
- Increased palatability

### *Negative Effects*

- Loss of lysine (essential amino acid)

- Reduced protein quality
- Formation of harmful compounds if overheated

## Control of Maillard Browning

- Lower cooking temperature
- Shorter cooking time
- Control pH
- Reduce sugar content

## 4. Enzymatic Browning

### Definition

**Enzymatic browning** occurs when **enzymes react with oxygen**, causing browning in cut or damaged fruits and vegetables.

### Enzyme Involved

- **Polyphenol oxidase (PPO)**

### Conditions Required

- Presence of enzyme
- Oxygen
- Phenolic compounds

### Examples of Enzymatic Browning

- Cut apples
- Bananas

- Potatoes
- Brinjal

## Effects of Enzymatic Browning

### *Negative Effects*

- Unattractive appearance
- Loss of nutrients
- Reduced market value

## Prevention of Enzymatic Browning

- Blanching (enzyme inactivation)
- Acid treatment (lemon juice)
- Exclusion of oxygen
- Refrigeration
- Use of antioxidants (ascorbic acid)

## 5. Comparison: Maillard vs Enzymatic Browning

Feature	Maillard Browning	Enzymatic Browning
Type	Chemical	Enzymatic
Enzyme required	No	Yes
Requires heat	Yes	No
Occurs in	Cooked foods	Cut fruits
Effect	Often desirable	Usually undesirable

## 6. Importance in Food Processing and Nutrition

- Helps develop flavor in cooked foods

- Affects nutrient quality
- Influences consumer acceptance
- Important in food preservation and processing

# GELS AND FOAMS IN FOOD

## 1. Introduction

Many foods do not exist as simple solids or liquids. Instead, they form **special physical structures** such as **gels** and **foams**, which determine:

- Texture
- Mouthfeel
- Appearance
- Acceptability of food

👉 Understanding gels and foams helps explain **why foods look and feel the way they do**.

## 2. What Are Food Colloids?

Gels and foams are types of **food colloids**.

### Colloid

A colloid is a system where **one substance is dispersed in another** without dissolving completely.

- Dispersed phase
- Continuous phase

## 3. Gels

### Definition

A **gel** is a **semi-solid system** in which a **liquid is trapped within a three-dimensional solid network**.

👉 In simple words:

**Liquid held inside a solid structure**

### Characteristics of Gels

- Soft but firm texture
- Do not flow easily
- Hold shape
- Contain large amount of water

### Examples of Gels in Foods

- Jelly
- Custard
- Paneer
- Curd
- Jam

### Substances Responsible for Gel Formation

#### 1. *Proteins*

- Gelatin
- Egg proteins
- Milk proteins

## 2. Polysaccharides

- Agar-agar
- Pectin
- Starch

### Mechanism of Gel Formation (Simple Explanation)

1. Heating dissolves the gelling agent
2. Cooling allows molecules to re-associate
3. A network forms
4. Water is trapped inside

### Factors Affecting Gel Formation

- Concentration of gelling agent
- Temperature
- pH
- Presence of sugar or salts

### Importance of Gels in Food

- Provide structure and shape
- Improve texture
- Enhance mouthfeel
- Increase product stability

## 4. Foams

### Definition

A **foam** is a colloidal system in which **gas is dispersed in a liquid or semi-solid phase.**

👉 In simple words:

**Air trapped inside liquid or soft solid**

## Characteristics of Foams

- Light and airy texture
- Large surface area
- Less dense
- Often unstable without stabilizers

## Examples of Foams in Foods

- Whipped cream
- Egg white foam
- Meringue
- Ice cream
- Sponge cake batter

## Substances Responsible for Foam Formation

- Proteins (egg albumin, milk proteins)
- Emulsifiers

## Mechanism of Foam Formation

1. Beating or whipping incorporates air
2. Proteins unfold
3. Proteins form a film around air bubbles
4. Foam structure is stabilized

## Factors Affecting Foam Stability

- Type of protein
- Degree of beating
- Presence of fat (fat reduces foam stability)
- Sugar (improves stability)
- Temperature

## Importance of Foams in Food

- Improve volume
- Enhance light texture
- Improve appearance
- Increase palatability

## 5. Comparison: Gels vs Foams

Aspect	Gels	Foams
Dispersed phase	Liquid	Gas
Continuous phase	Solid network	Liquid or semi-solid
Texture	Firm / semi-solid	Light / airy
Examples	Jelly, curd	Whipped cream, meringue

## 6. Role of Gels and Foams in Food Processing

- Used to design food texture
- Improve sensory quality
- Enhance product stability
- Important in bakery, dairy, and confectionery products

# EMULSIONS AND COLLOIDAL SYSTEMS

## 1. Introduction to Colloidal Systems

### What is a Colloid?

A **colloidal system** is a mixture in which one substance is **dispersed as very fine particles** in another substance and does not settle on standing.

### Components of a Colloid

- **Dispersed phase** – the substance present as particles
- **Dispersion medium** – the substance in which particles are dispersed

### Importance in Foods

- Determine texture and appearance
- Influence mouthfeel
- Affect stability and shelf life

Many foods like milk, butter, jelly, whipped cream are colloidal in nature.

## 2. Types of Colloidal Systems in Foods

Colloids are classified based on the **physical state of dispersed phase and dispersion medium**.

### Common Food Colloids

Dispersed Phase	Dispersion Medium	Colloid Type	Food Example
Solid	Liquid	Sol	Gravy, starch paste
Liquid	Solid	Gel	Jelly, curd
Gas	Liquid	Foam	Whipped cream
Liquid	Liquid	Emulsion	Milk

Solid	Gas	Aerosol	Spray-dried milk powder
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## 3. Emulsions

### Definition

An **emulsion** is a **colloidal system** in which **one liquid is dispersed in another immiscible liquid**.

👉 Example: Oil and water system.

### Types of Emulsions

#### 1. *Oil-in-Water (O/W) Emulsion*

- Oil droplets dispersed in water
- Water is the continuous phase

#### Examples

- Milk
- Cream
- Salad dressing

#### 2. *Water-in-Oil (W/O) Emulsion*

- Water droplets dispersed in oil
- Oil is the continuous phase

#### Examples

- Butter
- Margarine

## Role of Emulsifying Agents

### *Emulsifier – Definition*

An **emulsifier** is a substance that **stabilizes an emulsion** by preventing separation of oil and water.

### Common Food Emulsifiers

- Lecithin (egg yolk)
- Milk proteins (casein)
- Mono- and diglycerides

### Mechanism of Emulsion Formation

- Emulsifier has:
  - Water-loving (hydrophilic) part
  - Oil-loving (lipophilic) part
- It forms a protective layer around droplets
- Prevents coalescence

### Factors Affecting Emulsion Stability

- Type and amount of emulsifier
- Droplet size
- Temperature
- pH
- Mechanical treatment (mixing)

## **4. Colloidal Stability and Breakdown**

### **Instability in Colloids**

Colloids may break down due to:

- Creaming
- Coalescence
- Flocculation
- Phase separation

### **Prevention of Breakdown**

- Proper emulsifier selection
- Controlled processing
- Proper storage conditions

## **5. Importance of Emulsions and Colloids in Food Science**

- Improve texture and consistency
- Enhance appearance and palatability
- Increase stability of food products
- Important in dairy, bakery, sauces, and confectionery industries

## **6. Applications in Daily Foods**

- Milk as natural emulsion
- Butter as water-in-oil emulsion
- Ice cream as complex colloidal system
- Mayonnaise as stabilized emulsion

# Principles of Food Preservation & Hurdle Technology

## 1. Introduction

Foods spoil mainly due to:

- Microbial growth
- Enzymatic activity
- Chemical reactions

Factors like **water activity, pH, oxygen, and temperature** control these processes.

👉 **Food preservation** applies scientific principles to **slow or prevent spoilage**.

## 2. Principles of Food Preservation

Food preservation works by **controlling one or more spoilage factors**.

### Major Principles

#### 2.1 Control of Water Activity

- Microorganisms need free water
- Lowering water activity slows spoilage

#### Methods

- Drying
- Dehydration
- Adding salt or sugar

#### Examples

- Pickles
- Jams
- Dried fruits

## 2.2 Control of pH

- Most bacteria grow best at neutral pH
- Acidic foods spoil slowly

### Methods

- Fermentation
- Pickling
- Acid addition

### Examples

- Curd
- Vinegar pickles

## 2.3 Control of Temperature

- Low temperature slows microbial and enzymatic activity
- High temperature destroys microorganisms

### Methods

- Refrigeration
- Freezing
- Pasteurization
- Sterilization

## 2.4 Control of Oxygen

- Oxygen promotes oxidation and microbial growth

## Methods

- Vacuum packing
- Modified atmosphere packaging

# 3. Role of Heat in Food Preservation

## Heat Treatment

Heat:

- Destroys microorganisms
- Inactivates enzymes
- Reduces spoilage

## Examples

- Boiling milk
- Canning
- Pasteurization

⚠ Excess heat may affect:

- Vitamins
- Texture
- Browning reactions (Maillard)

# 4. Chemical Preservation

## Preservatives

Substances added to food to prevent spoilage.

## Common Preservatives

- Salt

- Sugar
- Vinegar
- Sodium benzoate

### Mode of Action

- Reduce water activity
- Alter pH
- Inhibit microbial enzymes

## 5. Hurdle Technology

### Definition

**Hurdle technology** is the use of **multiple preservation factors together** to control spoilage.

👉 Instead of one strong method, **several mild methods** are combined.

### Common Hurdles Used

- Low water activity
- Acidic pH
- Mild heat
- Preservatives
- Refrigeration

### Example: Jam

- Low water activity (high sugar)
- Acidic pH
- Heat during preparation

👉 Microbes cannot cross all hurdles → food remains safe.

## Advantages of Hurdle Technology

- Better food quality
- Improved safety
- Longer shelf life
- Reduced nutrient loss

## 6. Relation to Colloids, Gels, Foams, and Emulsions

- Gels: Sugar and pectin help preservation (jam)
- Emulsions: Stability affects shelf life (mayonnaise)
- Foams: Sensitive to moisture and oxygen
- Colloids: Stability depends on pH and temperature

👉 Preservation methods must **maintain food structure** along with safety.

## 7. Spoilage vs Preservation – Concept Link

Factor	Spoilage	Preservation
Water activity	High	Reduced
pH	Neutral	Acidic
Oxygen	Present	Controlled
Temperature	Favorable	Controlled

# MODULE-7

## THERMAL PROCESSING

### Pasteurization and Blanching

#### 1. Introduction to Thermal Processing

**Thermal processing** refers to the use of **heat treatment** to improve food safety, quality, and shelf life. Heat helps in:

- Destroying harmful microorganisms
- Inactivating enzymes
- Reducing food spoilage

It is one of the **most widely used food preservation techniques**.

#### 2. Objectives of Thermal Processing

- Ensure food safety
- Prevent microbial spoilage
- Extend shelf life
- Maintain nutritional quality
- Improve food acceptability

#### 3. Pasteurization

##### Definition

**Pasteurization** is a **controlled heat treatment** applied mainly to **liquid foods** to destroy **pathogenic microorganisms** without significantly affecting nutritional value and quality.

Pasteurized foods are **not sterile**, but are safe for consumption.

## Foods Commonly Pasteurized

- Milk and milk products
- Fruit juices
- Liquid egg products

## Principle of Pasteurization

Pasteurization involves:

1. Heating food to a specific temperature
2. Holding it for a defined time
3. Rapid cooling

This process destroys disease-causing microorganisms while preserving food quality.

## Methods of Pasteurization

### *Low Temperature Long Time (LTLT)*

- Heating at **63°C for 30 minutes**
- Traditional method
- Used in small-scale processing

### *High Temperature Short Time (HTST)*

- Heating at **72°C for 15 seconds**
- Most commonly used method for milk
- Better retention of nutrients and flavor

### ***Ultra-High Temperature (UHT)***

- Heating at **135–150°C for 1–2 seconds**
- Produces shelf-stable milk
- Does not require refrigeration until opened

### **Advantages of Pasteurization**

- Destroys harmful pathogens
- Extends shelf life
- Minimal nutrient loss
- Improves public health safety

### **Limitations of Pasteurization**

- Does not destroy bacterial spores
- Refrigeration needed after processing (except UHT)

## **4. Blanching**

### **Definition**

**Blanching** is a **short heat treatment** given to **fruits and vegetables**, using **hot water or steam**, followed by **rapid cooling**.

It is a **pre-treatment process**, not a preservation method by itself.

### **Objectives of Blanching**

- Inactivate enzymes
- Reduce microbial load
- Preserve color, texture, and flavor

- Prepare food for freezing or drying

## **Foods Commonly Blanched**

- Green leafy vegetables
- Root vegetables
- Fruits before freezing

## **Methods of Blanching**

### ***Hot Water Blanching***

- Food is immersed in boiling water
- Simple and widely used
- Higher nutrient losses compared to steam blanching

### ***Steam Blanching***

- Food exposed to steam
- Better nutrient retention
- More efficient enzyme inactivation

## **Steps in Blanching**

1. Heating in hot water or steam
2. Enzyme inactivation
3. Immediate cooling in cold water
4. Draining

## Advantages of Blanching

- Prevents enzymatic browning
- Retains natural color and texture
- Improves storage quality

## Disadvantages of Blanching

- Loss of water-soluble vitamins (vitamin C, B-complex)
- Over-blanching can soften texture

## 5. Difference Between Pasteurization and Blanching

Aspect	Pasteurization	Blanching
Purpose	Destroy pathogens	Inactivate enzymes
Applied to	Liquids	Fruits & vegetables
Preservation	Yes	No (pre-treatment)
Heat duration	Longer	Very short

## 6. Nutritional Impact of Thermal Processing

- Proteins and fats remain stable
- Some loss of vitamin C and B-complex vitamins
- Proper time–temperature control minimizes losses

# STERILIZATION

## 1. Introduction to Sterilization

**Sterilization** is a **severe heat treatment** used in food processing to **destroy all forms of microorganisms**, including:

- Pathogenic bacteria
- Spoilage microorganisms
- Heat-resistant bacterial spores

👉 Sterilized foods are **commercially sterile** and can be stored for **long periods at room temperature**.

## 2. Definition of Sterilization

**Sterilization** is the process of heating food at **high temperature for a sufficient time** to make it **free from all living microorganisms and spores** that may cause spoilage or disease.

## 3. Objectives of Sterilization

- Ensure complete food safety
- Destroy spores and pathogens
- Extend shelf life significantly
- Enable storage without refrigeration
- Prevent foodborne illnesses

## 4. Principle of Sterilization

Sterilization works on the principle that:

- **High temperature** causes:
  - Protein denaturation
  - Enzyme inactivation
  - Cell membrane destruction

This leads to **irreversible damage** to microorganisms and spores.

## 5. Methods of Sterilization in Food Processing

### 5.1 In-Container Sterilization (Canning)

#### Definition

Food is sealed in containers (cans, bottles) and then heated to sterilization temperature.

#### Process

1. Filling food into container
2. Sealing
3. Heating under pressure
4. Cooling

#### Temperature

- Above **100°C**, usually **115–121°C**

#### Examples

- Canned vegetables
- Canned fruits
- Meat products

### 5.2 Ultra-High Temperature (UHT) Sterilization

#### Definition

Food is heated to **very high temperature for a very short time**, then packed aseptically.

## Temperature

- 135–150°C for 1–4 seconds

## Examples

- UHT milk
- Liquid soups

## Advantages

- Minimal nutrient loss
- Long shelf life
- No refrigeration needed until opened

## 5.3 Retort Sterilization

### Definition

Sterilization using **pressurized steam** in a retort (pressure vessel).

