

AP PGECET 2026 Food Technology

Question Paper with Solutions

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General Instructions

- (i) The examination was conducted in Computer-Based Test (CBT) mode.
- (ii) Question Paper consists of 120 questions.
- (iii) Each correct answer carries 1 mark and there is no negative marking for incorrect answer.
- (iv) Duration of the exam is 2 hour (120 minutes).

1. Moulds are usually detected in food by observing _____.

- (A) Pinpoint colonies on nutrient agar
- (B) Acid production in broth
- (C) Fuzzy, spreading colonies with mycelium
- (D) Gram-positive chains

Correct Answer: (C) Fuzzy, spreading colonies with mycelium

Solution:

Step 1: Understanding the Question:

The question asks for the primary visual and morphological method used to identify the presence of moulds (filamentous fungi) in food products.

Recognizing macroscopic differences between moulds, yeasts, and bacteria is essential for microbial analysis in food microbiology.

Step 2: Detailed Explanation:

- **Mould Morphology:** Moulds are multicellular, filamentous fungi whose vegetative and reproductive structures are highly characteristic.
- **Mycelium Structure:** The basic vegetative unit of a mould is a microscopic thread-like filament called a hypha. As these hyphae grow and branch out extensively over a food matrix, they form a visible, tangled web-like network known as a mycelium.
- **Colony Appearance:** On solid surfaces (such as bread, cheese, fruits, or agar plates), this mycelial growth manifests macroscopically as fuzzy, cottony, powdery, or velvety colonies that spread rapidly across the surface.
- **Comparison with Other Microorganisms:**
 - **Pinpoint colonies on nutrient agar:** This is a typical morphological feature of unicellular bacteria (e.g., lactic acid bacteria) or yeasts, which do not form extensive filamentous networks.
 - **Acid production in broth:** This is a metabolic activity characteristic of fermentative bacteria (such as *Lactobacillus*), detected via pH indicator color shifts, rather than a visual morphological cue.
 - **Gram-positive chains:** This is a microscopic cellular arrangement under a Gram stain, characteristic of bacterial genera like *Streptococcus*, and is not used for macroscopic fungal detection.

Step 3: Final Answer:

Moulds are macroscopically identified in foods by their distinct fuzzy, spreading colonies characterized by a multicellular mycelium network, making option (C) the correct choice.

Quick Tip: Bacterial colonies on agar plates typically appear as small, shiny, circular, and distinct pinpoint spots, whereas moulds form dry, fuzzy, and rapidly spreading networks of hyphae that often cover the entire surface of the medium.

2. Which of the following is an intrinsic factor influencing microbial growth in food?

- (A) Storage temperature
- (B) Relative humidity of storage room
- (C) Packaging atmosphere
- (D) Food pH

Correct Answer: (D) Food pH

Solution:

Step 1: Understanding the Question:

The question asks to identify which of the listed parameters is an intrinsic factor affecting the growth of microorganisms in food.

Factors that influence microbial survival and proliferation in food systems are classified into intrinsic (inherent to the food itself) and extrinsic (environmental conditions).

Step 2: Detailed Explanation:

- **Intrinsic Factors:** These are the physical, chemical, and structural properties inherent to the food product itself. They dictate which microorganisms can grow and at what rate. Key intrinsic factors include:
 - **pH (Acidity/Alkalinity):** Most foodborne pathogens prefer neutral pH values (6.5 – 7.5). Highly acidic foods ($\text{pH} < 4.6$) inhibit most bacterial pathogens, though yeasts and moulds can tolerate lower pH values.

