Chapter 1: DEFINITION AND SCOPE OF FOOD SCIENCE

Food Science is the study of the physical, biological, and chemical makeup of food; the causes of food deterioration; and the concepts underlying food processing. It is an applied science that draws heavily on other scientific disciplines.

a) Inter-relationship with Food Chemistry

Food Chemistry is the study of chemical processes and interactions of all biological and non-biological components of foods. It provides the foundational knowledge for Food Science. Food scientists use chemical principles to understand how ingredients react during cooking, processing, and storage. This includes analyzing the molecular structure of components like carbohydrates, which dictates their function (e.g., starch gelatinization) and nutritional value. The stability of vitamins, the browning reactions of sugars, and the oxidation of fats are all chemical phenomena central to Food Science.

b) Food Microbiology & Food Processing

These are two critical pillars of Food Science. **Food Microbiology** focuses on the role of microorganisms—bacteria, yeasts, molds, and viruses—in food. This is crucial for ensuring food safety (pathogen control), understanding food spoilage, and harnessing beneficial microbes for fermentation (e.g., producing yogurt, cheese, or bread). **Food Processing** is the conversion of raw ingredients into food, or of food into other forms, which often involves preservation techniques. Food processing relies on microbiological principles to select methods that inhibit or kill unwanted microbes, extending shelf life and ensuring food safety.

c) Constituents of Food

Foods are complex mixtures, and understanding how their components interact requires classifying the mixtures by particle size.

i. True Solution

A true solution is a homogeneous mixture where solute particles are dissolved completely in a solvent, typically water. The particles are extremely small (less than 1 nanometer) and are invisible, stable, and cannot be separated by filtration or centrifugation. Examples include dissolved sugar, salt, and water-soluble vitamins.

ii. Suspension

A suspension is a heterogeneous mixture where particles are much larger (over 1,000 nanometers) and are dispersed throughout the medium. These particles are often visible, and if left undisturbed, they will eventually settle out under gravity (sedimentation). Examples include sand stirred in water or uncooked starch granules settled in cold water.

iii. Colloids

Colloidal dispersions are intermediate between true solutions and suspensions (particles are 1 to 1,000 nanometers). The particles are small enough not to settle out but large enough to scatter light (Tyndall effect). Most food systems are colloidal.

d) Types of Colloidal Systems in Food

Colloidal systems are classified based on the state (solid, liquid, or gas) of the dispersed phase and the continuous phase (or medium).

i. Sol

A sol is a colloidal system where a solid is dispersed in a liquid. Sols typically flow easily. Examples include hot starch paste, some sauces, and gravies before they cool and thicken.

ii. Gel

A gel is formed when a sol cools or undergoes a chemical change, resulting in a continuous, three-dimensional network of solid particles that traps the liquid phase. It is characterized by its semi-rigid structure. Examples include jelly, set custard, and gelatin desserts.

iii. Emulsion

An emulsion is a colloidal system where one liquid is dispersed in another immiscible liquid. They are stabilized by an emulsifying agent (like protein or lecithin) which reduces surface tension. There are two main types: oil-in-water (O/W, e.g., milk, mayonnaise) and water-in-oil (W/O, e.g., butter, margarine).

iv. Foam

A foam is a colloidal system where a gas is dispersed in a liquid. The liquid creates films around the gas bubbles. Foams are unstable and will eventually break down unless stabilized by proteins or other substances. Examples include whipped cream and meringue.

v. Solid Foam or Suspension

This system occurs when a gas is dispersed in a solid. This structure is typically created when a liquid foam (or batter/dough containing air bubbles) is cooked and the liquid sets into a solid structure. Examples include bread, cake, and marshmallows.

vi. Aerosol

An aerosol involves a liquid or solid dispersed in a gas. In a food context, this is often encountered in sprays or mists. Examples include cooking sprays or the mist created by dry ice.

e) Carbohydrates

Carbohydrates are polyhydroxy aldehydes or ketones, or substances that yield such compounds on hydrolysis. They are the primary source of energy in the human diet and are vital structural components in food.