### Used For

- Low-acid foods (vegetables, meat, fish)

## 6. Types of Foods Requiring Sterilization

### Low-Acid Foods (pH > 4.6)

- Vegetables
- Meat
- Fish
- Poultry

👉 These foods support growth of **Clostridium botulinum**, so sterilization is essential.

## High-Acid Foods (pH < 4.6)

- Fruits
- Pickles

👉 Require less severe heat treatment.

## 7. Effect of Sterilization on Food Quality

### Positive Effects

- Complete microbial safety
- Long shelf life
- Convenient storage

### Negative Effects

- Loss of heat-sensitive vitamins (Vitamin C, B-complex)
- Texture softening
- Flavor changes
- Browning reactions

## 8. Comparison with Other Thermal Processes

Aspect	Pasteurization	Sterilization
Heat intensity	Mild	Severe
Destroys spores	No	Yes
Shelf life	Short	Long
Refrigeration	Required	Not required

## 9. Importance of Sterilization in Food Safety

- Prevents deadly food poisoning (botulism)
- Ensures safe canned foods
- Essential for emergency and long-term food storage
- Widely used in food industry

## 10. Precautions in Sterilization

- Proper temperature–time control
- Correct container sealing
- Avoid under-processing
- Proper cooling after heating

# NON-THERMAL FOOD PROCESSING

## HPP, Irradiation, and Cold Plasma

### 1. Introduction to Non-Thermal Processing

Traditional food preservation mainly uses **heat**, which can:

- Destroy microorganisms
- But also damage nutrients, color, flavor, and texture

**Non-thermal processing** uses **methods other than heat** to:

- Improve food safety
- Extend shelf life
- Preserve nutritional and sensory quality

👉 These technologies are also called **minimal processing techniques**.

## 2. Need for Non-Thermal Processing

- Increasing demand for **fresh-like foods**
- Retention of **vitamins and antioxidants**
- Better **color, flavor, and texture**
- Improved **food safety** without high heat
- Longer shelf life with **minimal quality loss**

## 3. High Pressure Processing (HPP)

### Definition

**High Pressure Processing (HPP)** is a non-thermal method in which food is subjected to **very high hydrostatic pressure** to destroy microorganisms.

### Principle of HPP

- Food is placed in a sealed chamber
- Pressure of **300–600 MPa** is applied
- Pressure is transmitted uniformly through water
- Microbial cell membranes and enzymes are damaged

👉 Pressure destroys microbes **without heat**.

### Foods Commonly Processed by HPP

- Fruit juices
- Ready-to-eat meals
- Meat and seafood
- Dairy products

## Effects of HPP

### *On Microorganisms*

- Destroys bacteria, yeasts, and molds
- Spores are more resistant

### *On Food Quality*

- Retains natural color and flavor
- Minimal nutrient loss
- Texture largely preserved

## Advantages of HPP

- Fresh-like quality
- No chemical preservatives
- Extended refrigerated shelf life
- Uniform treatment

## Limitations of HPP

- High equipment cost
- Not effective against all spores
- Limited use for dry foods

## 4. Food Irradiation

### Definition

**Food irradiation** is the process of exposing food to **controlled doses of ionizing radiation** to destroy microorganisms and pests.

## Sources of Radiation

- Gamma rays
- X-rays
- Electron beams

## Principle of Irradiation

- Radiation damages DNA of microorganisms
- Prevents growth and reproduction
- Food **does not become radioactive**

## Applications of Food Irradiation

- Spices and condiments
- Cereals and pulses
- Fruits and vegetables
- Meat and poultry

## Effects of Irradiation

### *Positive Effects*

- Reduces microbial load
- Extends shelf life
- Controls insects and parasites
- Delays sprouting (potatoes, onions)

### *Nutritional Impact*

- Minimal effect on proteins and fats
- Some loss of vitamin C and thiamine at high doses

## Advantages

- Effective at room temperature
- Improves food safety
- Reduces foodborne diseases

## Limitations

- Consumer acceptance issues
- Requires strict regulation
- Specialized facilities needed

# 5. Cold Plasma Processing

## Definition

**Cold plasma** is a non-thermal technology using **ionized gas at low temperature** to inactivate microorganisms on food surfaces.

## What is Plasma?

- Fourth state of matter
- Contains ions, electrons, and reactive species

## Principle of Cold Plasma

- Reactive species interact with microbial cells
- Cause damage to:
  - Cell walls
  - Proteins
  - DNA

## Applications

- Fresh fruits and vegetables
- Packaging materials
- Food contact surfaces

## Advantages of Cold Plasma

- Very low temperature
- No water or chemicals required
- Short treatment time
- Minimal effect on food quality

## Limitations

- Mainly surface treatment
- Technology still developing
- Limited large-scale application

## 6. Comparison of Non-Thermal Methods

Aspect	HPP	Irradiation	Cold Plasma
Heat used	No	No	No
Main action	Pressure	Radiation	Reactive species
Best for	Juices, meats	Spices, grains	Fresh produce
Nutrient loss	Minimal	Very low	Very minimal
Industrial use	High	Moderate	Emerging

## 7. Importance in Modern Food Industry

- Meets demand for fresh and safe foods
- Reduces reliance on chemical preservatives
- Improves shelf life and safety
- Supports clean-label foods

# FOOD PRESERVATION METHODS

## Freezing, Drying, and Fermentation

### 1. Introduction to Food Preservation

**Food preservation** is the process of treating and handling food to **prevent spoilage** and **extend shelf life** while maintaining safety and quality.

Foods spoil due to:

- Microbial growth
- Enzymatic activity
- Chemical reactions

Preservation methods aim to **slow or stop these processes**.

## 2. Freezing

### Definition

**Freezing** is a method of food preservation in which food is stored at **very low temperatures (usually -18°C or below)** to inhibit microbial growth and enzymatic reactions.

## Principle of Freezing

- Low temperature slows down enzyme activity
- Microbial growth is greatly reduced
- Water in food forms ice crystals, making it unavailable for microbes

## Foods Commonly Preserved by Freezing

- Fruits and vegetables
- Meat, fish, poultry
- Ready-to-eat foods

## Advantages of Freezing

- Retains color, flavor, and nutrients
- Long shelf life
- Minimal use of preservatives
- Maintains fresh-like quality

## Disadvantages of Freezing

- Texture changes after thawing
- Requires continuous cold storage
- High energy cost
- Ice crystal damage if frozen slowly

## Nutritional Impact

- Minimal loss of nutrients
- Some loss of vitamin C in fruits and vegetables

## 3. Drying (Dehydration)

### Definition

**Drying** is the removal of **moisture from food** to prevent microbial growth and enzyme activity.

### Principle of Drying

- Microorganisms need water to grow
- Removing water reduces water activity
- Shelf life increases significantly

### Methods of Drying

- Sun drying
- Hot air drying
- Spray drying
- Freeze drying

### Foods Commonly Dried

- Grains and cereals
- Fruits (raisins, dates)
- Vegetables
- Milk powder

### Advantages of Drying

- Lightweight and easy storage
- No refrigeration needed
- Long shelf life

- Reduces transport cost

## Disadvantages of Drying

- Loss of flavor and color
- Loss of heat-sensitive vitamins
- Texture changes

## Nutritional Impact

- Concentration of nutrients
- Loss of vitamin C and some B vitamins

# 4. Fermentation

## Definition

**Fermentation** is a biological process in which **microorganisms convert sugars into acids, alcohol, or gases**, thereby preserving food.

## Principle of Fermentation

- Beneficial microorganisms grow
- Produce acids or alcohol
- Create unfavorable environment for spoilage microbes

## Common Fermented Foods

- Curd and yogurt
- Idli and dosa batter
- Pickles

- Sauerkraut
- Cheese

## Advantages of Fermentation

- Improves digestibility
- Enhances flavor and aroma
- Increases shelf life
- Produces probiotics
- Improves nutrient availability

## Disadvantages of Fermentation

- Risk of contamination if unhygienic
- Taste changes may not be acceptable to all

## Nutritional Impact

- Increased B-vitamins
- Improved mineral absorption
- Better gut health

## 5. Comparison of Preservation Methods

Aspect	Freezing	Drying	Fermentation
Main principle	Low temperature	Moisture removal	Microbial action
Shelf life	Long	Very long	Moderate
Refrigeration needed	Yes	No	Sometimes
Nutrient retention	High	Moderate	Improved

Cost	High	Low	Low
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# MODULE-8

## PRINCIPLES OF HACCP

### 1. Introduction to HACCP

#### What is HACCP?

**HACCP** stands for **Hazard Analysis and Critical Control Points**.

It is a **systematic, preventive approach** to food safety that:

- Identifies potential hazards
- Controls them at critical points
- Prevents food-borne illnesses

👉 HACCP focuses on **prevention rather than inspection**.

### 2. Objectives of HACCP

- Ensure food safety
- Identify hazards in food production
- Prevent contamination
- Improve quality control
- Protect consumer health

## 3. Types of Hazards in Food

HACCP identifies three main types of hazards:

### 3.1 Biological Hazards

- Bacteria (Salmonella, E. coli)
- Viruses
- Parasites

### 3.2 Chemical Hazards

- Pesticide residues
- Cleaning chemicals
- Food additives (excess)

### 3.3 Physical Hazards

- Glass
- Metal pieces
- Stones
- Hair

## 4. The Seven Principles of HACCP

HACCP is based on **7 internationally accepted principles**.

### Principle 1: Conduct Hazard Analysis

Identify potential hazards at each stage of food processing.

Example:

- Raw milk → microbial contamination
- Vegetables → pesticide residues

## **Principle 2: Determine Critical Control Points (CCPs)**

Identify points where hazards can be **prevented, eliminated, or reduced**.

Example:

- Pasteurization of milk
- Cooking temperature of meat

## **Principle 3: Establish Critical Limits**

Set **maximum or minimum values** to control hazards.

Example:

- Milk must be heated to **72°C for 15 seconds**
- Freezer temperature must be **-18°C**

## **Principle 4: Establish Monitoring Procedures**

Regular checks to ensure CCPs are under control.

Example:

- Measuring temperature
- Checking pH

## **Principle 5: Establish Corrective Actions**

Actions taken when critical limits are not met.

Example:

- Reheating food
- Discarding contaminated batch

## **Principle 6: Establish Verification Procedures**

Confirm that the HACCP system is working effectively.

Example:

- Microbial testing
- Internal audits

## **Principle 7: Establish Record Keeping and Documentation**

Maintain written records of:

- Monitoring results
- Corrective actions
- Verification activities

## **5. Steps in Implementing HACCP**

1. Form HACCP team
2. Describe product
3. Identify intended use

4. Construct flow diagram
5. Verify flow diagram
6. Apply 7 HACCP principles

## **6. Advantages of HACCP**

- Prevents food poisoning
- Improves consumer confidence
- Reduces product loss
- Ensures compliance with food laws
- Internationally accepted system

## **7. Limitations of HACCP**

- Requires trained personnel
- Costly to implement initially
- Needs regular monitoring
- Documentation is time-consuming

## **8. HACCP in Indian and Global Context**

- Recommended by WHO and FAO
- Mandatory for food industries
- Required for food export
- Supported by FSSAI in India

# FOOD ADULTERATION AND FOOD CONTAMINATION

## 1. Introduction

Food should be **safe, pure, and wholesome**. However, during production, processing, storage, and distribution, food may become:

- **Adulterated** (intentionally or unintentionally mixed with inferior substances)
- **Contaminated** (presence of harmful substances or microorganisms)

👉 Both adulteration and contamination **reduce food quality and pose health risks**.

## 2. Food Adulteration

### Definition

**Food adulteration** is the **addition, substitution, or removal of substances in food** that makes it **inferior in quality and unsafe for consumption**.

It is usually done for **economic gain**.

### Types of Food Adulteration

#### *2.1 Intentional Adulteration*

Deliberate addition of inferior or harmful substances.

#### **Examples**

- Water in milk
- Sand in sugar
- Brick powder in chili powder
- Vanaspati in ghee

## 2.2 Unintentional Adulteration

Occurs due to poor handling or lack of hygiene.

### Examples

- Pesticide residues on vegetables
- Insect infestation in grains
- Chemical contamination from packaging

## Common Adulterants and Their Foods

Food Item	Adulterant
Milk	Water, detergent
Turmeric	Metanil yellow
Chili powder	Brick powder
Honey	Sugar syrup
Tea	Used tea leaves

## Health Effects of Adulteration

- Food poisoning
- Digestive disorders
- Allergic reactions
- Liver and kidney damage
- Cancer risk (long-term)

## Simple Detection Tests (Household Level)

- Milk + water → check density
- Turmeric in water → yellow streak indicates adulteration
- Sugar in honey → water separation test

## 3. Food Contamination

### Definition

**Food contamination** is the **presence of harmful substances or microorganisms** in food, making it unsafe to eat.

Unlike adulteration, contamination may be **accidental**.

### Types of Food Contamination

#### 3.1 Biological Contamination

Caused by microorganisms.

#### Examples

- Bacteria: Salmonella, E. coli
- Viruses: Hepatitis A
- Parasites

#### Sources

- Poor hygiene
- Unclean water

- Improper cooking

### 3.2 Chemical Contamination

Caused by harmful chemicals.

#### Examples

- Pesticides
- Heavy metals (lead, mercury)
- Cleaning agents

### 3.3 Physical Contamination

Foreign objects in food.

#### Examples

- Glass
- Metal pieces
- Hair
- Stones

## 4. Difference Between Adulteration and Contamination

Aspect	Adulteration	Contamination
Nature	Mostly intentional	Mostly accidental
Purpose	Economic gain	Poor handling
Examples	Water in milk	Bacteria in meat
Legal status	Criminal offense	Food safety issue

## 5. Prevention of Food Adulteration and Contamination

### At Consumer Level

- Buy from reliable sources
- Check labels and expiry dates
- Avoid loose, unpacked foods
- Store food properly

### At Industry Level

- Follow HACCP principles
- Good manufacturing practices (GMP)
- Proper hygiene and sanitation
- Quality control testing

## 6. Food Laws and Regulations

### In India

- **FSSAI (Food Safety and Standards Authority of India)**
- Food Safety and Standards Act

### International

- WHO
- FAO
- Codex Alimentarius

## 7. Importance of Food Safety Awareness

- Protects public health
- Reduces disease burden
- Improves food quality
- Builds consumer confidence

# SHELF LIFE EVALUATION

## 1. Introduction to Shelf Life

### What is Shelf Life?

**Shelf life** is the **period during which a food product remains safe and acceptable for consumption** under specified storage conditions.

👉 It indicates how long a food:

- Maintains quality
- Remains safe
- Retains nutritional value

## 2. Importance of Shelf Life Evaluation

Shelf life evaluation is important to:

- Ensure food safety
- Reduce food wastage
- Maintain product quality
- Set expiry/best-before dates
- Comply with food laws

## **3. Types of Shelf Life**

### **3.1 Microbial Shelf Life**

Time until food becomes unsafe due to microbial growth.

### **3.2 Sensory Shelf Life**

Time until unacceptable changes in:

- Taste
- Smell
- Texture
- Appearance

### **3.3 Nutritional Shelf Life**

Time until significant loss of nutrients occurs.

## **4. Factors Affecting Shelf Life**

### **4.1 Intrinsic Factors (Food-related)**

- pH
- Water activity
- Nutrient composition
- Natural enzymes

### **4.2 Extrinsic Factors (Environment-related)**

- Temperature
- Humidity
- Oxygen

- Light
- Packaging

### **4.3 Processing Factors**

- Type of preservation method
- Heat treatment
- Use of preservatives

## **5. Methods of Shelf Life Evaluation**

Shelf life is evaluated using **three main approaches**:

### **5.1 Microbiological Methods**

#### **Purpose**

To determine microbial safety.