- **Water Activity (a_w):** The amount of free water available for microbial metabolic reactions.
- **Oxidation-Reduction Potential (E_h):** The ease with which the substrate loses or gains electrons, affecting aerobic and anaerobic growth.
- **Nutrient Content:** Presence of proteins, carbohydrates, lipids, vitamins, and minerals.
- **Antimicrobial Constituents:** Naturally occurring compounds like lactoferrin in milk or lysozyme in eggs.
- **Extrinsic Factors:** These are environmental parameters acting upon the food during storage and handling. They include:
 - **Storage Temperature:** An external parameter (e.g., refrigeration vs. room temperature).
 - **Relative Humidity:** The moisture content of the ambient air surrounding the stored food.
 - **Packaging/Gaseous Atmosphere:** Modified atmosphere packaging (MAP) using gases like CO_2 or N_2 to alter the surrounding air.

Step 3: Final Answer:

Since food pH is a chemical property of the food matrix itself, it is classified as an intrinsic factor, making option (D) the correct answer.

Quick Tip: A simple way to distinguish between these factors is to ask: "Does this factor change if I move the food to a different room?" If the answer is yes (like temperature or humidity), it is extrinsic. If the answer is no (like pH or water activity), it is intrinsic.

3. In the typical microbial growth curve in food, the lag phase is characterized by:

- (A) Rapid cell division
- (B) Maximum metabolic waste
- (C) Death of most cells
- (D) No net increase in cell number

Correct Answer: (D) No net increase in cell number

Solution:

Step 1: Understanding the Question:

The question requires us to identify the defining characteristic of the lag phase within a typical closed-system (batch culture) microbial growth curve.

Understanding the physical and biological changes during each phase of bacterial growth is fundamental to predicting shelf-life and food spoilage.

Step 2: Detailed Explanation:

- **Microbial Growth Curve Phases:** When microorganisms are introduced into a food matrix, they go through four distinct phases of growth:

1. **Lag Phase:** This is the initial adaptation period. The cells are metabolically active and synthesizing necessary macromolecules (enzymes, proteins, cofactors, RNA) to prepare for replication in the new medium, but they do not divide yet. Consequently, there is no net increase in the total cell count.

2. **Log (Exponential) Phase:** Characterized by rapid, balanced cell division where the population doubles at a constant rate. This corresponds to option (A).
3. **Stationary Phase:** Nutrients deplete and toxic waste products accumulate. The rate of new cell division equals the rate of cell death, leading to a plateau. This is where maximum metabolic waste is observed, corresponding to option (B).
4. **Death (Decline) Phase:** The cells run out of energy reserves, and toxicity levels cause the death of most cells, corresponding to option (C).

Step 3: Final Answer:

The lag phase is a period of physiological adaptation with zero net growth in cell population. Thus, the correct option is (D).

Quick Tip: During the lag phase, even though the cell count remains constant, individual cells are physically growing in size and are highly active biochemically as they synthesize enzymes specific to the nutrients available in their new environment.

4. Which method is most appropriate for quantifying bacteria in a liquid food samples?

- (A) Direct microscopic count on slide
- (B) Serial dilution and standard plate count
- (C) Gram staining alone
- (D) Simple pH measurement

Correct Answer: (B) Serial dilution and standard plate count

Solution:

Step 1: Understanding the Question:

The question asks for the most appropriate and widely accepted analytical method used to quantify (enumerate) viable bacterial populations in liquid food matrices (e.g., milk, fruit juices, or beverages).

Step 2: Detailed Explanation:

- **Quantification in Food Analysis:** Accurately determining bacterial concentrations is critical for verifying compliance with food safety regulations and assessing microbial quality.
- **Serial Dilution and Standard Plate Count (SPC):** This is the gold standard method for viable microbial enumeration.
 - **Serial Dilution:** High bacterial concentrations are systematically diluted (typically 10-fold steps: 10^{-1} , 10^{-2} , etc.) in sterile diluent to ensure that when plated, the colonies will be sparse enough to be resolved individually.
 - **Standard Plate Count:** Aliquots of the dilutions are transferred onto or into nutrient agar (using spread-plate or pour-plate methods). After incubation, plates containing 30 – 300 colonies are counted. Each colony represents a single Colony Forming Unit (CFU) present in the original sample.
- **Why Other Methods are Less Suitable:**
 - **Direct Microscopic Count:** Uses a hemocytometer slide. It is rapid but counts both live and dead cells, is physically tiring, and has low sensitivity (unsuitable for low bacterial counts).
 - **Gram Staining:** This is a qualitative, differential staining technique to determine cell-wall morphology (Gram-positive vs. Gram-negative), not a quantitative enumeration tool.