i. Classification

Carbohydrates are primarily classified by the number of sugar units:

- **Monosaccharides:** Single sugar units, such as glucose, fructose (fruit sugar), and galactose. They are readily absorbed and are the building blocks of all other carbohydrates.
- **Disaccharides:** Two monosaccharide units joined together, such as sucrose (table sugar, glucose + fructose), lactose (milk sugar, glucose + galactose), and maltose (malt sugar, glucose + glucose).
- **Polysaccharides:** Many monosaccharide units linked together. They are not sweet and function as energy storage (starch, glycogen) or structural components (cellulose, pectin).

ii. Effects of Cooking on Starch

The most important effect of cooking starch is **gelatinization**. When starch granules are heated in a liquid, they absorb water, swell significantly, and lose their crystalline structure. This causes the liquid to thicken. If the mixture is allowed to cool, it may form a rigid structure called a gel, a process known as **gelation**. Over time, upon cooling, some starches undergo **retrogradation**, where the amylose and amylopectin chains re-associate, squeezing out water (syneresis), which can cause staling in bread or a grainy texture in sauces.

iii. Types of Starches

Starches vary based on the ratio of two polysaccharides: **amylose** (linear chains) and **amylopectin** (highly branched chains).

- **Normal Starch:** Contains both amylose (20-30%) and amylopectin (70-80%). It forms cloudy, relatively strong gels upon cooling.
- **Waxy Starches:** Contains almost 100% amylopectin. They gelatinize readily but do not form true gels; instead, they remain relatively clear and viscous. They are excellent for frozen foods as they resist retrogradation.
- **High-Amylose Starches:** Contains up to 70% amylose. They are difficult to gelatinize but form very strong, opaque gels.

iv. Uses of Carbohydrates

Carbohydrates serve multiple functions in food preparation:

- **Sweetener:** Sugars (mono- and disaccharides) provide sweetness and flavor.
- **Thickener/Stabilizer:** Starches and gums (polysaccharides like pectin and guar gum) are used to increase viscosity and stabilize emulsions and foams.
- **Structure/Body:** Starch and fiber provide bulk and structure, especially in baked goods.

- **Preservative:** High concentrations of sugar act as a preservative by binding water (e.g., in jams and jellies).
- **Color/Flavor:** Sugars participate in browning reactions (Maillard reaction and caramelization) when heated, contributing flavor and color to crusts and candies.

f) Proteins

Proteins are large biological molecules made up of chains of amino acids. They are essential for structure, function, and regulation of the body's tissues and organs.

i. Classification based on Characterization & Function

- **Characterization:**
  - **Simple Proteins:** Yield only amino acids upon hydrolysis (e.g., albumin in egg, gluten in wheat).
  - **Conjugated Proteins:** Proteins combined with non-protein components (e.g., lipoprotein—protein + lipid; glycoprotein—protein + carbohydrate).
  - **Derived Proteins:** Products of protein breakdown (e.g., gelatin).
- **Function:**
  - **Structural:** Provide physical support and shape (e.g., collagen in meat).
  - **Enzymatic:** Catalyze chemical reactions (e.g., amylase).
  - **Hormonal:** Act as chemical messengers (e.g., insulin).
  - **Transport:** Carry substances (e.g., hemoglobin).
  - **Defense:** Antibodies.

ii. Functional Properties of Protein-rich Food

The unique behavior of proteins during processing is based on their functional properties:

- **Gelatin (Gelling):** Gelatin, a derived protein from collagen, forms heat-reversible gels. Its chains unfold when heated in water and then intertwine upon cooling, trapping water to form a soft, elastic gel structure, vital for desserts and aspics.
- **Milk (Emulsification):** Milk proteins, particularly casein and whey proteins, act as excellent emulsifiers, surrounding fat globules and preventing them from coalescing. This keeps the fat and water phases of milk stably mixed.
- **Egg (Foaming):** Egg white proteins (albumins) have remarkable foaming ability. When whipped, the proteins denature, unfold, and reorganize at the air-water interface, creating a stable film around the air bubbles, essential for meringue and soufflés.
- **Meat (Water-Holding Capacity):** Muscle proteins (actin and myosin) can bind and hold water within the muscle fibers. This property is crucial for the juiciness and texture of cooked meat. Factors like pH and salt content can significantly alter this capacity.