#### **Tests Include**

- Total plate count
- Yeast and mold count
- Pathogen detection

#### **Application**

Used for:

- Meat
- Dairy
- Ready-to-eat foods

## 5.2 Sensory Evaluation

### Purpose

To assess acceptability by human senses.

### Parameters

- Color
- Flavor
- Texture
- Overall acceptability

### Methods

- Hedonic scale
- Triangle test
- Panel evaluation

## 5.3 Chemical and Physical Methods

### Chemical Tests

- pH measurement
- Peroxide value (rancidity)
- Moisture content

### Physical Tests

- Texture analysis
- Color measurement
- Water activity

## 6. Accelerated Shelf Life Testing (ASLT)

### Definition

A method where food is stored under **stress conditions** to **predict shelf life quickly**.

### Conditions Used

- Higher temperature
- Higher humidity
- Increased oxygen

### Advantages

- Saves time
- Cost-effective
- Useful for new products

## 7. Real-Life Examples

Food	Shelf Life Factor
Milk	Microbial growth
Chips	Rancidity
Bread	Mold growth
Fruits	Enzymatic browning
Jam	Sugar and pH

## **8. Shelf Life Labeling**

### **Types of Labels**

- Best before
- Use by
- Expiry date

### **Purpose**

- Guide consumers
- Ensure safety
- Reduce legal issues

## **9. Role of Shelf Life in Food Industry**

- Product development
- Quality assurance
- Inventory control
- Export and trade
- Consumer satisfaction

# **INTRODUCTION TO FSSAI AND ISO 22000**

## **1. Introduction to Food Safety Standards**

Food safety is essential to protect consumers from:

- Food-borne diseases
- Adulteration and contamination

- Poor quality food

To ensure safe food from **farm to fork**, governments and international organizations have established **food safety standards and regulatory bodies**.

Two important systems are:

- **FSSAI** – National (India)
- **ISO 22000** – International

## 2. FSSAI – Food Safety and Standards Authority of India

### 2.1 What is FSSAI?

**FSSAI** stands for **Food Safety and Standards Authority of India**.

It is an **autonomous statutory body** established under the **Food Safety and Standards Act, 2006**.

FSSAI works under the **Ministry of Health and Family Welfare, Government of India**.

### 2.2 Objectives of FSSAI

- Ensure availability of safe and wholesome food
- Regulate manufacture, storage, distribution, sale, and import of food
- Protect public health
- Prevent food adulteration

- Create awareness among consumers

## **2.3 Functions of FSSAI**

FSSAI performs the following functions:

### **1. Setting Food Standards**

- Prescribes standards for different food products
- Limits for additives, contaminants, pesticides

### **2. Licensing and Registration**

- All food businesses must register or obtain license
- Hotels, restaurants, food manufacturers, vendors

### **3. Food Inspection and Surveillance**

- Conducts food safety inspections
- Collects food samples for testing

### **4. Food Testing and Laboratories**

- Approves food testing laboratories
- Ensures quality analysis

### **5. Consumer Awareness**

- Educates public about safe food practices
- Campaigns like “*Eat Right India*”

## 2.4 Importance of FSSAI

- Prevents food fraud
- Improves food quality
- Builds consumer trust
- Supports public health
- Mandatory for all food businesses in India

## 3. ISO 22000 – Food Safety Management System

### 3.1 What is ISO 22000?

**ISO 22000** is an **international standard for Food Safety Management Systems (FSMS)**.

It is developed by the **International Organization for Standardization (ISO)**.

ISO 22000 provides a **framework for managing food safety hazards** across the entire food chain.

### 3.2 Objective of ISO 22000

- Ensure food safety at every stage
- Identify and control hazards
- Improve global food safety
- Facilitate international trade

## **3.3 Key Features of ISO 22000**

ISO 22000 is based on:

- HACCP principles
- Good Manufacturing Practices (GMP)
- Good Hygiene Practices (GHP)

## **Main Components of ISO 22000**

1. Interactive communication
2. System management
3. Prerequisite programs (PRPs)
4. HACCP principles

## **3.4 Who Can Use ISO 22000?**

- Food manufacturers
- Food processors
- Packaging units
- Transport and storage companies
- Catering services

## **3.5 Benefits of ISO 22000**

- Improves food safety
- Reduces food risks
- Enhances brand reputation
- Increases consumer confidence

- Required for export business

## 4. Difference Between FSSAI and ISO 22000

Aspect	FSSAI	ISO 22000
Nature	Government authority	International standard
Area	India	Global
Purpose	Regulation	Certification
Mandatory	Yes (India)	Voluntary
Focus	Food laws	Food safety management

## 5. Role in Food Industry and Public Health

- FSSAI ensures legal compliance in India
- ISO 22000 ensures systematic safety management
- Together they improve:
  - Food quality
  - Hygiene
  - Consumer protection
  - Global food trade

# Good Manufacturing Practices (GMP) & Good Hygiene Practices (GHP)

## 1. Introduction

Food safety does not depend only on testing the final product.

It mainly depends on:

- How food is produced
- How workers handle food
- How equipment and environment are maintained

Two fundamental systems ensure this:

- **GMP – Good Manufacturing Practices**
- **GHP – Good Hygiene Practices**

👉 GMP and GHP are the **foundation of HACCP and ISO 22000**.

## 2. Good Manufacturing Practices (GMP)

### Definition

**Good Manufacturing Practices (GMP)** are a set of **guidelines and procedures** followed in food production to ensure that products are:

- Consistently produced
- Controlled according to quality standards
- Safe for consumption

## **Objectives of GMP**

- Prevent contamination
- Maintain product quality
- Ensure consistency
- Reduce production errors
- Comply with food laws

## **Key Elements of GMP**

### ***2.1 Premises and Layout***

- Clean and spacious environment
- Proper ventilation and lighting
- Separate areas for raw and cooked foods

### ***2.2 Equipment and Machinery***

- Food-grade materials
- Easy to clean
- Proper maintenance

### ***2.3 Raw Material Control***

- Approved suppliers
- Quality checking
- Proper storage conditions

## ***2.4 Process Control***

- Standard operating procedures (SOPs)
- Temperature and time control
- Proper documentation

## ***2.5 Packaging and Labeling***

- Safe packaging materials
- Correct labeling
- Traceability

# **3. Good Hygiene Practices (GHP)**

## **Definition**

**Good Hygiene Practices (GHP)** are practices followed to **maintain cleanliness and personal hygiene** in food handling.

## **Objectives of GHP**

- Prevent microbial contamination
- Maintain cleanliness
- Protect consumer health

## **Components of GHP**

### **3.1 Personal Hygiene**

- Clean uniforms
- Hand washing
- Short nails
- No jewellery
- Health check-ups

### **3.2 Cleaning and Sanitation**

- Regular cleaning schedules
- Use of approved disinfectants
- Cleaning of equipment and surfaces

### **3.3 Pest Control**

- Rodent control
- Insect control
- Waste management

### **3.4 Water Quality**

- Safe potable water
- Clean storage tanks

### **3.5 Waste Disposal**

- Proper garbage bins
- Regular waste removal

## 4. Relationship with HACCP and ISO 22000

System	Role
GHP	Maintains hygiene
GMP	Maintains production quality
HACCP	Identifies and controls hazards
ISO 22000	Integrates all systems

👉 Without GMP and GHP, **HACCP cannot work effectively.**

## 5. Importance in Food Industry

- Prevents food-borne diseases
- Improves product quality
- Reduces product rejection
- Builds consumer confidence
- Mandatory for food businesses

## 6. Real-Life Examples

- Hand washing in hotels
- Hair caps in bakeries
- Clean utensils in canteens
- Temperature logs in dairy plants



# MODULE-9

## OVERVIEW OF LIFESTYLE DISORDERS: OBESITY

### 1. Introduction to Lifestyle Disorders

#### What are Lifestyle Disorders?

**Lifestyle disorders** are diseases that develop mainly due to:

- Unhealthy eating habits
- Physical inactivity
- Stress
- Poor sleep patterns
- Substance abuse

Examples:

- Obesity
- Diabetes mellitus
- Hypertension
- Cardiovascular diseases

☞ These disorders are also called **non-communicable diseases (NCDs)**.

## 2. What is Obesity?

### Definition

**Obesity** is a condition characterized by **excessive accumulation of body fat** that may impair health.

It occurs when:

**Energy intake > Energy expenditure (TDEE)**

### Body Mass Index (BMI)

BMI is used to assess obesity.

**$BMI = \text{Weight}(kg) / \text{Heights}(m)^2$**

### BMI Classification (WHO)

<b>BMI</b>	<b>Category</b>
< 18.5	Underweight
18.5– 24.9	Normal
25–29.9	Overweight
≥ 30	Obese

## 3. Types of Obesity

### 3.1 Based on Fat Distribution

#### *Android Obesity (Apple-shaped)*

- Fat around abdomen
- More dangerous
- High risk of heart disease

#### *Gynoid Obesity (Pear-shaped)*

- Fat around hips and thighs
- More common in women
- Less risk compared to android type

### 3.2 Based on Cause

#### *Primary Obesity*

- Due to overeating and inactivity

#### *Secondary Obesity*

- Due to:
  - Hormonal disorders
  - Medications
  - Genetic conditions

## **4. Causes of Obesity**

### **4.1 Dietary Factors**

- High intake of:
  - Junk foods
  - Fast foods
  - Sugar-sweetened beverages
- Low intake of:
  - Fruits
  - Vegetables
  - Fiber

### **4.2 Physical Inactivity**

- Sedentary lifestyle
- Excess screen time
- Lack of exercise

### **4.3 Psychological Factors**

- Stress eating
- Emotional eating
- Depression

### **4.4 Genetic Factors**

- Family history
- Metabolic differences

## **4.5 Environmental Factors**

- Urbanization
- Easy availability of processed foods
- Lack of open spaces

# **5. Health Effects of Obesity**

## **5.1 Metabolic Disorders**

- Type 2 diabetes
- Insulin resistance

## **5.2 Cardiovascular Diseases**

- Hypertension
- Coronary heart disease
- Stroke

## **5.3 Musculoskeletal Problems**

- Joint pain
- Osteoarthritis

## **5.4 Respiratory Problems**

- Sleep apnea

- Breathlessness

## **5.5 Psychological Effects**

- Low self-esteem
- Depression
- Social isolation

## **6. Obesity and Nutrition**

### **Role of Diet**

- High calorie density foods increase obesity risk
- Low nutrient density foods cause overeating

### **Role of Macronutrients**

- Excess fat and refined carbs → weight gain
- Low fiber intake → poor satiety

## **7. Prevention and Management of Obesity**

### **7.1 Dietary Measures**

- Balanced diet
- Reduce sugar and fat
- Increase fruits, vegetables, whole grains
- Portion control

## 7.2 Physical Activity

- At least 30–60 minutes daily
- Walking, cycling, sports

## 7.3 Behavioral Changes

- Regular meal timings
- Avoid emotional eating
- Reduce screen time

## 7.4 Community and Public Health Measures

- Nutrition education
- School health programs
- Promotion of physical activity

# 8. Role of Obesity in Other Lifestyle Disorders

Obesity is a **major risk factor** for:

- Diabetes
- Heart disease
- Hypertension
- Fatty liver disease

👉 Obesity is often called the “**mother of lifestyle diseases.**”

# Diabetes Mellitus and Hypertension

## 1. Introduction to Lifestyle Disorders

Lifestyle disorders are **non-communicable diseases (NCDs)** that develop due to:

- Unhealthy diet
- Physical inactivity
- Stress
- Obesity
- Genetic predisposition

Among them, **diabetes and hypertension** are the **most common and serious disorders worldwide**.

## 2. Diabetes Mellitus

### Definition

**Diabetes mellitus** is a chronic metabolic disorder characterized by **high blood glucose levels (hyperglycemia)** due to:

- Lack of insulin
- Or ineffective action of insulin

### Role of Insulin

Insulin is a hormone produced by the **pancreas** that:

- Helps glucose enter cells

- Maintains normal blood sugar levels

## **Types of Diabetes**

### ***2.1 Type 1 Diabetes***

- Autoimmune disorder
- Pancreas produces little or no insulin
- Occurs in children and young adults

### ***2.2 Type 2 Diabetes***

- Most common type
- Insulin resistance
- Strongly related to obesity and lifestyle

### ***2.3 Gestational Diabetes***

- Occurs during pregnancy
- Increases risk of future diabetes

## **Causes of Diabetes**

- Excess intake of refined carbohydrates
- Obesity
- Physical inactivity
- Family history
- Stress

## **Symptoms of Diabetes**

- Frequent urination
- Excessive thirst
- Increased hunger
- Fatigue
- Weight loss
- Slow wound healing

## **Complications of Diabetes**

### ***Acute***

- Hypoglycemia
- Hyperglycemia

### ***Chronic***

- Heart disease
- Kidney damage (nephropathy)
- Eye damage (retinopathy)
- Nerve damage (neuropathy)

## **Nutritional Management of Diabetes**

- Low GI foods
- High fiber diet
- Controlled carbohydrate intake
- Avoid refined sugar

- Regular meal timings

## 3. Hypertension

### Definition

**Hypertension** is a condition in which **blood pressure remains persistently high.**

Normal BP: **120/80 mmHg**

Hypertension:  $\geq$  **140/90 mmHg**

### Types of Hypertension

#### *3.1 Primary (Essential)*

- No specific cause
- Related to lifestyle factors

#### *3.2 Secondary*

- Due to kidney disease
- Hormonal disorders

### Causes of Hypertension

- High salt intake
- Obesity
- Stress
- Smoking

- Alcohol
- Lack of exercise

## Symptoms of Hypertension

Often called a “**silent killer**” because:

- Usually no early symptoms
- Detected during routine check-up

Sometimes:

- Headache
- Dizziness
- Nosebleeds

## Complications of Hypertension

- Heart attack
- Stroke
- Kidney failure
- Vision loss

## Nutritional Management of Hypertension

- Low salt diet
- Increase potassium-rich foods
- DASH diet
- Reduce saturated fats
- Avoid alcohol

## 4. Relationship Between Diabetes and Hypertension

Diabetes	Hypertension
High blood sugar	High blood pressure
Causes insulin resistance	Causes vessel damage
Leads to heart disease	Leads to heart disease
Common risk factor: obesity	Common risk factor: obesity

👉 Both often occur together and **increase cardiovascular risk**.

## 5. Prevention and Control

### Lifestyle Modifications

- Balanced diet
- Regular physical activity
- Weight control
- Stress management
- Avoid smoking and alcohol

## 6. Public Health Importance

- Major cause of mortality
- Increases healthcare burden
- Preventable with lifestyle changes

- Early detection saves lives

# POPULATION DIETARY MODELS

## DASH Diet (Dietary Approaches to Stop Hypertension)

### 1. Introduction to Population Dietary Models

#### What are Population Dietary Models?

Population dietary models are **evidence-based eating patterns** designed to:

- Improve public health
- Prevent lifestyle diseases
- Provide practical nutrition guidance

Examples:

- DASH diet
- Mediterranean diet
- MyPlate model

These models focus on **overall dietary pattern**, not individual nutrients.