- **Simple pH Measurement:** Measures chemical acidity/alkalinity. While acid production indicates bacterial metabolism, it cannot be used to calculate physical cell numbers.

Step 3: Final Answer:

Serial dilution followed by the standard plate count is the standard quantitative, viable-cell enumeration technique for liquid foods, making option (B) the correct choice.

Quick Tip: Standard Plate Count (SPC) only measures viable (living, actively dividing) cells, which is the most critical parameter in food safety, whereas direct microscopic counts do not differentiate between living and dead bacteria.

5. Which fungal genus commonly produces aflatoxins in nuts and grains?

- (A) Penicillium
- (B) Aspergillus
- (C) Mucor
- (D) Rhizopus

Correct Answer: (B) Aspergillus

Solution:

Step 1: Understanding the Question:

The question asks to identify the genus of fungi responsible for synthesizing aflatoxins, which are highly toxic, carcinogenic contaminants commonly found in agricultural commodities such as nuts and grains.

Step 2: Detailed Explanation:

- **Aflatoxins:** Aflatoxins are a group of highly toxic secondary metabolites (primarily types B_1 , B_2 , G_1 , and G_2) that pose severe health risks. Aflatoxin B_1 is classified as a Class 1 human carcinogen, primarily targeting the liver and causing hepatocellular carcinoma.
- **Causative Genus:** These mycotoxins are synthesized primarily by specific strains of filamentous fungi belonging to the genus *Aspergillus*.
- **Key Species:** *Aspergillus flavus* and *Aspergillus parasiticus* are the two main species responsible for aflatoxin contamination. These moulds thrive in warm, humid climates and easily colonize agricultural crops rich in lipids and starches.
- **Vulnerable Crops:** Peanuts, tree nuts (pistachios, almonds), maize (corn), cottonseed, and various cereals are particularly susceptible to pre-harvest or post-harvest contamination if moisture control is inadequate.
- **Other Genera:**
 - *Penicillium*: Known for producing other mycotoxins like patulin, ochratoxin A, and citrinin, but not aflatoxins.
 - *Mucor* and *Rhizopus*: These are Zygomycetes. While they are major causes of food spoilage (e.g., bread mould, soft rot), they are not known to synthesize aflatoxins.

Step 3: Final Answer:

The genus *Aspergillus* is the primary producer of aflatoxins in agricultural commodities, making option (B) the correct choice.

Quick Tip: Associate "A"flatoxins with the letter "A" in *Aspergillus*. The name "afla-toxin" is actually derived directly from *Aspergillus flavus* **toxin**.

6. "Probiotic" yogurts usually contain added strains of _____.

- (A) *Escherichia coli*
- (B) *Clostridium botulinum*
- (C) *Bifidobacterium* and *Lactobacillus*
- (D) *Aspergillus flavus*

Correct Answer: (C) *Bifidobacterium* and *Lactobacillus*

Solution:

Step 1: Understanding the Question:

The question asks to identify the common bacterial genera used as active probiotic cultures added to commercial functional foods like probiotic yogurts.

Step 2: Detailed Explanation:

- **Probiotics Definition:** Probiotics are live microorganisms that, when administered in adequate amounts, confer health benefits on the host by improving gut microflora, enhancing gut barrier function, and modulating the immune system.
- **Target Microorganisms:** To act as effective probiotics, strains must survive gastric transit (stomach acid and bile salts) and colonize the human intestinal tract.
- **Key Genera:** Specific strains of Lactic Acid Bacteria (LAB) belonging to the genera *Lactobacillus* and *Bifidobacterium* are most commonly utilized.