iii. Commercial Uses of Proteins

Proteins are widely used in the food industry for various purposes:

- **Texturizers and Stabilizers:** Used to improve mouthfeel, consistency, and shelf stability (e.g., soy protein in meat analogues, whey protein concentrates in sports nutrition products).
- **Enzymes:** Commercial enzymes derived from proteins are used to ripen cheese (rennet), tenderize meat (papain), and clarify juices (pectinase).
- **Meat Substitutes:** Plant-based proteins (soy, pea) are processed to mimic the texture and structure of meat.

g) Fat & Oils

Fats and oils are lipids, which are organic compounds insoluble in water. They are concentrated sources of energy and carriers of fat-soluble vitamins. The difference between fat and oil is simply that fats are solid at room temperature and oils are liquid.

i. Classification based on Origin & Saturation

- **Origin:**
  - **Animal Fats:** Derived from animal sources (e.g., butter, lard). They are typically high in saturated fatty acids.
  - **Vegetable Oils:** Derived from plants (e.g., olive oil, soybean oil, sunflower oil). They are generally higher in unsaturated fatty acids.
- **Saturation:** Refers to the number of double bonds in the fatty acid chains.
  - **Saturated Fats:** Have no double bonds. They are straight chains, pack tightly, and are solid at room temperature (e.g., palm oil, coconut oil, animal fats).
  - **Monounsaturated Fats:** Have one double bond (e.g., olive oil, canola oil).
  - **Polyunsaturated Fats:** Have two or more double bonds (e.g., soybean oil, corn oil).

ii. Rancidity

Rancidity is the chemical deterioration of fats and oils resulting in unpleasant odors and flavors.

- **Hydrolytic Rancidity:** Occurs when water breaks the ester linkages of triglycerides, releasing free fatty acids. This is often catalyzed by enzymes (lipases) and results in the soapy, sharp flavor characteristic of old butter.
- **Oxidative Rancidity:** Occurs when unsaturated fatty acids react with oxygen from the air, forming peroxides and other compounds. This is a chain reaction accelerated by heat, light, and metals, resulting in a "warmed over" or "fishy" flavor.

iii. Reversion

Reversion is a specific type of off-flavor development that occurs in certain polyunsaturated oils (like soybean and canola oil) even before full rancidity. The flavor changes are often described as "beany," "grassy," or "fishy" and are due to the oxidation of highly sensitive fatty acids.

iv. Effect of Heat on Fats & Oil

Heating fats causes several changes:

- **Melting:** Solid fats become liquid.
- **Smoke Point:** The temperature at which a fat or oil begins to break down into glycerol and free fatty acids, producing a bluish smoke. A low smoke point indicates degradation and is unsuitable for high-heat cooking.
- **Polymerization:** Prolonged, excessive heating causes fatty acids to link together (polymerize), increasing the viscosity of the oil and leading to the formation of undesirable, difficult-to-clean residues.

v. Shortening

The term "shortening" describes the ability of fat to interfere with the formation of long gluten strands in wheat flour doughs. Fat coats the flour particles, physically shortening the gluten network and resulting in a tender, flaky, or crumbly texture (e.g., in pastries, biscuits, and pie crusts).

vi. Uses of Popular Fats & Oils

- **Butter/Margarine:** Used for flavor, creaming, and spreadability.
- **Lard/Shortening:** Used in baking for excellent shortening power and flaky texture due to their high proportion of solid fat crystals.
- **Olive Oil:** Used for salad dressings and sautéing due to its distinct flavor and moderate smoke point.
- **Vegetable Oils (e.g., Soybean, Canola):** Used primarily for deep-frying and high-heat applications due to their high smoke points and relatively neutral flavor.