### 2. What is the DASH Diet?

#### Definition

**DASH** stands for **Dietary Approaches to Stop Hypertension**.

The DASH diet is a **balanced eating plan** developed to:

- Prevent and control high blood pressure
- Improve heart health
- Support weight management

It is recommended by **WHO, American Heart Association, and health professionals worldwide.**

### **3. Objectives of the DASH Diet**

- Lower blood pressure
- Reduce risk of heart disease
- Improve cholesterol levels
- Promote healthy body weight
- Increase intake of protective nutrients

### **4. Key Principles of DASH Diet**

The DASH diet emphasizes:

#### **4.1 High Intake of:**

- Fruits and vegetables
- Whole grains
- Low-fat milk and milk products
- Pulses, nuts, seeds
- Lean protein sources (fish, poultry)

## 4.2 Low Intake of:

- Salt (sodium)
- Saturated fats
- Trans fats
- Red meat
- Sugar and sweets

## 4.3 Nutrient Focus:

- High in potassium
- High in calcium
- High in magnesium
- Rich in fiber
- Moderate protein

## 5. Food Groups in DASH Diet

Food Group	Recommended
Grains	6–8 servings/day
Vegetables	4–5 servings/day
Fruits	4–5 servings/day
Low-fat dairy	2–3 servings/day
Lean meat/fish	≤ 2 servings/day

Nuts & legumes	4–5 servings/week
Fats & oils	Limited
Sweets	Rare

## 6. Sodium Levels in DASH Diet

Two versions:

- Standard DASH:  $\leq 2300$  mg sodium/day
- Low-sodium DASH:  $\leq 1500$  mg sodium/day

## 7. Health Benefits of DASH Diet

- Lowers blood pressure
- Reduces LDL cholesterol
- Improves insulin sensitivity
- Helps weight loss
- Reduces risk of stroke and heart disease

## 8. DASH Diet and Indian Context

Adaptation:

- Use whole grains (millets, brown rice)
- Use low-salt cooking methods
- Include curd, buttermilk
- More vegetables and pulses
- Avoid fried and packaged foods

# POPULATION DIETARY MODELS :

## Mediterranean Diet and MyPlate

### PART A: MEDITERRANEAN DIET (30 minutes)

#### 1. What is the Mediterranean Diet?

The **Mediterranean diet** is a traditional eating pattern followed by people living in countries around the Mediterranean Sea (like Greece, Italy, Spain).

It is considered one of the **healthiest diets in the world**.

#### 2. Key Principles of Mediterranean Diet

The Mediterranean diet emphasizes:

##### High intake of:

- Fruits and vegetables
- Whole grains
- Legumes and pulses
- Nuts and seeds
- Olive oil (main fat source)

##### Moderate intake of:

- Fish and seafood
- Poultry
- Dairy (curd, cheese)

## Low intake of:

- Red meat
- Processed foods
- Sugar and sweets

## 3. Main Features of Mediterranean Diet

- Uses **healthy fats** (olive oil instead of butter)
- High in **fiber and antioxidants**
- Includes **plant-based foods daily**
- Encourages **physical activity and social eating**

## 4. Health Benefits of Mediterranean Diet

- Reduces heart disease risk
- Improves cholesterol levels
- Helps control blood sugar
- Supports weight management
- Reduces inflammation

👉 It is highly recommended for **diabetes, hypertension, and cardiovascular diseases**.

## PART B: MYPLATE MODEL

## 5. What is MyPlate?

**MyPlate** is a **visual food guide** developed to help people build a **balanced meal** easily.

It shows how a plate should be divided into **different food groups**.

## 6. Components of MyPlate

MyPlate includes **five food groups**:

1. Grains
2. Vegetables
3. Fruits
4. Protein foods
5. Dairy (on the side)

## 7. Plate Division in MyPlate

The plate is divided as:

- **½ plate** – Fruits and vegetables
- **¼ plate** – Grains (prefer whole grains)
- **¼ plate** – Protein foods
- Dairy – on the side (milk/curd)

## 8. Key Messages of MyPlate

- Make half your plate fruits and vegetables

- Choose whole grains
- Include lean protein
- Limit sugar, salt, and fat
- Drink water and milk instead of soft drinks

## 9. Comparison: Mediterranean Diet vs MyPlate

Aspect	Mediterranean Diet	MyPlate
Type	Cultural pattern	Visual guide
Focus	Healthy lifestyle	Balanced meals
Fat source	Olive oil	Any healthy fat
Emphasis	Plant-based foods	Food group balance
Use	Long-term lifestyle	Daily meal planning

## 10. Application in Indian Context

### Mediterranean Diet

- Use groundnut or mustard oil instead of olive oil
- Include more vegetables and pulses
- Reduce fried foods

### MyPlate

- Use Indian thali concept
- Rice/roti as grains

- Dal as protein
- Sabzi and fruits as vegetables

## 11. Importance of These Models

- Easy to understand
- Promote balanced eating
- Prevent lifestyle disorders
- Useful for community nutrition education
- Suitable for all age groups

# NUTRITION AND EPIDEMIOLOGY – BASICS

## 1. Introduction

Health and disease in a population are strongly influenced by **dietary patterns, lifestyle, and environment**.

To understand how nutrition affects health at the population level, we use a branch of public health called **nutritional epidemiology**.

👉 It helps answer questions like:

- Why do some populations have more obesity?
- What dietary factors cause diabetes or heart disease?
- Which nutrients prevent deficiencies?

## 2. What is Nutrition?

### Definition

**Nutrition** is the science of **food and its relationship to health**.

It includes:

- Intake of nutrients
- Digestion and absorption
- Utilization by the body
- Role of diet in health and disease

### Branches of Nutrition

- **Human nutrition** – nutrition of individuals
- **Public health nutrition** – nutrition of communities
- **Clinical nutrition** – diet in disease management
- **Sports nutrition** – diet for performance

### Importance of Nutrition

- Supports growth and development
- Maintains immunity
- Prevents malnutrition and lifestyle disorders
- Improves quality of life

## 3. What is Epidemiology?

### Definition

**Epidemiology** is the study of:

**Distribution and determinants of health and disease in populations.**

In simple words:

👉 It studies **who gets disease, where, when, and why.**

### Key Terms in Epidemiology

#### *Population*

Group of people under study.

#### *Distribution*

Frequency and pattern of disease.

#### *Determinants*

Causes or risk factors.

### Objectives of Epidemiology

- Identify causes of diseases
- Measure disease burden
- Plan prevention strategies
- Evaluate health programs

## 4. What is Nutritional Epidemiology?

### Definition

**Nutritional epidemiology** studies the **relationship between diet, nutrition, and disease patterns in populations.**

It links:

- Nutrition science
- Public health
- Epidemiology

### Examples

- Studying anemia prevalence in women
- Diet and heart disease relationship
- Obesity trends in urban populations

## 5. Measures Used in Epidemiology

### 5.1 Incidence

Number of **new cases** of a disease in a given time.

Example:

New diabetes cases in one year.

## **5.2 Prevalence**

Total **existing cases** of a disease at a given time.

Example:

Total people living with diabetes.

## **5.3 Mortality Rate**

Number of deaths in a population.

## **5.4 Morbidity**

Presence of illness in a population.

# **6. Types of Epidemiological Studies**

## **6.1 Descriptive Studies**

Describe disease patterns.

Example:

Survey on obesity prevalence.

## **6.2 Analytical Studies**

Study association between diet and disease.

Example:

Diet and blood pressure study.

### **6.3 Experimental Studies**

Intervention-based.

Example:

Vitamin supplementation trial.

## **7. Role of Nutrition in Epidemiology**

Nutrition plays a role in:

### **Deficiency Diseases**

- Iron → anemia
- Iodine → goiter
- Vitamin A → night blindness

### **Lifestyle Diseases**

- Excess calories → obesity
- High salt → hypertension
- High sugar → diabetes

### **Protective Role**

- Fruits and vegetables → reduce cancer risk

- Omega-3 → heart protection
- Fiber → gut health

## **8. Applications of Nutritional Epidemiology**

- Policy making (ICMR, WHO guidelines)
- Food fortification programs
- Mid-day meal schemes
- Obesity prevention programs
- Dietary guidelines

## **9. Importance in Public Health**

- Identifies nutrition-related problems
- Helps in planning interventions
- Monitors population health trends
- Supports national nutrition programs

# MODULE-10

## NUTRITIONAL REQUIREMENTS:

### Children and Adolescents

#### 1. Introduction

Childhood and adolescence are **critical growth periods**.

During these stages:

- Height increases rapidly
- Organs develop
- Bones strengthen
- Hormonal changes occur

☞ Therefore, **nutritional needs are higher than in adults (per kg body weight)**.

Poor nutrition at this stage may cause:

- Stunting
- Poor learning ability
- Delayed puberty
- Weak immunity

## PART A: NUTRITION FOR CHILDREN

## 2. Characteristics of Childhood Growth

- Rapid physical growth
- Brain development
- Tooth formation
- Development of immunity
- Increased activity levels

Hence, children require **energy + body-building nutrients + protective nutrients**.

## 3. Energy Requirements

Energy is needed for:

- Growth
- Play and physical activity
- Basal metabolism

Children are active → **higher calorie needs per kg body weight** than adults.

Sources:

- Rice, wheat, millets
- Potato
- Oils and fats (small amounts)

## 4. Protein Requirements

Protein is essential for:

- Muscle development

- Tissue repair
- Enzyme and hormone formation

## Good Sources

- Milk and curd
- Eggs
- Pulses and legumes
- Soybean
- Nuts

Deficiency may cause:

- Growth retardation
- Protein-energy malnutrition

## 5. Fat Requirements

Functions:

- Concentrated energy
- Brain development
- Absorption of vitamins A, D, E, K

Children need **moderate fat intake**.

Sources:

- Groundnut oil
- Ghee (small quantity)
- Nuts and seeds

## 6. Vitamin Requirements

### Vitamin A

- Vision and immunity  
Sources: carrot, spinach, mango, milk

### Vitamin D

- Bone growth  
Sources: sunlight, fortified milk

### Vitamin C

- Wound healing and immunity  
Sources: citrus fruits, guava, amla

### B-Complex

- Energy metabolism  
Sources: whole grains, pulses

Deficiency leads to:

- Night blindness
- Rickets
- Poor immunity

## 7. Mineral Requirements

### Calcium

- Bone and teeth formation  
Sources: milk, ragi, green leafy vegetables

### Iron

- Hemoglobin formation  
Sources: green leafy vegetables, jaggery, pulses

### Iodine

- Brain development  
Sources: iodized salt

Iron deficiency → **anemia**, very common in children.

## 8. Balanced Diet for Children

A child's daily meal should include:

- Cereals
- Pulses
- Milk
- Vegetables
- Fruits
- Nuts

Important practices:

- Regular meal timings

- Healthy snacks
- Avoid junk foods

## PART B: NUTRITION FOR ADOLESCENTS

### 9. Characteristics of Adolescence

Adolescence is a **second growth spurt**:

- Rapid height and weight gain
- Hormonal changes
- Puberty
- Increased appetite

👉 Nutrient needs increase significantly.

### 10. Energy Requirements

Adolescents require more calories due to:

- Growth spurt
- Increased physical activity

Boys generally require **more calories than girls** due to higher muscle mass.

### 11. Protein Requirements

Protein supports:

- Muscle development
- Hormonal changes
- Tissue growth

Sources:

- Eggs
- Milk
- Pulses
- Meat/fish (if consumed)

## 12. Mineral Requirements

### Iron (Very Important)

Especially for girls due to menstruation.

Deficiency causes:

- Fatigue
- Poor concentration
- Anemia

Sources:

- Green leafy vegetables
- Dates
- Jaggery
- Pulses

## Calcium

Needed for peak bone mass.

Sources:

- Milk
- Curd
- Paneer
- Ragi

## 13. Vitamin Requirements

- B-complex → energy metabolism
- Vitamin D → bone growth
- Vitamin C → immunity

## 14. Common Nutritional Problems in Adolescents

- Anemia
- Obesity
- Eating disorders
- Acne due to poor diet
- Fast-food dependence

## 15. Healthy Dietary Guidelines

- Do not skip breakfast
- Eat fruits daily

- Reduce soft drinks
- Limit junk food
- Drink enough water
- Regular physical activity

## NUTRITIONAL REQUIREMENTS:

### Adults and Elderly

#### 1. Introduction

Human nutritional needs change across the **life cycle**.

After adolescence, growth slows, but the body still requires nutrients for:

- Maintenance of body tissues
- Work and daily activities
- Immunity and disease prevention
- Healthy aging

Two important stages:

- **Adulthood (20–59 years)** → maintenance stage
- **Elderly (60+ years)** → protective and preventive stage

## PART A: NUTRITION FOR ADULTS

#### 2. Characteristics of Adult Stage

- Physical growth completed
- Stable body composition
- Active working life
- Reproductive responsibilities

👉 Main nutritional goal: **maintain health and prevent lifestyle disorders.**

### 3. Energy Requirements

Energy needs depend on:

- Age
- Sex
- Occupation
- Physical activity

#### Categories of Activity

- Sedentary (office workers)
- Moderate (teachers, shopkeepers)
- Heavy (laborers, farmers)

Adults require energy mainly for:

- Basal metabolism
- Work
- Physical activity

Excess calorie intake → **obesity**

Low intake → **weakness and fatigue**

### 4. Protein Requirements

Protein is needed for:

- Tissue repair
- Muscle maintenance
- Enzyme and hormone production
- Immunity

## Sources

- Pulses and legumes
- Milk and curd
- Eggs
- Meat and fish (if consumed)
- Soybean and nuts

Inadequate protein causes:

- Muscle loss
- Low immunity
- Poor healing

## 5. Fat Requirements

Functions:

- Energy source
- Absorption of fat-soluble vitamins
- Hormone production

Recommendations:

- Prefer unsaturated fats
- Limit saturated fats
- Avoid trans fats

Healthy sources:

- Groundnut oil
- Mustard oil
- Nuts and seeds
- Fish oils

## 6. Carbohydrates and Fiber

Carbohydrates:

- Main source of energy
- Should come from complex sources

Sources:

- Whole grains
- Millets
- Brown rice

Fiber:

- Improves digestion
- Prevents constipation
- Controls cholesterol and blood sugar

Sources:

- Vegetables
- Fruits
- Whole grains

## 7. Vitamin Requirements

### B-Complex Vitamins

- Energy metabolism  
Sources: whole grains, pulses

### Vitamin C

- Immunity and wound healing  
Sources: citrus fruits, guava

## **Vitamin A**

- Vision and immunity  
Sources: carrots, green leafy vegetables

## **Vitamin D**

- Bone health  
Sources: sunlight exposure

# **8. Mineral Requirements**

## **Calcium**

- Bone and teeth maintenance  
Sources: milk, ragi, sesame seeds

## **Iron**

- Prevents anemia  
Sources: green leafy vegetables, jaggery

## **Sodium & Potassium Balance**

- Important for blood pressure control

# **9. Common Nutritional Problems in Adults**

- Obesity
- Diabetes
- Hypertension
- High cholesterol

Prevention:

- Balanced diet

- Physical activity
- Stress management

## PART B: NUTRITION FOR ELDERLY

### 10. Characteristics of Aging

Aging causes:

- Reduced metabolism
- Reduced appetite
- Tooth loss
- Poor digestion
- Reduced absorption

☞ Nutrient needs increase but energy needs decrease.

### 11. Energy Requirements

Elderly require **fewer calories** because:

- Less physical activity
- Lower basal metabolic rate

However, diet must be **nutrient-dense**.

### 12. Protein Requirements

Important to prevent:

- Muscle wasting (sarcopenia)

- Weakness

Sources:

- Milk and curd
- Soft pulses
- Eggs
- Soy products

## **13. Vitamin Requirements**

### **Vitamin D**

- Prevents osteoporosis

### **Vitamin B12**

- Needed for nerve function
- Deficiency common in elderly

### **Antioxidant Vitamins (A, C, E)**

- Protect against aging and disease

## **14. Mineral Requirements**

### **Calcium**

- Prevents bone fractures

### **Iron**

- Prevents anemia

## Zinc

- Improves immunity

## 15. Common Nutritional Problems in Elderly

- Osteoporosis
- Anemia
- Constipation
- Loss of appetite
- Dehydration

## 16. Dietary Guidelines for Elderly

- Small frequent meals
- Soft, easily digestible foods
- Adequate fluids
- High fiber foods
- Limit salt and sugar

# NUTRITION DURING PREGNANCY AND LACTATION

## 1. Introduction

Pregnancy and lactation are **physiologically demanding stages** in a woman's life.

Nutrition during this period affects:

- Mother's health
- Fetal growth and development
- Birth weight of the baby
- Infant immunity and survival

☞ Therefore, maternal nutrition is called “**foundation of future health.**”

## **PART A: NUTRITION DURING PREGNANCY**

### **2. Physiological Changes During Pregnancy**

During pregnancy:

- Blood volume increases
- Hormonal changes occur
- Uterus and breast tissues grow
- Fetus develops rapidly

Hence, nutrient requirements increase.

### **3. Energy Requirements**

Additional calories are required for:

- Fetal growth
- Placenta formation
- Maternal tissue expansion

Approximate additional requirement:

- **2nd trimester:** +350 kcal/day
- **3rd trimester:** +450 kcal/day

Sources:

- Cereals and millets
- Pulses
- Milk
- Nuts

## 4. Protein Requirements

Protein is essential for:

- Fetal tissue growth
- Placenta development
- Maternal tissue expansion

Good sources:

- Milk and curd
- Eggs
- Pulses and legumes
- Soybean
- Nuts

Deficiency may cause:

- Low birth weight baby
- Poor fetal growth

## 5. Fat Requirements

- Provides concentrated energy
- Essential fatty acids support **brain development of fetus**

Healthy sources:

- Groundnut oil
- Mustard oil
- Nuts and seeds

Avoid:

- Excess fried foods
- Trans fats

## 6. Vitamin Requirements

### Folic Acid

- Prevents neural tube defects
- Important in early pregnancy

Sources:

- Green leafy vegetables
- Citrus fruits
- Pulses

### Vitamin A

- Growth and immunity  
Sources: carrot, spinach, mango

### Vitamin D

- Bone formation  
Sources: sunlight exposure, fortified milk

### Vitamin C

- Iron absorption  
Sources: amla, guava, citrus fruits

## 7. Mineral Requirements

### Iron (Very Important)

- Needed for hemoglobin formation
- Prevents anemia

Sources:

- Green leafy vegetables
- Jaggery
- Dates
- Pulses

Iron deficiency → maternal anemia, premature delivery

### Calcium

- Fetal bone and teeth formation

Sources:

- Milk and milk products
- Ragi
- Sesame seeds

### Iodine

- Brain development of fetus

Sources: iodized salt

## 8. Common Problems During Pregnancy

- Anemia

- Morning sickness
- Constipation
- Edema
- Low birth weight

## 9. Dietary Guidelines for Pregnant Women

- Eat small frequent meals
- Include fruits and vegetables daily
- Drink adequate fluids
- Avoid alcohol and tobacco
- Limit caffeine
- Take iron–folic acid supplements as advised

# PART B: NUTRITION DURING LACTATION

## 10. Introduction to Lactation

**Lactation** is the period of breast milk production after childbirth.

Breast milk is:

- Complete food for infants
- Easily digestible
- Rich in antibodies

## 11. Energy Requirements

Milk production requires extra energy.

Additional requirement:

- About **+500–600 kcal/day**

## **12. Protein Requirements**

Needed for:

- Milk protein synthesis

Sources:

- Milk
- Pulses
- Eggs
- Soy products

## **13. Vitamin and Mineral Requirements**

### **Calcium**

- Prevents maternal bone loss

### **Iron**

- Replaces blood loss during delivery

### **Vitamin A**

- Improves infant immunity

### **Vitamin B-complex**

- Supports energy metabolism

## 14. Fluid Requirements

Mother should drink:

- Plenty of water
- Milk
- Soups
- Buttermilk

Adequate fluids → better milk production.

## 15. Dietary Guidelines for Lactating Mothers

- Eat balanced meals
- Avoid spicy and very oily foods (if infant intolerance)
- Continue iron and calcium supplements
- Adequate rest and hydration
- Exclusive breastfeeding for 6 months

## 16. Benefits of Breastfeeding

### For Baby

- Immunity
- Proper growth
- Protection from infections

### For Mother

- Faster recovery
- Reduced risk of breast cancer
- Helps weight reduction

# SPORTS AND PERFORMANCE NUTRITION

## 1. Introduction

**Sports nutrition** is the study of how **diet affects athletic performance, endurance, strength, and recovery.**

Athletes need special nutrition because:

- They expend more energy
- Muscles undergo wear and tear
- Fluid and electrolyte losses are high

👉 Proper nutrition improves **stamina, strength, and recovery.**

## 2. Goals of Sports Nutrition

- Provide sufficient energy
- Improve performance
- Delay fatigue
- Maintain hydration
- Promote recovery
- Prevent injury

## 3. Energy Requirements

Athletes require **higher calories** compared to non-athletes.

Energy needs depend on:

- Type of sport
- Duration of activity
- Intensity of exercise
- Body weight

## Types of Sports by Energy Demand

- Endurance sports (running, cycling)
- Strength sports (weight lifting)
- Team sports (football, cricket)

Energy mainly comes from **carbohydrates and fats**.

## 4. Macronutrients in Sports Nutrition

### 4.1 Carbohydrates

Carbohydrates are the **primary fuel** for muscles.

Stored as **glycogen** in liver and muscles.

Functions:

- Provide quick energy
- Delay fatigue
- Improve endurance

Sources:

- Rice, chapati
- Oats
- Fruits (banana)

- Potatoes

Low carbohydrate intake → early tiredness.

## 4.2 Proteins

Needed for:

- Muscle repair
- Muscle growth
- Recovery after exercise

Sources:

- Milk and curd
- Eggs
- Pulses
- Soybean
- Nuts

Athletes require **higher protein intake** than sedentary individuals.

## 4.3 Fats

Provide:

- Long-duration energy
- Support hormone production

Healthy sources:

- Nuts
- Seeds

- Fish oils
- Vegetable oils

Avoid excess fried and junk foods.

## **5. Micronutrients**

### **Iron**

- Oxygen transport
- Prevents fatigue

### **Calcium**

- Bone strength
- Muscle contraction

### **B-Complex Vitamins**

- Energy metabolism

### **Antioxidants (A, C, E)**

- Reduce muscle damage

Sources:

- Fruits
- Vegetables
- Milk
- Green leafy vegetables

## 6. Hydration and Electrolytes

During exercise:

- Sweat loss increases
- Water and electrolytes are lost

Important electrolytes:

- Sodium
- Potassium
- Chloride

### Effects of Dehydration

- Weakness
- Dizziness
- Reduced performance
- Muscle cramps

### Hydration Guidelines

- Drink water before exercise
- Drink during activity
- Rehydrate after exercise

ORS, lemon water, coconut water are useful.

## 7. Pre-, During-, and Post-Exercise Nutrition

### Pre-Exercise Meal (2–3 hours before)

- High carbohydrates

- Low fat
- Easy to digest

Examples:

- Banana
- Idli
- Oats

## **During Exercise**

(For long activities >1 hour)

- Fluids
- Electrolytes
- Sports drinks

## **Post-Exercise Meal**

Goal: recovery

Include:

- Carbohydrates + protein

Examples:

- Milk
- Fruit + nuts
- Curd rice

## 8. Ergogenic Aids and Supplements

Ergogenic aids = substances used to improve performance.

Examples:

- Protein supplements
- Caffeine
- Creatine

⚠ Should be used carefully and preferably under supervision.

Natural foods are safer and sufficient in most cases.

## 9. Common Nutritional Problems in Athletes

- Dehydration
- Muscle cramps
- Iron deficiency anemia
- Fatigue
- Overtraining

# Meal Planning and Menu Planning

## 1. Introduction

Knowing nutrient requirements alone is not enough.

People eat **foods, not nutrients.**

Therefore, we must:

- Select appropriate foods

- Combine food groups
- Prepare balanced meals

This process is called **meal planning**.

## 2. What is Meal Planning?

### Definition

**Meal planning** is the process of **selecting foods in appropriate quantities and combinations to meet nutritional needs of an individual or group**.

### Objectives of Meal Planning

- Provide balanced nutrition
- Maintain health
- Prevent deficiency diseases
- Suit age, activity, and economic status

## 3. Principles of Meal Planning

### 3.1 Nutritional Adequacy

Meals must supply:

- Energy
- Proteins
- Vitamins

- Minerals

### **3.2 Balance**

Include all food groups:

- Cereals
- Pulses
- Milk
- Vegetables
- Fruits
- Fats

### **3.3 Variety**

Different foods prevent nutrient deficiencies and improve appetite.

Example:

- Not same vegetable daily
- Rotate cereals (rice, wheat, millets)

### **3.4 Moderation**

Avoid:

- Excess sugar
- Excess oil
- Excess salt

### **3.5 Acceptability**

Meals should consider:

- Taste
- Culture
- Religion
- Food habits

### **3.6 Economy**

Use locally available seasonal foods to reduce cost.

## **4. Factors Affecting Meal Planning**

- Age
- Sex
- Occupation
- Health status
- Climate
- Socioeconomic status
- Food availability

## **5. Food Groups in Balanced Diet**

### **Energy Giving Foods**

- Rice, wheat, millets
- Oils and fats

## Body Building Foods

- Pulses
- Milk
- Eggs
- Meat

## Protective Foods

- Fruits
- Vegetables

# 6. Menu Planning

## Definition

**Menu planning** is the practical application of meal planning in daily meals.

It includes deciding:

- Breakfast
- Lunch
- Snacks
- Dinner

## Points to Remember

- Combine cereal + pulse (complete protein)
- Include raw foods (salad/fruits)
- Avoid repetition
- Consider cooking time

## **7. Sample Balanced Day Menu**

### **Breakfast**

Idli + sambar + milk

### **Lunch**

Rice + dal + vegetable curry + curd + salad

### **Snack**

Fruit + groundnuts

### **Dinner**

Chapati + vegetable curry + egg/curd

## **8. Meal Planning for Different Groups**

### **Children**

- Small frequent meals
- Energy dense foods

### **Adolescents**

- More protein and iron

### **Adults**

- Balanced calorie intake

## **Elderly**

- Soft, easy-to-digest foods

## **Pregnant Women**

- Iron, calcium, folic acid rich foods

## **Athletes**

- High carbohydrates and fluids

## **9. Importance of Meal Planning**

- Prevents malnutrition
- Improves family health
- Saves money and time
- Reduces food wastage

# MODULE-11

## BASICS OF FOOD PRODUCT DEVELOPMENT: Concept Development

### 1. Introduction to Food Product Development

Food product development is the process of **creating a new food product or improving an existing one** to meet consumer needs.

It includes:

- Idea generation
- Planning
- Testing
- Production
- Marketing

☞ The first and most important step is **Concept Development**.

### 2. What is Concept Development?

#### Definition

**Concept development** is the stage where an **idea is converted into a clear product plan**, describing:

- What the product is
- Who will consume it
- Why it is needed
- How it will be different from existing products

In simple words:

Concept development means turning a food idea into a workable product proposal.

### 3. Need for Concept Development

Concept development is necessary to:

- Identify market demand
- Avoid product failure
- Understand target consumers
- Decide product characteristics
- Save time and cost during production

Without proper concept development, many food products fail in the market.

## **4. Sources of Product Ideas**

Ideas for new food products may come from:

### **4.1 Consumer Needs**

- Health foods
- Ready-to-eat foods
- Convenience foods

### **4.2 Market Trends**

- Low-fat foods
- Sugar-free foods
- Organic foods
- Functional foods

### **4.3 Nutritional Problems**

- Iron-rich foods for anemia
- Protein-rich foods for children

### **4.4 Technological Advances**

- Fortified foods
- Instant mixes
- Shelf-stable products

### **4.5 Traditional Foods Modification**

- Millet snacks
- Healthy versions of local foods

## **5. Steps in Concept Development**

## **Step 1: Idea Generation**

Collect as many ideas as possible.

Methods:

- Brainstorming
- Consumer surveys
- Market research

Example:

“Healthy snack for school children.”

## **Step 2: Idea Screening**

Remove unsuitable ideas by checking:

- Feasibility
- Cost
- Safety
- Consumer acceptance

Example:

Reject ideas that are too expensive or unsafe.

## **Step 3: Define Target Consumers**

Identify who will use the product:

- Children
- Adolescents
- Elderly
- Athletes
- Diabetic patients

## **Step 4: Product Concept Description**

Clearly define:

- Product type
- Ingredients
- Nutritional benefit
- Packaging

- Price range

Example:

“An iron-fortified millet biscuit for school-age children.”

## Step 5: Concept Testing

Test whether consumers like the idea.

Methods:

- Questionnaires
- Interviews
- Focus groups

Purpose:

To know if people are willing to buy the product.

## 6. Characteristics of a Good Product Concept

A good food product concept should be:

- Safe
- Nutritious
- Affordable
- Convenient
- Acceptable in taste
- Easy to produce
- Different from existing products

## 7. Role of Nutrition in Concept Development

Nutrition plays a major role in modern food products.

Examples:

- Low-salt foods for hypertension
- Low-sugar foods for diabetes
- High-protein foods for athletes
- Calcium-rich foods for elderly

Thus, concept development often focuses on **functional and health-based foods**.

## 8. Examples of Product Concepts

- Ready-to-cook idli mix
- Iron-fortified ladoo
- High-fiber biscuits
- Protein-rich energy bars
- Low-glycemic index snacks

## 9. Advantages of Proper Concept Development

- Reduces product failure
- Saves cost and time
- Improves market success
- Ensures consumer satisfaction

# Prototype Development and Sensory Evaluation

## PART A: PROTOTYPE DEVELOPMENT

### 1. What is a Prototype?

#### Definition

A **prototype** is the **first trial version of a food product** prepared based on the developed concept.

It is a sample product made to:

- Check feasibility
- Evaluate quality
- Identify problems before large-scale production.

☞ It is also called a **trial product** or **experimental product**.

### 2. Purpose of Prototype Development

- Convert idea into real food product

- Test recipe and formulation
- Check taste and texture
- Evaluate processing method
- Improve the product before marketing

### **3. Steps in Prototype Development**

#### **Step 1: Selection of Ingredients**

Choose ingredients based on:

- Nutrition
- Availability
- Cost
- Shelf life

#### **Step 2: Formulation**

Decide the proportion of ingredients.

Example:

Flour : sugar : fat : flavoring ratio in biscuits.

#### **Step 3: Preparation Method**

- Mixing
- Cooking/baking
- Cooling
- Packaging

Standardize the procedure.

#### **Step 4: Standardization**

Repeat preparation several times until:

- Same taste
- Same texture
- Same quality

This ensures consistency.