h) Flavour

i. Definition

Flavour is a composite, multi-sensory experience perceived when food or drink is consumed. It is not just the simple taste sensed by the tongue, but the combined input from all the senses, primarily **taste** (sweet, sour, salty, bitter, umami) and **aroma** (smell), which is sensed through the nasal cavity. Texture, temperature, and pain (e.g., chili heat) also contribute significantly to the overall flavor profile.

ii. Types

Flavour components can be broadly categorized into:

- **Volatiles (Aroma/Odor):** These are compounds that easily evaporate into the air and travel to the olfactory receptors in the nose. They are responsible for the complex "smell" of food. Examples include esters in fruits and sulfur compounds in garlic.
- **Non-volatiles (Taste):** These are compounds that dissolve in saliva and interact directly with the taste buds on the tongue, sensing the five basic tastes. Examples include sugars (sweet), acids (sour), and sodium chloride (salty).

iii. Uses of Flavors in Food Preparation

Flavors are crucial in food preparation for:

- **Enhancement:** Using spices, herbs, and aromatics to boost the natural flavor of ingredients (e.g., salt in soup).
- **Masking:** Using strong flavors (e.g., garlic, chili) to cover up undesirable off-notes or bitter components in a dish.
- **Consistency:** Ensuring that a prepared food item consistently tastes the same every time it is made, often achieved through the use of standardized extracts and flavorings in commercial preparation.

Chapter 2: FOOD AND NUTRITION

a) Introduction & Classification of Nutrients

Nutrition is the study of food and how the body uses it for growth, repair, and maintenance of health. **Nutrients** are chemical substances in food that are required by the body. They are classified based on the quantity required.

- **Macronutrients:** Needed in large amounts (grams per day). These provide energy and building materials. This group includes **Carbohydrates, Fats, and Proteins**.
- **Micronutrients:** Needed in small amounts (milligrams or micrograms per day). These primarily function as catalysts and regulators. This group includes **Vitamins and Minerals**.
- **Water** is also an essential nutrient, required in large amounts, playing a vital role in virtually every bodily function.

b) Micro Nutrients: Vitamins & Minerals

Micronutrients do not provide energy but are critical for nearly all metabolic processes.

Nutrient Type	Classification & Role	Food Sources	Deficiency Diseases
Vitamins	**Fat-Soluble (A, D, E, K):** Stored in the body's fat tissues. **Water-Soluble (B-complex, C):** Must be consumed regularly as they are not stored efficiently. They act as coenzymes, helping enzymes catalyze reactions.	**A:** Liver, dark leafy greens, carrots. **D:** Fortified milk, sunlight, fatty fish. **C:** Citrus fruits, bell peppers. **B-complex:** Whole grains, meat, legumes.	**A:** Night blindness. **D:** Rickets (in children). **C:** Scurvy. **B1 (Thiamin):** Beriberi.
Minerals	**Major Minerals** (e.g., Calcium, Potassium): Required in large amounts. **Trace Minerals** (e.g., Iron, Iodine, Zinc): Required in very small amounts. They are inorganic, acting as structural components (bones) and regulators (fluid balance, nerve function).	**Calcium:** Dairy, broccoli. **Iron:** Red meat, beans, fortified cereals. **Iodine:** Iodized salt, seafood.	**Calcium:** Osteoporosis. **Iron:** Anemia. **Iodine:** Goiter.

c) Balanced Diet

i. Definition and its Importance

A balanced diet is one that provides all the essential nutrients in the correct proportions and amounts necessary to maintain optimal health, growth, and physiological well-being. Its importance lies in preventing both nutrient deficiency diseases (like scurvy or anemia) and diet-related chronic diseases (like obesity, diabetes, and heart disease), while ensuring optimal physical and cognitive performance.

ii. Factors Affecting a Balanced Diet

The ideal balanced diet is not universal but varies significantly based on individual needs:

- **Age:** Children and adolescents require higher energy and protein intake for growth, while older adults may need fewer calories but more nutrient-dense foods (e.g., high calcium for bone health).
- **Gender:** Men generally have a larger muscle mass and higher basal metabolic rate, requiring higher caloric intake than women. Women of childbearing age have higher iron requirements due to menstrual losses.
- **Physiological State:** Specific life stages drastically alter nutrient needs. Pregnant women require increased calories, folate, and iron to support fetal development. Lactating women require extra fluids and energy to produce breast milk. Individuals recovering from illness or undergoing high-intensity athletic training also have modified protein and energy requirements.

d) Function of Water in Maintaining Health

Water is arguably the most critical nutrient, making up about 60% of body weight. Its functions are diverse and essential:

- **Solvent and Transport Medium:** Water dissolves nutrients, metabolic wastes, and other essential substances, allowing them to be transported throughout the body via the blood and lymph.
- **Temperature Regulation:** Water has a high heat capacity, helping to stabilize body temperature. Evaporation of sweat is the primary mechanism for cooling the body.
- **Lubrication and Cushioning:** Water lubricates joints, cushions the spinal cord, and protects the fetus during pregnancy.
- **Chemical Reactions:** Water is a reactant or product in many metabolic chemical reactions (e.g., hydrolysis).
- **Fluid and Electrolyte Balance:** Water is vital for maintaining the correct balance of fluids inside and outside cells.

Chapter 3: FOOD HYGIENE, QUALITY ASSURANCE & FSSAI

a) Personal, Equipment & Workstation Hygiene

Food Hygiene involves all measures necessary to ensure the safety and suitability of food at all stages of the food chain.

- **Personal Hygiene:** This is paramount. It includes frequent and correct handwashing (especially before handling food and after using the restroom), wearing clean protective clothing (aprons, hair restraints), and maintaining good health (avoiding food handling when ill with symptoms like vomiting or diarrhea).
- **Equipment Hygiene:** All utensils, machinery, and food contact surfaces must be regularly cleaned, sanitized, and maintained. Equipment should be designed to be easily cleaned, minimizing crevices where microbes can hide.
- **Workstation Hygiene:** The preparation area must be kept clean, organized, and free from debris. A clear distinction must be maintained between raw food areas and ready-to-eat food areas to prevent **cross-contamination**. Cleaning chemicals must be stored separately from food.

b) CCPs (Critical Control Points)

A Critical Control Point (CCP) is a step in the food production process where control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level. CCPs are the cornerstones of the Hazard Analysis and Critical Control Points (HACCP) system. Examples of CCPs include the cooking step (to kill pathogens), the cooling step (to prevent bacterial growth), and the metal detection step (to eliminate physical hazards). Each CCP must have established critical limits that must be met to ensure food safety.

c) Hygiene in Different Catering Establishments

Hygiene protocols are tailored to the unique risks and operational tempo of various settings:

- **Railways/Airlines:** Focus on minimizing preparation on-site, using pre-packaged or pre-cooked meals, ensuring strict temperature control during transport and short holding times, and managing waste disposal efficiently in confined spaces.
- **Restaurants:** Emphasis on strict personal hygiene, proper cold and hot holding temperatures, preventing cross-contamination between raw and cooked items, and effective cleaning schedules for high-volume equipment.
- **QSR (Quick Service Restaurants):** Focus on standardized procedures, rapid cooling and reheating protocols, validated cooking temperatures for mass-produced items, and robust staff training due to high turnover.
- **Home Delivery Service:** The primary focus is on maintaining the food temperature during the entire transport period. This requires insulated carriers and time limits to ensure hot food stays above 60°C and cold food stays below 5°C until it reaches the consumer.

d) Quality Assurance

i. Characteristics of Quality

Food quality is the totality of features and characteristics that bear on the food's ability to satisfy stated or implied needs. Key characteristics include:

- **Safety:** Absence of hazards (microbiological, chemical, physical).
- **Sensory:** Attributes like taste, aroma, texture, and appearance.
- **Nutritional:** Content of essential nutrients and calories.