## Step 5: Storage Study

Observe:

- Spoilage
- Texture changes
- Color changes
- Shelf life

## 4. Factors to Evaluate in Prototype

- Appearance
- Flavor
- Texture
- Nutritional value
- Cost
- Shelf life

## 5. Importance of Prototype Development

- Reduces product failure
- Improves quality
- Helps final formulation
- Saves cost in large-scale production

# PART B: SENSORY EVALUATION

## 6. What is Sensory Evaluation?

### Definition

**Sensory evaluation** is the scientific method of **assessing food quality using human senses**.

Senses used:

- Sight
- Smell
- Taste
- Touch
- Hearing (crispness)

↳ It determines **consumer acceptability**.

## 7. Sensory Characteristics of Food

### Appearance

Color, shape, size

### Flavor

Taste + aroma

### Texture

Softness, crispness, smoothness

### Mouthfeel

Creamy, watery, chewy

## 8. Types of Sensory Tests

### 8.1 Hedonic Rating Test (Most Common)

Panelists rate liking on a scale (usually 9-point scale):

1 = Dislike extremely

9 = Like extremely

Used to measure acceptability.

### 8.2 Difference Test

Checks whether two samples are different.

Example:

Triangle test (3 samples, one different).

### **8.3 Ranking Test**

Panelists arrange samples from best to worst.

### **8.4 Descriptive Test**

Panel describes specific characteristics:

- Sweetness
- Sourness
- Texture

## **9. Sensory Panel**

Panelists may be:

- Trained panel (experts)
- Semi-trained
- Consumers (general public)

Panelists should:

- Be healthy
- Non-smokers
- Free from colds
- Not hungry or too full

## **10. Conditions for Sensory Evaluation**

- Quiet room
- Neutral lighting
- No strong odors
- Room temperature samples
- Plain water for mouth rinsing

## **11. Importance of Sensory Evaluation**

- Determines market success
- Improves product quality
- Helps product modification
- Ensures consumer satisfaction

## 12. Relationship Between Prototype and Sensory Evaluation

Prototype → prepared first

Sensory evaluation → checks acceptability

If sensory score is poor → modify formulation → re-test.

## FUNCTIONAL FOODS AND NUTRACEUTICAL TRENDS

### 1. Introduction

Traditionally, food was eaten only to:

- Satisfy hunger
- Provide energy

Today, food is also used to:

- Prevent diseases
- Improve immunity
- Promote long-term health

This has led to the development of:

- **Functional foods**
- **Nutraceuticals**

👉 Modern nutrition follows the idea: “**Food as medicine.**”

### 2. Functional Foods

#### Definition

**Functional foods** are foods that provide **health benefits beyond basic nutrition** when consumed regularly as part of a normal diet.

They look like ordinary foods but contain **bioactive components** that help protect health.

#### Key Characteristics

- Consumed as part of daily diet

- Naturally rich or fortified
- Prevent disease risk
- Improve body functions

## **Types of Functional Foods**

### ***2.1 Naturally Functional Foods***

Contain natural beneficial compounds.

Examples:

- Oats (soluble fiber)
- Fruits and vegetables (antioxidants)
- Garlic (heart protective compounds)

### ***2.2 Fortified Functional Foods***

Nutrients are added to improve health value.

Examples:

- Iodized salt
- Calcium-fortified milk
- Iron-fortified cereals

### ***2.3 Modified Functional Foods***

Composition changed to improve health.

Examples:

- Low-fat yogurt
- Probiotic curd
- Omega-3 enriched eggs

## **Health Benefits of Functional Foods**

- Improve immunity
- Reduce cholesterol
- Improve digestion
- Support heart health
- Help control diabetes

## Bioactive Components in Functional Foods

Component	Function
Probiotics	Gut health
Prebiotics	Support beneficial bacteria
Antioxidants	Prevent cell damage
Omega-3 fatty acids	Heart protection
Phytochemicals	Disease prevention

## 3. Nutraceuticals

### Definition

**Nutraceuticals** are products derived from food sources that provide **medical or health benefits**, including prevention or treatment of disease.

They are usually taken in **capsule, tablet, or powder form**.

👉 Difference:

Functional food = eaten as food

Nutraceutical = taken as supplement

### Categories of Nutraceuticals

#### 3.1 Dietary Supplements

- Vitamin tablets
- Mineral capsules
- Protein powders

#### 3.2 Herbal Nutraceuticals

- Turmeric capsules
- Aloe vera extract
- Ashwagandha supplements

### 3.3 Probiotic Supplements

- Lactobacillus capsules
- Gut health powders

### 3.4 Functional Beverages

- Energy drinks
- Protein shakes
- Fortified health drinks

## Benefits of Nutraceuticals

- Improve immunity
- Prevent deficiencies
- Support chronic disease management
- Promote general wellness

## Caution

- Overconsumption may be harmful
- Should not replace balanced diet
- Should be taken with professional advice

## 4. Functional Foods vs Nutraceuticals

Feature	Functional Foods	Nutraceuticals
Form	Normal foods	Pills, powders, capsules
Consumption	Part of daily diet	Taken as supplement
Example	Probiotic yogurt	Probiotic capsule
Regulation	Food regulation	Often supplement regulation
Purpose	Health maintenance	Health support/therapy

## **5. Current Nutraceutical Trends**

### **5.1 Probiotics and Gut Health**

Focus on improving digestive health and immunity.

### **5.2 Plant-Based Products**

- Soy foods
- Almond milk
- Millet-based products

### **5.3 Immunity Boosting Foods**

After pandemics, demand increased for:

- Vitamin C products
- Herbal drinks

### **5.4 Personalized Nutrition**

Diets based on:

- Age
- Lifestyle
- Health condition

### **5.5 Functional Snacks**

- High-protein bars
- Low-sugar biscuits
- Fiber-rich snacks

## **6. Role in Lifestyle Disease Prevention**

Functional foods and nutraceuticals help in:

- Diabetes management
- Cholesterol reduction
- Blood pressure control
- Weight management
- Improving gut microbiome

# NUTRITION LABELING AND CLAIMS

## 1. Introduction

When consumers buy packaged foods, they cannot directly judge:

- Quality
- Nutritional value
- Safety

Therefore, food packages provide **nutrition labels and claims**.

👉 Nutrition labeling helps people **make informed and healthy food choices**.

## 2. What is Nutrition Labeling?

### Definition

**Nutrition labeling** is the information provided on food packages that describes the **nutrient content and energy value of a food product**.

It usually appears as a **Nutrition Information Panel** on the back of the pack.

### Objectives of Nutrition Labeling

- Inform consumers
- Promote healthy eating
- Prevent misleading information
- Help diet planning
- Support disease prevention

## 3. Components of a Nutrition Label

A typical label includes:

### 3.1 Serving Size

- Quantity of food considered for nutrient calculation
- Important for calculating actual intake

## 3.2 Energy Value

- Given in **kilocalories (kcal)**
- Shows how much energy the food provides

## 3.3 Macronutrients

### Carbohydrates

- Includes sugars and dietary fiber

### Proteins

- Body building nutrient

### Fats

- Total fat
- Saturated fat
- Trans fat

## 3.4 Micronutrients

- Vitamins (A, C, D, B-complex)
- Minerals (iron, calcium, sodium)

## 3.5 Other Important Information

- Ingredients list
- Allergen information
- Manufacturing and expiry date
- Storage instructions

# 4. Importance of Reading Labels

Reading labels helps to:

- Control calorie intake
- Limit sugar and salt
- Choose healthy fats
- Avoid allergens
- Manage diseases like diabetes and hypertension

## 5. Recommended Label Understanding Tips

- Check serving size first
- Look for high sugar or sodium
- Prefer high fiber foods
- Avoid trans fats
- Compare similar products

# NUTRITION CLAIMS

## 6. What are Nutrition Claims?

### Definition

**Nutrition claims** are statements on food labels that describe the **nutritional characteristics or health benefits** of a product.

Example:

- “Low fat”
- “High fiber”
- “Sugar free”

👉 Claims attract consumers but must be scientifically justified.

## 7. Types of Nutrition Claims

### 7.1 Nutrient Content Claims

Indicate the level of a nutrient.

Examples:

- Low fat
- High protein
- Source of calcium
- Sugar free

## 7.2 Health Claims

Link food with health benefit.

Examples:

- “Calcium supports bone health”
- “Oats help reduce cholesterol”

## 7.3 Structure/Function Claims

Describe the role of a nutrient in body function.

Examples:

- “Iron helps form hemoglobin”
- “Vitamin C supports immunity”

## 7.4 Comparative Claims

Compare with another product.

Examples:

- Reduced fat
- Less sugar
- Light product

## 8. Misleading Claims

Some labels may confuse consumers:

- “Natural” does not always mean healthy
- “Cholesterol-free” foods may still be high in fat
- “Sugar-free” may still contain high calories

👉 Always read the **nutrition panel**, not only the front label.

## 9. Regulation of Labeling

Food labeling is regulated to protect consumers.

In India:

- Food Safety and Standards Authority of India (FSSAI) sets rules

- Labels must be truthful and not misleading

Internationally:

- Codex Alimentarius guidelines

## 10. Importance in Public Health

Nutrition labeling:

- Helps prevent obesity
- Supports diabetic diet control
- Reduces heart disease risk
- Encourages healthy food industry practices

# Food Product Standardization and Quality Control

## 1. Introduction

After developing a new food product, it cannot be immediately marketed.

The product must:

- Maintain the same taste every batch
- Be safe to eat
- Have proper shelf life

This requires **standardization and quality control**.

🔗 Without quality control, a product will fail in the market even if the idea is good.

## 2. What is Standardization?

### Definition

**Standardization** is the process of **fixing the exact recipe, ingredients, and preparation method** so the product gives the **same quality every time it is prepared**.

### Objectives of Standardization

- Maintain uniform quality

- Fix ingredient quantity
- Determine cooking time and temperature
- Ensure consumer satisfaction

## Steps in Standardization

1. Select best formulation
2. Fix ingredient proportions
3. Standardize preparation method
4. Repeat preparation trials
5. Record the final procedure (Standard Recipe)

## Example

If making a high-protein biscuit:

- Fix amount of flour, sugar, fat, protein powder
- Fix baking temperature and time
- Repeat until same quality is obtained

## 3. Standard Recipe

A **standard recipe** is a written document including:

- Ingredients
- Exact quantities
- Preparation method
- Cooking time
- Yield (number of servings)

It helps large-scale production.

## 4. What is Quality Control?

### Definition

**Quality control (QC)** is the process of ensuring that a food product meets **defined standards of safety, hygiene, and quality** before reaching the consumer.

## Objectives of Quality Control

- Ensure food safety
- Prevent contamination
- Maintain product consistency
- Protect brand reputation

## 5. Types of Quality Evaluation

### 5.1 Physical Quality

- Color
- Size
- Shape
- Texture

Example: Biscuit crispness

### 5.2 Chemical Quality

- Moisture content
- pH
- Fat oxidation (rancidity)
- Nutrient content

### 5.3 Microbiological Quality

- Bacterial count
- Yeast and mold count
- Absence of pathogens

Ensures product safety.

### 5.4 Sensory Quality

- Taste
- Aroma
- Mouthfeel

- Appearance

(Connected to sensory evaluation you studied earlier)

## 6. Quality Assurance vs Quality Control

Quality Control	Quality Assurance
Testing product	Preventing defects
End-product check	Process control
Detects problem	Prevents problem

## 7. Good Practices in Food Production

To maintain quality:

- Clean equipment
- Hygienic workers
- Safe water
- Proper storage
- Pest control

These practices support HACCP and food safety systems.

## 8. Importance in Food Industry

- Increases consumer trust
- Prevents product rejection
- Required for certification
- Supports export quality



# MODULE-12

## RDA, RDI, EAR AND THEIR APPLICATIONS

### 1. Introduction

Every person needs a certain amount of nutrients daily to:

- Maintain health
- Support growth
- Prevent deficiency diseases

But one question arises:

**How much nutrient is enough?**

To answer this, nutrition science uses **dietary reference standards** such as:

- EAR
- RDA
- RDI

These are called **Dietary Reference Values (DRVs)**.

### 2. Estimated Average Requirement (EAR)

#### Definition

**EAR (Estimated Average Requirement)** is the **daily nutrient intake level estimated to meet the requirement of 50% of healthy individuals** in a particular age and gender group.

☞ It is the **minimum average requirement**.

#### Purpose of EAR

- Used for research

- Used for population studies
- Basis for calculating RDA

## Example

If EAR for iron in adult women is 10 mg:

- Half the women will meet their needs at 10 mg
- The other half may still be deficient

So EAR is **not enough for everyone**.

## 3. Recommended Dietary Allowance (RDA)

### Definition

**RDA (Recommended Dietary Allowance) is the average daily intake level sufficient to meet the nutrient needs of nearly all (97–98%) healthy individuals.**

👉 It is the most commonly used nutritional standard.

### Purpose of RDA

- Prevent deficiency diseases
- Guide daily diet planning
- Used in hospitals and community nutrition

## Example

If RDA of calcium for adults = 600 mg/day

A person consuming around this amount daily is unlikely to develop deficiency.

## Key Points

- Higher than EAR
- Designed for individuals
- Used for meal planning

## 4. Recommended Daily Intake (RDI)

### Definition

**RDI (Recommended Daily Intake)** is the **reference value used on food labels to indicate how much of a nutrient a person should consume daily.**

It is mainly used for:

- Nutrition labeling
- Consumer awareness

👉 You often see RDI as % **Daily Value (%DV)** on packaged foods.

### Example

If a biscuit provides 5 mg iron and RDI is 10 mg:  
It supplies **50% RDI**.

## 5. Relationship Between EAR, RDA, and RDI

Term	Purpose	Coverage
EAR	Research & assessment	Meets 50% people
RDA	Individual diet planning	Meets ~98% people

RDI	Food labeling	Consumer guidance
-----	---------------	-------------------

## Simple Understanding

EAR → starting point

RDA → safe intake level

RDI → label reference value

## 6. Application in Nutrition

### 6.1 Meal Planning

Dietitians use **RDA** to plan balanced diets for:

- Children
- Pregnant women
- Elderly
- Patients

### 6.2 Nutritional Assessment

Compare a person's intake with:

- EAR → risk of deficiency
- RDA → adequacy of diet

### 6.3 Public Health Programs

Used in:

- Midday meal schemes
- ICDS programs
- Supplementation programs

## 6.4 Food Product Development

Food industries:

- Fortify foods based on RDA
- Design health foods
- Calculate nutrient claims

## 6.5 Nutrition Labeling

RDI used on:

- Packaged foods
- Supplements
- Fortified products

## 7. Importance in Preventing Deficiencies

These standards help prevent:

- Anemia
- Rickets
- Scurvy
- Night blindness
- Protein-energy malnutrition

## 8. Limitations

- Values are for healthy individuals only
- Not exact for sick patients
- Individual variation exists
- Depends on activity and metabolism

# MEAL TIMING, PORTION CONTROL & FOOD EXCHANGE LISTS

## 1. Introduction

Balanced nutrition is not only about **what we eat**, but also:

- **When we eat**
- **How much we eat**
- **How foods can be substituted**

Proper meal management helps in:

- Weight control
- Diabetes management
- Good digestion
- Stable energy levels

Three important tools:

1. Meal timing
2. Portion control
3. Food exchange lists

## PART A: MEAL TIMING

### 2. What is Meal Timing?

#### Definition

**Meal timing** refers to **planning meals at appropriate intervals throughout the day** to maintain steady energy and metabolism.

Instead of 1–2 heavy meals, the body works better with **regularly spaced meals**.