- **Value:** Price relative to the perceived quality and shelf life.
- **Conformity:** Compliance with standards, regulations, and label claims.

ii. Good Manufacturing Practices (GMP)

GMP are a system of processes, procedures, and documentation that ensures products are consistently produced and controlled according to quality standards. GMP cover all aspects of production, from the starting materials, premises, and equipment to the training and personal hygiene of staff. Adherence to GMP minimizes the risk of product contamination and mix-ups.

iii. Total Quality Management (TQM)

TQM is a management philosophy focused on continuous quality improvement and meeting customer requirements. It involves all staff, from top management to line workers, in improving processes, products, and services. In food service, this means continuously seeking feedback on flavor, texture, service speed, and presentation, and implementing changes based on that feedback.

iv. Risk Assessment

Risk assessment is the scientific process of evaluating the potential adverse health effects resulting from human exposure to foodborne hazards. It consists of four steps: **Hazard Identification** (identifying the biological, chemical, or physical agent that may cause adverse health effects), **Hazard Characterization** (describing the nature of the adverse effects), **Exposure Assessment** (evaluating the degree of intake of the hazard), and **Risk Characterization** (combining the first three to estimate the severity and probability of the adverse health outcome).

e) FSSAI - Role, Functions & Initiatives

The **Food Safety and Standards Authority of India (FSSAI)** is an autonomous body established under the Ministry of Health & Family Welfare, Government of India.

- **Role:** The FSSAI is the single reference point for all matters relating to food safety and standards in India, ensuring safe and wholesome food for human consumption.
- **Functions:**
    - **Framing Regulations:** Developing and enforcing standards and guidelines for food articles.
    - **Licensing and Registration:** Granting licenses to food businesses to ensure compliance.
    - **Testing:** Laying down procedures and guidelines for the accreditation of food testing laboratories.
    - **Surveillance:** Monitoring the quality of food sold in the market.
    - **Information Dissemination:** Promoting general awareness about food safety and nutrition.
- **Initiatives:** FSSAI runs several programs, such as 'Eat Right India' (to promote healthy and sustainable eating), 'Food Safety Training and Certification' (FoSTaC), and 'Clean Street Food' projects.

Chapter 4: FOOD MICROBIOLOGY

a) Microorganisms & their Types

Microorganisms are tiny living organisms, some of which are beneficial, while others can cause spoilage or disease in food.

- **Bacteria:** Single-celled organisms that reproduce rapidly. They are the most common cause of foodborne illness and spoilage, but are also essential for fermentation (e.g., *Lactobacillus* in yogurt).
- **Fungi:** Include molds and yeasts. **Molds** are multicellular, often visible as fuzzy growth, and can produce toxins (mycotoxins). **Yeasts** are unicellular and are vital for bread making and brewing due to their ability to produce carbon dioxide and alcohol.
- **Viruses:** Non-living, parasitic agents that require a living host cell to replicate. They are transmitted through food (e.g., Norovirus, Hepatitis A) but do not grow in the food itself.
- **Algae:** Mostly aquatic and photosynthetic, but some species can produce toxins that accumulate in seafood, leading to food poisoning.
- **Parasites:** Organisms that live on or in a host and benefit at the host's expense. Examples include protozoa (e.g., *Giardia*) and worms (e.g., *Trichinella*), often transmitted through improperly cooked meat or contaminated water.

b) Factors Affecting the Growth of Microbes

The growth of most spoilage and pathogenic microorganisms is governed by the acronym **FATTOM**:

- **Food:** Microbes need nutrients, especially protein and carbohydrates, to grow. High-protein foods are highly susceptible.
- **Acidity (pH):** Most bacteria thrive in a neutral environment (pH 6.5–7.5). Highly acidic foods (below pH 4.5, like citrus) inhibit bacterial growth but may allow molds and yeasts to survive.
- **Time:** Given enough time, bacteria can multiply exponentially. The "Danger Zone" is the time period when temperature allows for rapid growth.
- **Temperature:** Bacteria grow most rapidly between 5°C and 60°C (the Danger Zone). Low temperatures (refrigeration/freezing) slow growth, and high temperatures (cooking) kill them.
- **Oxygen:** Microbes can be aerobic (require oxygen), anaerobic (cannot tolerate oxygen), or facultative (can grow with or without oxygen). Food packaging (vacuum sealing) controls oxygen availability.
- **Moisture (Water Activity, Aw):** Microbes need available water to grow. Foods with low water activity (below 0.85, like crackers, dried fruit, or high-sugar/salt foods) inhibit most microbial growth.

c) Benefits of Microbes

While often associated with spoilage and disease, microorganisms are indispensable to the food world:

- **Fermentation:** Microbes (bacteria and yeast) transform food through the production of acid, alcohol, or carbon dioxide. This preserves food (e.g., pickling, curing), improves digestibility, and enhances flavor (e.g., cheese, yogurt, wine, soy sauce).
- **Probiotics:** These are live microorganisms that, when administered in adequate amounts, confer a health benefit on the host. They are often added to dairy products (e.g., *Lactobacillus* and *Bifidobacterium*).
- **Enzyme Production:** Yeasts and molds are used commercially to produce food-grade enzymes (e.g., amylases, proteases) used in processing.

d) Food Spoilage & Preservation – Techniques & Methods

Food spoilage is the decomposition of food that renders it undesirable or unsuitable for consumption, usually caused by microbial activity, enzymes, or chemical reactions. **Food preservation** is the process of treating and handling food to stop or slow down spoilage.

- **Preservation Techniques (Principles of Action):**
    - **Asepsis:** Keeping microbes out (e.g., proper packaging, good hygiene).
    - **High Temperature:** Using heat to destroy microbes and enzymes (e.g., pasteurization, sterilization, canning).
    - **Low Temperature:** Slowing or stopping microbial and enzyme activity (e.g., refrigeration, freezing).
    - **Chemical Preservatives:** Adding substances like acids, salts, or sugar to inhibit growth.
    - **Reducing Water Activity:** Removing available water (e.g., drying, adding salt/sugar).
- **Preservation Methods (Practical Applications):**
    - **Canning:** Sealing food in sterile containers and subjecting it to high heat to sterilize the contents.
    - **Freezing:** Storing food at temperatures well below 0°C to halt microbial growth and slow enzyme activity.
    - **Drying/Dehydration:** Removing moisture to prevent microbial growth (e.g., sun-drying, freeze-drying).
    - **Fermentation:** Using beneficial microbes to produce inhibitory compounds (like lactic acid) that preserve the food.

Chapter 5: CONSERVING NUTRIENTS FOR FOOD SERVICE OPERATIONS

a) Conserving Nutrients During Purchase, Storage & Food Preparation

Nutrient loss (especially of water-soluble vitamins like C and B-complex) can occur at every stage.

- **Purchase:** Select fresh, undamaged foods. Purchase locally grown items when possible to minimize transport and storage time. Use the **FIFO (First-In, First-Out)** rule to ensure older stock is used first.
- **Storage:**

    - **Perishable Foods (e.g., fresh meat, dairy):** Require immediate chilling (refrigeration below 5°C) to slow microbial growth and enzyme activity. Store away from strong-smelling foods.
    - **Semi-perishable Foods (e.g., root vegetables, eggs):** Can be stored for moderate periods. Keep in cool, dark, and dry conditions (e.g., root cellar, refrigerator vegetable drawer) to reduce respiration and sprouting.
    - **Non-perishable Foods (e.g., dried grains, canned goods):** Store in a cool, dry place off the floor to prevent pest infestation and moisture damage.
- **Food Preparation:**
    - **Pre-cooking:** Minimize trimming/peeling (nutrients concentrate near the skin). Chop foods just before use (exposure to air causes vitamin C oxidation). Do not soak cut vegetables.
    - **During Cooking:** Use minimal amounts of cooking liquid and minimal cooking time (to limit leaching and heat destruction). Use cooking methods that require little or no water, such as steaming, pressure cooking, or stir-frying. Re-use cooking water (e.g., vegetable stock) whenever possible to retain leached nutrients.

b) Pest Control

Pests are any animals or insects that infest food service operations, posing significant risks to food safety and hygiene by spreading pathogens, causing physical damage, and contaminating food with waste.