### 3. Importance of Meal Timing

Proper timing:

- Maintains blood glucose levels
- Improves digestion
- Prevents overeating
- Enhances metabolism
- Improves concentration

Irregular meals may cause:

- Fatigue
- Acidity
- Obesity
- Blood sugar fluctuations

### 4. Ideal Meal Pattern

A healthy schedule:

Time	Meal
Early morning	Light drink (milk/warm water)
Breakfast	Main meal
Mid-morning	Fruit/snack
Lunch	Balanced meal
Evening	Healthy snack
Dinner	Light meal

#### Important Rules

- Do not skip breakfast

- Eat every 3–4 hours
- Avoid late-night heavy meals
- Dinner should be lighter than lunch

## 5. Special Importance in Diseases

Meal timing is essential in:

- Diabetes (prevents hypoglycemia)
- Gastric ulcers
- Obesity
- Athletes (energy management)

# PART B: PORTION CONTROL

## 6. What is Portion Control?

### Definition

**Portion control** means **eating the right quantity of food according to body needs.**

It prevents both:

- Overeating
- Undereating

👉 Even healthy foods can cause weight gain if eaten in excess.

## 7. Importance of Portion Control

- Maintains body weight

- Prevents obesity
- Controls diabetes and hypertension
- Improves digestion

## **8. Practical Methods of Portion Control**

### **Plate Method**

- $\frac{1}{2}$  plate → vegetables & fruits
- $\frac{1}{4}$  plate → cereals/grains
- $\frac{1}{4}$  plate → protein foods

### **Household Measures**

- 1 katori rice
- 1 chapati
- 1 cup milk
- 1 tablespoon oil

### **Behavioral Tips**

- Eat slowly
- Avoid second serving
- Use smaller plates
- Avoid eating while watching TV

## **PART C: FOOD EXCHANGE LISTS**

## 9. What is a Food Exchange List?

### Definition

A **food exchange list** is a system where foods are grouped based on **similar nutrient content**, so one food can be substituted for another.

It is widely used in:

- Diabetic diet planning
- Weight management diets
- Hospital diets

## 10. Purpose of Food Exchange System

- Provides variety in diet
- Helps meal planning
- Controls calorie intake
- Allows food substitutions

## 11. Major Food Exchange Groups

### 11.1 Cereal Exchange

(Provides carbohydrates)

Examples:

- 1 chapati
- ½ cup rice
- 1 slice bread

All provide approximately similar energy.

## **11.2 Pulse/Protein Exchange**

(Body-building foods)

Examples:

- 1 katori dal
- 1 egg
- Paneer portion

## **11.3 Milk Exchange**

Examples:

- 1 cup milk
- 1 cup curd

## **11.4 Fruit Exchange**

Examples:

- 1 apple
- 1 orange
- 1 banana (small)

## **11.5 Fat Exchange**

Examples:

- 1 teaspoon oil
- 5–6 nuts

## 12. Advantages of Food Exchange Lists

- Flexible diet planning
- Useful in diabetes
- Improves diet compliance
- Encourages variety

## 13. Relationship Between the Three Concepts

- Meal timing → **When to eat**
- Portion control → **How much to eat**
- Food exchange list → **What can be substituted**

Together they help create a **personalized balanced diet**.

# SPECIAL DIETS: Vegan Diet and Ketogenic (Keto) Diet

## 1. Introduction

A **special diet** is an eating pattern followed for:

- Health reasons
- Disease management
- Ethical or cultural beliefs
- Weight control

Two popular modern diets are:

- Vegan diet (plant-based)
- Ketogenic diet (low-carbohydrate, high-fat)

# PART A: VEGAN DIET

## 2. What is a Vegan Diet?

### Definition

A **vegan diet** is a diet that **excludes all animal products**.

Avoided foods:

- Meat
- Fish
- Eggs
- Milk and dairy products
- Honey

Consumed foods:

- Cereals and millets
- Pulses and legumes
- Fruits and vegetables
- Nuts and seeds
- Plant-based milk (soy, almond)

## 3. Types of Plant-Based Diets

- Vegetarian: includes milk
- Lacto-vegetarian: milk allowed
- Ovo-vegetarian: eggs allowed
- **Vegan: no animal foods**

## 4. Nutritional Features of Vegan Diet

### Rich in:

- Fiber
- Antioxidants
- Phytochemicals
- Vitamins C and E

### Low in:

- Saturated fat
- Cholesterol

## 5. Health Benefits

- Reduces obesity risk
- Lowers cholesterol
- Improves heart health
- Helps control blood pressure
- Supports gut health

## 6. Nutritional Concerns

Possible deficiencies:

### Protein

Plant proteins are incomplete → combine cereals + pulses.

### Vitamin B12

Only found in animal foods → supplementation needed.

### Iron

Plant iron absorption is lower → take with vitamin C foods.

## Calcium

Important to include:

- Ragi
- Sesame seeds
- Soy products

## Omega-3 fatty acids

Sources:

- Flax seeds
- Walnuts
- Chia seeds

## 7. Who Should Be Careful?

- Children
- Pregnant women
- Elderly

They need careful planning.

# PART B: KETOGENIC (KETO) DIET

## 8. What is a Ketogenic Diet?

### Definition

A **ketogenic diet** is a **very low carbohydrate, high fat, moderate protein diet** designed to shift body metabolism into **ketosis**.

## 9. What is Ketosis?

When carbohydrate intake is very low:

- Body cannot use glucose
- Fat is broken down
- Ketone bodies are produced

The body uses fat as the main energy source.

## 10. Macronutrient Distribution

Typical keto diet:

- Fat → 70–75%
- Protein → 20–25%
- Carbohydrate → 5–10%

## 11. Foods Allowed

- Eggs
- Meat and fish
- Butter and ghee
- Cheese
- Nuts and seeds
- Low-carb vegetables (spinach, cabbage)

## 12. Foods Restricted

- Rice
- Wheat
- Sugar
- Fruits (most)
- Potatoes
- Bakery products

## 13. Health Benefits

- Rapid weight loss
- Blood sugar control
- May help epilepsy management
- Appetite reduction

## 14. Risks and Side Effects

- Nutrient deficiencies
- Constipation
- Fatigue (“keto flu”)
- Increased cholesterol
- Not suitable long-term without supervision

Not recommended for:

- Children (general use)
- Pregnant women
- Kidney disease patients

## 15. Comparison: Vegan vs Keto Diet

Feature	Vegan Diet	Keto Diet
Basis	Plant-based	Low carbohydrate
Carbohydrates	High	Very low
Fat	Low to moderate	Very high
Protein	Plant protein	Animal + fat-based
Purpose	Health & ethics	Weight loss & metabolic control
Fiber	High	Low

# Diabetic Diet and Low-FODMAP Diet

## 1. Introduction

A **therapeutic diet** is a modified diet prescribed to:

- Manage diseases
- Reduce symptoms
- Support treatment
- Improve quality of life

Two important therapeutic diets:

- **Diabetic diet** → controls blood sugar
- **Low-FODMAP diet** → manages digestive disorders (especially IBS)

## PART A: DIABETIC DIET

### 2. What is a Diabetic Diet?

#### Definition

A **diabetic diet** is a planned eating pattern designed to:

- Maintain normal blood glucose levels
- Prevent complications
- Provide balanced nutrition

Main goal:

👉 **Control carbohydrate intake and improve insulin response**

### 3. Principles of Diabetic Diet

- Regular meal timing
- Controlled carbohydrate intake
- High fiber foods
- Limit sugar and refined foods
- Moderate fat intake
- Adequate protein

### 4. Role of Carbohydrates

Carbohydrates affect blood glucose the most.

#### Recommended

- Whole grains (brown rice, millets)
- Oats
- Whole wheat chapati
- Legumes

#### Avoid

- Sugar
- Sweets
- Sweetened beverages
- Refined flour products

Focus on **low Glycemic Index (GI) foods**.

## 5. Protein and Fat

### Protein

Helps slow glucose absorption

Sources:

- Pulses
- Eggs
- Milk
- Soy products

### Fat

Choose healthy fats:

- Nuts
- Seeds
- Vegetable oils

Avoid:

- Fried foods
- Trans fats

## 6. Fiber and Micronutrients

Fiber:

- Slows glucose absorption
- Improves satiety

Sources:

- Vegetables
- Fruits (controlled portions)
- Whole grains

Important micronutrients:

- Magnesium
- Chromium
- Vitamin D

## 7. Meal Planning for Diabetes

### Recommended Meal Pattern

- Small frequent meals (every 3–4 hours)

### Sample Day

Breakfast: Idli + sambar

Mid-morning: Fruit (guava/apple)

Lunch: Brown rice + dal + vegetable + curd

Snack: Roasted chana

Dinner: Chapati + vegetable curry

## 8. Foods to Limit or Avoid

- Sweets and desserts
- Soft drinks
- Bakery products
- Excess fruit juices
- Alcohol (limit)

## 9. Benefits of Diabetic Diet

- Controls blood sugar
- Prevents complications
- Maintains body weight

- Improves energy levels

## PART B: LOW-FODMAP DIET

### 10. What is Low-FODMAP Diet?

#### Definition

A **Low-FODMAP diet** is a diet that restricts certain carbohydrates that are **poorly digested and fermented in the intestine**, causing digestive discomfort.

Used mainly for:

👉 **Irritable Bowel Syndrome (IBS)**

### 11. What are FODMAPs?

FODMAP =

**F**ermentable

**O**ligosaccharides

**D**isaccharides

**M**onosaccharides

**A**nd

**P**olyols

These carbohydrates:

- Are poorly absorbed
- Ferment in colon
- Produce gas and bloating

## **12. Symptoms Managed by Low-FODMAP Diet**

- Bloating
- Gas
- Abdominal pain
- Diarrhea
- Constipation

## **13. High-FODMAP Foods (to Avoid)**

- Onion
- Garlic
- Wheat
- Milk (lactose)
- Apples
- Mango
- Beans
- Artificial sweeteners (sorbitol)

## **14. Low-FODMAP Foods (Allowed)**

- Rice
- Oats
- Potato
- Carrot
- Spinach
- Banana (ripe, small portion)
- Lactose-free milk
- Eggs
- Meat

## 15. Phases of Low-FODMAP Diet

1. **Elimination phase** – restrict FODMAP foods
2. **Reintroduction phase** – add foods slowly
3. **Personalization phase** – identify tolerance

## 16. Comparison: Diabetic vs Low-FODMAP Diet

Feature	Diabetic Diet	Low-FODMAP Diet
Purpose	Control blood sugar	Control digestive symptoms
Focus	Carbohydrate quality	Fermentable carbohydrates
Used for	Diabetes	IBS
Fiber	High fiber encouraged	Certain fibers restricted

# Dietary Assessment Methods

## 1. Introduction

In nutrition practice, a dietitian must answer:

- Is the person eating enough?
- Is the diet balanced?
- Are nutrient requirements met?

This is done by **dietary assessment**.

### Definition

**Dietary assessment** is the process of **evaluating a person's food and nutrient intake to determine nutritional adequacy**.

## 2. Objectives of Dietary Assessment

- Evaluate food intake
- Detect nutrient deficiencies
- Plan therapeutic diets
- Monitor nutrition programs
- Compare intake with RDA/EAR

## 3. Components of Nutritional Assessment

Dietary assessment is part of a broader **nutritional assessment**, which includes:

1. Anthropometric assessment
2. Clinical assessment
3. Biochemical assessment
4. Dietary assessment

### 3.1 Anthropometric

- Height
- Weight
- BMI
- Waist circumference

### 3.2 Clinical

- Signs of deficiency (pale skin, edema, hair changes)

### 3.3 Biochemical

- Blood tests (hemoglobin, glucose, cholesterol)

### 3.4 Dietary

- Food intake evaluation (main focus)

# METHODS OF DIETARY ASSESSMENT

## 4. 24-Hour Dietary Recall

### Method

Person recalls all foods eaten in the past 24 hours.

Includes:

- Meals
- Snacks
- Beverages
- Quantity

### Advantages

- Simple
- Quick
- Low cost

### Limitations

- Memory errors
- May not represent usual diet

## 5. Food Frequency Questionnaire (FFQ)

### Method

Person reports how often certain foods are eaten:

- Daily

- Weekly
- Monthly

## Uses

- Community surveys
- Research studies

## Advantages

- Shows long-term food habits

## Limitations

- Less precise quantity estimation

# 6. Food Diary / Diet Record

## Method

Individual records everything eaten for **3–7 days**.

Includes:

- Food type
- Preparation method
- Portion size

## Advantages

- Most accurate method
- Good for clinical practice

## Limitations

- Time-consuming
- Requires cooperation

## 7. Weighed Food Record

Food is weighed before eating.

### Advantages

- Highly accurate

### Limitation

- Difficult to follow in daily life

## 8. Comparison of Methods

Method	Accuracy	Practical Use
24-hour recall	Moderate	Clinics
FFQ	Low-moderate	Surveys
Food diary	High	Diet therapy
Weighed record	Very high	Research

## 9. Using Dietary Assessment with RDA

After collecting diet data:

1. Calculate nutrient intake
2. Compare with RDA/EAR
3. Identify deficiencies
4. Plan diet modification

Example:

If iron intake < RDA → anemia risk.

## 10. Importance in Therapeutic Diets

Dietary assessment helps in:

- Diabetes diet planning
- Obesity management
- Renal diet
- Pediatric nutrition

# MODULE-13

## DEFINING INPUT VARIABLES: AGE AND ACTIVITY LEVEL

When we plan a diet or calculate nutrient requirements, we cannot give the same diet to everyone.

Nutritional needs depend on **input variables**, especially:

- Age
- Physical activity level

These variables help us estimate:

- Energy needs (calories)
- Protein needs
- Micronutrient requirements

👉 Therefore, diet planning always begins with **collecting personal information**.

## 2. What are Input Variables?

### Definition

**Input variables** are personal characteristics used to calculate an individual's nutrient and energy requirements.

Common input variables:

- Age
- Gender
- Body weight
- Activity level
- Physiological condition (pregnancy, illness)

In this lesson we focus on **age and activity level**.

## PART A: AGE AS AN INPUT VARIABLE

### 3. Importance of Age in Nutrition

Age is the **most important determinant** of nutrient requirement because the body changes throughout life.

With age:

- Growth rate changes
- Metabolism changes
- Hormones change
- Physical activity changes

☞ Therefore calorie and nutrient needs vary at each life stage.

### 4. Age Groups and Nutritional Needs

#### 4.1 Infants (0–1 year)

- Rapid growth
- Highest nutrient needs per kg body weight
- Require breast milk or formula

Focus nutrients:

- Protein
- Fat
- Calcium
- Iron

## 4.2 Children (1–12 years)

- Growth and brain development
- Active lifestyle

Needs:

- Energy for play
- Protein for growth
- Calcium for bones

## 4.3 Adolescents (13–19 years)

- Growth spurt
- Puberty
- Hormonal changes

Higher needs for:

- Iron (especially girls)
- Protein
- Calcium

## 4.4 Adults (20–59 years)

- Growth stops
- Maintenance stage

Needs:

- Balanced energy
- Disease prevention nutrients
- Adequate fiber

#### 4.5 Elderly (60+ years)

- Decreased metabolism
- Reduced appetite
- Poor absorption

Needs:

- Less calories
- More micronutrients
- More calcium and vitamin D

### 5. Effect of Age on Energy Requirement

General pattern:

Age	Energy Requirement
Infants	Very high (per kg)
Children	High
Adolescents	Very high
Adults	Moderate
Elderly	Low

👉 As age increases → metabolism decreases → calorie needs decrease.

## PART B: ACTIVITY LEVEL AS AN INPUT VARIABLE

## 6. What is Physical Activity Level? (5 minutes)

### Definition

**Activity level** refers to the amount of physical work a person performs daily.

It strongly influences **Total Daily Energy Expenditure (TDEE)**.

More activity → more calories required.