- **Types:** Rodents (rats, mice), insects (cockroaches, flies, ants), and birds.
- **Infestation:** Pests are attracted by food scraps, water sources, and harborage (warm, hidden places). Signs of infestation include droppings, gnaw marks, nesting materials, and sightings of live or dead pests.
- **Control & Treatment:** The best approach is **Integrated Pest Management (IPM)**, which is a long-term strategy that focuses on prevention:
    - **Exclusion:** Sealing all entry points (cracks, holes, gaps around pipes).
    - **Sanitation:** Eliminating food and water sources and cleaning up spills immediately.
    - **Treatment:** Using chemical or physical control methods (traps, baits) as a last resort, applied only by licensed professionals.

c) Recent Concerns of Nutrition

i. Organic Foods

Organic foods are produced without the use of synthetic pesticides, chemical fertilizers, growth hormones, or genetic engineering. The focus is on ecological balance and natural resource conservation. Consumers choose them due to concerns about pesticide residue and the belief that they are more environmentally friendly.

ii. Genetically Modified Food (GM food)

GM foods are derived from organisms (plants or animals) whose genetic material (DNA) has been altered in a way that does not occur naturally, for example, to introduce resistance to pests or tolerance to herbicides. While offering benefits like increased yield and enhanced

nutrition (e.g., Golden Rice), there are public concerns regarding their safety, potential allergenicity, and long-term environmental impact.

iii. Novel Foods

Novel foods are those that have not been consumed to any significant degree by humans in the European Union or other jurisdictions before a certain date. This includes foods produced using new technologies, such as certain insect-based proteins, or traditional foods from third countries. They require rigorous pre-market safety assessment.

iv. Functional Foods

Functional foods are foods that provide health benefits beyond basic nutrition. They may contain bioactive compounds or be fortified with specific ingredients. Examples include foods fortified with Omega-3 fatty acids for heart health, or yogurts containing probiotic cultures for gut health.

v. Nutrition Labels and Health Claims

Nutrition labels provide standardized information on nutrient content (calories, fat, sugar, sodium, etc.), helping consumers make informed choices. **Health Claims** are statements made on food products suggesting a relationship between a food component and reduced risk of a disease (e.g., "Calcium helps maintain strong bones"). These claims are strictly regulated and must be scientifically substantiated.

vi. Dietary Supplements and their Health Claims

Dietary supplements are products intended to supplement the diet, containing vitamins, minerals, herbs, or amino acids. Unlike pharmaceuticals, they are generally not subject to the same rigorous testing for efficacy and safety before market. Their **Health Claims** often rely on broad, permissible statements and must carry disclaimers stating that the product is not intended to diagnose, treat, cure, or prevent any disease.

vii. Evaluation of Nutritive-based Products

This involves critically assessing the scientific evidence supporting the claims made by food and supplement manufacturers. Evaluation requires checking the source of the claims, looking for peer-reviewed research, verifying serving sizes, and ensuring the product complies with regulatory standards to prevent misleading consumers.

viii. New Trends in Food Packaging

Modern packaging is evolving beyond simple containment and protection. New trends include:

- **Active Packaging:** Incorporates components that interact with the food or environment to extend shelf life, such as oxygen scavengers or moisture absorbers.
- **Intelligent Packaging:** Contains indicators that monitor the condition of the food, such as time-temperature indicators that visually change color if the product has been improperly stored.

- **Sustainable Packaging:** Focuses on using biodegradable, compostable, or easily recyclable materials to reduce environmental impact.