## 7. Categories of Activity Level

### 7.1 Sedentary Activity

Very little physical movement.

Examples:

- Office workers
- Students studying most of the day
- Computer operators

Energy requirement: **lowest**

### 7.2 Moderate Activity

Regular movement but not heavy work.

Examples:

- Teachers
- Shopkeepers
- Homemakers

Energy requirement: **moderate**

### 7.3 Heavy Activity

Intense physical labor.

Examples:

- Farmers
- Construction workers
- Athletes

Energy requirement: **highest**

## 8. How Activity Affects Nutrient Needs

### Energy

Mainly affected — increases with activity.

### Protein

Needed for muscle repair in active persons.

### Water

Higher sweating → higher fluid requirement.

### Electrolytes

Sodium and potassium loss in sweat.

## 9. Combining Age and Activity

Diet planning must consider both together.

Example:

- Adolescent athlete → very high calories
- Elderly sedentary person → low calories

Same food cannot suit both.

## 10. Application in Diet Planning

Using age and activity, dietitian can:

1. Estimate calorie needs
2. Calculate protein requirement
3. Choose portion sizes
4. Select appropriate foods

Example:

Sedentary adult → lower rice quantity

Laborer → larger cereal portion

## 11. Importance in Public Health Nutrition

Used in:

- RDA calculations
- School meal programs
- Hospital diets
- Weight management
- Sports nutrition

# DEFINING INPUT VARIABLES: CULTURE AND GEOGRAPHY

## 1. Introduction

When planning a diet, nutritionists do not consider only nutrients. They must also consider the person's:

- Food habits
- Traditions
- Religion
- Climate
- Local food availability

Two very important **social and environmental input variables** are:

- **Culture**
- **Geography**

🔗 A scientifically perfect diet will fail if it does not suit the person's cultural practices and local environment.

## 2. What are Cultural and Geographical Input Variables?

### Definition

These are **social and environmental factors that influence what foods people eat, how they prepare them, and how often they consume them.**

They help in:

- Practical diet planning
- Community nutrition programs
- Public health interventions

# PART A: CULTURE AS AN INPUT VARIABLE

## 3. Meaning of Culture in Nutrition

**Culture** refers to the traditions, beliefs, customs, and social practices followed by a group of people.

It affects:

- Food selection
- Cooking methods
- Meal patterns
- Food combinations

☞ People eat according to tradition, not only nutrition.

## 4. How Culture Influences Food Habits

### 4.1 Religious Beliefs

Religion often determines what foods are allowed or restricted.

Examples:

- Vegetarian diets in certain communities
- Avoidance of beef or pork in some religions
- Fasting practices

### 4.2 Traditional Food Practices

Every culture has its own staple foods.

Examples:

- Rice-based diets
- Wheat-based diets
- Millet-based diets

These foods form the **major energy source** in daily meals.

### 4.3 Cooking Methods

Cultural practices influence preparation methods:

- Boiling
- Steaming
- Fermentation
- Frying

Some methods improve nutrition (fermentation), while some may reduce it (deep frying).

### 4.4 Meal Patterns

Culture decides:

- Number of meals per day
- Timing of meals
- Festival foods
- Special occasion foods

### 4.5 Food Taboos

Certain foods are avoided due to beliefs.

Examples:

- Avoiding papaya or pineapple during pregnancy
- Avoiding certain foods during illness

These may sometimes cause **nutritional deficiencies**.

## 5. Importance of Culture in Diet Planning

Considering culture helps to:

- Increase diet acceptance
- Improve compliance
- Prevent rejection of diet plans

Example:

A dietitian should not prescribe unfamiliar foods that a person never eats.

# PART B: GEOGRAPHY AS AN INPUT VARIABLE

## 6. Meaning of Geography in Nutrition

**Geography** refers to the physical environment where people live, including:

- Climate
- Soil
- Water availability
- Local agriculture

It determines **food availability**.

## 7. Influence of Geography on Diet

## 7.1 Climate

Climate affects energy and food choices.

### Cold regions

- Higher calorie foods
- More fats
- Hot beverages

### Hot regions

- Light meals
- More fluids
- Fruits and vegetables

## 7.2 Local Food Production

People eat foods that are easily grown locally.

- Coastal areas → fish and seafood
- Agricultural plains → cereals and pulses
- Hilly regions → roots and tubers

## 7.3 Seasonal Availability

Foods vary by season.

- Summer → fruits, vegetables, fluids
- Winter → energy-dense foods

Seasonal foods are:

- Cheaper
- More nutritious
- Easily available

## 7.4 Economic Accessibility

Geography affects:

- Market access
- Food transportation
- Food price

Remote areas may have limited food variety.

## 8. Cultural vs Geographical Influence

Factor	Culture	Geography
Type	Social	Environmental
Determines	Food beliefs	Food availability
Example	Vegetarianism	Coastal fish consumption

## 9. Application in Nutrition Programs

Used in:

- Midday meal programs
- Community nutrition education
- Therapeutic diet counseling
- Public health planning

Diet recommendations must be **locally suitable**.

## 10. Importance in Personalized Nutrition

Considering culture and geography:

- Improves acceptance
- Ensures affordability
- Maintains traditional healthy foods
- Prevents malnutrition

# NUTRIENT CALCULATOR LOGIC

## 1. Introduction

In modern nutrition practice, dietitians often use a **nutrient calculator** (manual or software-based) to:

- Estimate daily calorie needs
- Calculate nutrient intake
- Compare with RDA
- Plan personalized diets

👉 A nutrient calculator works like a **step-by-step decision system**. It converts **personal data + food intake** into **nutritional analysis**.

## 2. What is a Nutrient Calculator?

### Definition

A **nutrient calculator** is a method or tool used to **estimate the energy and nutrient intake of a person and compare it with recommended requirements**.

It may be:

- Manual (hand calculation)
- Computer software
- Mobile application

### 3. Basic Logic of the Nutrient Calculator (Overview)

The calculator follows four main stages:

1. Collect personal details
2. Estimate nutrient requirements
3. Calculate nutrient intake
4. Compare intake with requirements

## STEP 1: COLLECT INPUT VARIABLES

### 4. Personal Information Required

The first step is gathering **input variables**.

#### Required Data

- Age
- Gender
- Height
- Weight
- Activity level
- Physiological condition (pregnancy, illness)

These are necessary because nutrient needs differ for each person.

### 5. Why Input Variables Matter

Example:

- A 10-year-old child ≠ adult laborer
- Pregnant woman ≠ sedentary office worker

So diet must be individualized.

## STEP 2: ESTIMATE ENERGY REQUIREMENT

### 6. Basal Metabolic Rate (BMR)

#### Definition

**BMR** is the energy required by the body at rest to maintain vital functions such as:

- Breathing
- Blood circulation
- Heartbeat
- Body temperature

It is the **minimum energy requirement**.

#### Factors Affecting BMR

- Age
- Sex
- Body size
- Hormones

### 7. Total Daily Energy Expenditure (TDEE)

After calculating BMR, we adjust for activity.

$$TDEE = BMR + \text{Physical Activity} + \text{Thermic Effect of Food}$$

Activity multiplier:

Activity	Multiplier
Sedentary	Low
Moderate	Medium
Heavy	High

This gives the **daily calorie requirement**.

## STEP 3: CALCULATE NUTRIENT REQUIREMENTS

### 8. Macronutrient Distribution

After calories are known, they are divided into nutrients.

Typical distribution:

- Carbohydrates → 50–60%
- Protein → 10–15%
- Fat → 20–30%

#### Energy Values

- 1 g carbohydrate = 4 kcal
- 1 g protein = 4 kcal
- 1 g fat = 9 kcal

Using these, we calculate grams of each nutrient required.

### 9. Micronutrient Requirements

Next step:

Compare with **RDA/EAR values** for:

- Iron
- Calcium
- Vitamin A
- Vitamin C

This ensures nutritional adequacy.

## **STEP 4: CALCULATE FOOD INTAKE**

### **10. Collect Dietary Intake Data**

Use dietary assessment methods:

- 24-hour recall
- Food diary
- Food frequency questionnaire

Record:

- Type of food
- Quantity eaten

### **11. Convert Foods into Nutrients**

Each food has a standard nutrient value (food composition tables).

Example:

1 cup rice → carbohydrates

1 egg → protein

1 teaspoon oil → fat

We total all nutrients consumed in a day.

# STEP 5: COMPARISON AND INTERPRETATION

## 12. Compare Intake with Requirement

Now compare:

<b>Intake</b>	<b>Interpretation</b>
Less than RDA	Deficiency risk
Equal to RDA	Adequate
Excess	Overnutrition risk

## 13. Diet Modification

If intake is:

- Low → increase certain foods
- High → reduce certain foods

Example:

Low iron → add leafy vegetables and pulses.

## 14. Applications of Nutrient Calculator

- Weight management
- Diabetes diet planning
- Hospital dietetics
- Sports nutrition
- Community nutrition surveys

# FOOD SUBSTITUTION GROUPS ACROSS REGIONS

## 1. Introduction

People living in different regions do **not eat the same foods**.

Reasons:

- Culture
- Climate
- Agriculture
- Availability
- Cost

Yet, the body still needs the **same nutrients** everywhere.

🔗 Therefore, nutritionists use **food substitution groups**.

This means:

Replacing one food with another food that provides similar nutrients.

## 2. What is Food Substitution?

### Definition

**Food substitution** is replacing a food item with another food that has **similar nutritional value**.

Example:

Rice can be replaced with wheat because both mainly provide carbohydrates.

### 3. Importance of Food Substitution

Food substitution helps:

- Diet planning in different cultures
- Managing food shortages
- Therapeutic diet planning
- Cost reduction
- Increasing diet variety

It is especially useful in **community nutrition programs**.

### 4. Concept of Food Groups

Foods are grouped based on their **major nutrient contribution**:

1. Energy-giving foods
2. Body-building foods
3. Protective foods

Substitutions are done **within the same group**.

## MAJOR FOOD SUBSTITUTION GROUPS

### 5. Cereal Group (Energy Foods)

Main nutrient: **Carbohydrates**

Examples:

- Rice
- Wheat
- Maize

- Millets (ragi, jowar, bajra)

## Substitution Principle

All cereals provide similar calories → can replace each other.

Example:

- Rice ↔ Chapati ↔ Ragi ball ↔ Corn roti

## Regional Variations

- South India → Rice
- North India → Wheat
- Rural areas → Millets

## 6. Pulse/Protein Group

Main nutrient: **Protein**

Examples:

- Red gram dal
- Bengal gram
- Green gram
- Soybean
- Lentils

## Substitutions

Any pulse can replace another pulse nutritionally.

Example:

Dal ↔ Chana ↔ Rajma ↔ Soybean

## 7. Milk and Animal Protein Group

Main nutrients:

- High-quality protein
- Calcium

Examples:

- Milk
- Curd
- Paneer
- Egg
- Fish
- Chicken

### Substitutions

- Milk ↔ Curd ↔ Paneer
- Egg ↔ Meat ↔ Fish
- For vegetarians → Soy products

## 8. Vegetable Group (Protective Foods)

Main nutrients:

- Vitamins
- Minerals
- Fiber

Types:

- Green leafy vegetables
- Roots and tubers
- Other vegetables

## Substitution

Spinach ↔ Amaranth ↔ Drumstick leaves ↔ Cabbage  
All provide protective nutrients.

## 9. Fruit Group

Main nutrients:

- Vitamin C
- Antioxidants

Examples:

- Orange
- Guava
- Banana
- Papaya
- Apple

Any seasonal fruit can replace another fruit nutritionally.

## 10. Fat Group

Main nutrient: **Energy and essential fatty acids**

Examples:

- Oil
- Ghee
- Butter
- Nuts
- Seeds

Substitutions:

Groundnut oil ↔ Mustard oil ↔ Sunflower oil ↔ Sesame oil

# REGIONAL APPLICATION

## 11. Why Regional Substitution is Important

A dietitian should not prescribe unfamiliar foods.

Example:

- Suggesting oats where millets are common may fail.
- Suggesting quinoa in rural areas may be impractical.

Instead:

Choose **locally available equivalents**.

This improves:

- Acceptance
- Affordability
- Sustainability

## 12. Role in Public Health Nutrition

Used in:

- Midday meal schemes
- ICDS programs
- Disaster relief nutrition
- Community diet counseling

Helps maintain nutrition despite food shortages.

# PRACTICAL TESTING OF OUTPUT CONSISTENCY

## 1. Introduction

After developing a food product and finalizing the recipe, one important question remains:

👉 **Will the product come out the same every time it is prepared?**

If a product changes in:

- Taste
- Texture
- Color
- Shelf life

then consumers lose trust.

Therefore, we perform **practical testing of output consistency**.

## 2. What is Output Consistency?

### Definition

**Output consistency** means the food product shows **uniform quality in every batch of preparation** when made using the same method and ingredients.

In simple terms:

The product should taste, look, and feel the same every time it is produced.

## 3. Why Consistency is Important

- Maintains consumer satisfaction

- Builds brand reliability
- Prevents product rejection
- Ensures standard quality
- Required for commercial production

Example:

If a biscuit is crispy today but soft tomorrow → product failure.

## 4. When Consistency Testing is Done

Consistency testing is done:

- After prototype development
- Before commercialization
- During pilot-scale production
- Periodically in industry

# STEPS IN PRACTICAL TESTING

## 5. Step 1: Standardize the Recipe

Prepare a **standard recipe** including:

- Exact ingredient quantities
- Preparation steps
- Cooking temperature
- Cooking time

Record everything carefully.

This becomes the **reference formula**.

## 6. Step 2: Repeat Batch Preparation

Prepare the same product multiple times (at least 3–5 trials).

Purpose:

To see whether repeated preparation gives identical results.

This is called **batch replication**.

## 7. Step 3: Observe Physical Characteristics

Check:

### Appearance

- Color
- Shape
- Size

### Texture

- Crispness
- Softness
- Thickness

### Aroma

- Pleasant smell
- No off-odor

Any variation indicates lack of consistency.

## 8. Step 4: Sensory Evaluation

Conduct taste testing using panelists.

Evaluate:

- Taste
- Flavor
- Mouthfeel
- Overall acceptability

If scores differ widely → recipe not stable.

## **9. Step 5: Measure Chemical Parameters**

Laboratory tests may include:

- Moisture content
- pH
- Fat content
- Total solids

Consistent values = stable product.

## **10. Step 6: Microbiological Testing**

Check:

- Bacterial count
- Yeast and mold growth

Ensures product safety and shelf life.

## **11. Step 7: Shelf-Life Observation**

Store product under normal conditions and monitor:

- Spoilage
- Texture change

- Rancidity
- Color change

Consistency means shelf life remains similar in each batch.

# **FACTORS AFFECTING OUTPUT CONSISTENCY**

## **12. Raw Material Variation**

Different quality ingredients cause variation.

Example:

Old flour vs fresh flour → different texture.

## **13. Processing Conditions**

- Temperature
- Cooking time
- Mixing method

Small changes may produce large differences.

## **14. Human Factors**

- Measurement errors
- Improper mixing
- Cooking skill differences

Standard operating procedures (SOPs) reduce errors.

## 15. Equipment Factors

- Oven temperature variation
- Grinder speed
- Fermentation environment

Proper equipment calibration is important.

# APPLICATIONS

## 16. Use in Food Industry

Output consistency testing is required for:

- Bakery products
- Dairy products
- Snacks
- Ready-to-eat foods

It is essential before mass production.

## 17. Relationship with Quality Control

Consistency testing supports:

- Standardization
- HACCP
- Food safety
- Consumer acceptance