– *Lactobacillus* species (e.g., *L. acidophilus*, *L. casei*, *L. rhamnosus*) are rod-shaped,

acid-tolerant bacteria naturally residing in the digestive and urogenital tracts.

- *Bifidobacterium* species (e.g., *B. animalis*, *B. bifidum*) are anaerobic, branched rod-shaped bacteria dominant in the colon of healthy, breastfed infants and adults.

- **Why Other Options are Incorrect:**

- *Escherichia coli*: Most strains are indicators of fecal contamination; although some rare therapeutic strains exist, it is not a standard probiotic for dairy foods.
- *Clostridium botulinum*: An anaerobic pathogen that produces the highly lethal botulinum neurotoxin, causing botulism.
- *Aspergillus flavus*: A toxic, aflatoxigenic mould.

Step 3: Final Answer:

Probiotic yogurts are typically formulated with beneficial strains from the genera *Bifidobacterium* and *Lactobacillus*, corresponding to option (C).

Quick Tip: Almost all commercial dairy probiotics feature lactic acid bacteria. The prefix "lacto-" in *Lactobacillus* specifically relates to milk sugar (lactose), emphasizing its natural compatibility with dairy fermentations.

7. Meat food products order 1973 was promoted under the act

- (A) Right to food act
- (B) Essential services maintenance act
- (C) Essential commodities act, 1955
- (D) Consumer protection act, 1986

Correct Answer: (C) Essential commodities act, 1955

Solution:

Step 1: Understanding the Question:

The question asks for the specific legislative Act under which the Government of India promoted the Meat Food Products Order (MFPO), 1973.

Step 2: Detailed Explanation:

- **Meat Food Products Order (MFPO), 1973:** This regulatory order was established to control and monitor the manufacturing, sanitary standards, hygiene, and overall quality of meat food products in India. It mandated licensing for meat processors to ensure clean operations.
- **The Parent Act:** The order was promulgated under the authority of the **Essential Commodities Act, 1955**.
- **Legislative Mechanism:** Section 3 of the Essential Commodities Act, 1955 empowers the Indian Central Government to regulate the production, distribution, supply, and trade of essential items (which include foodstuffs, edible oils, meat, etc.) to ensure their fair availability and maintain public health standards.
- **Regulatory Evolution:** Historically, several food-specific orders were enacted under this parent act (such as the Fruit Products Order - FPO, and Milk and Milk Products Order - MMPO). With the implementation of the comprehensive Food Safety and Standards Act (FSSA) in 2006, these separate orders were repealed and integrated under a single authority: the Food Safety and Standards Authority of India (FSSAI).
- **Other Options:**

- The Right to Food Act relates to modern food security initiatives.
- The Essential Services Maintenance Act (ESMA) is utilized to maintain public order and prevent strikes in critical sectors.
- The Consumer Protection Act, 1986 deals with generic consumer disputes and unfair trade practices rather than specific food production hygiene standards.

Step 3: Final Answer:

The Meat Food Products Order, 1973 was established under the Essential Commodities Act, 1955, making option (C) the correct choice.

Quick Tip: Before FSSAI unified all food regulations in 2006, almost all major Indian product-specific quality control orders (like MFPO, FPO, and MMPO) were legally enforced under the umbrella of the Essential Commodities Act, 1955.

8. The Hunter Lab system is commonly used for objective colour measurement in foods. The a^* value represents

- (A) lightness from black to white
- (B) red-green axis
- (C) blue-yellow axis
- (D) glossiness

Correct Answer: (B) red-green axis

Solution:

Step 1: Understanding the Question:

The question asks for the physical definition and representation of the a^* value within the

Hunter L, a, b color space system, which is a standard method for objective, non-destructive color measurement in the food industry.

Step 2: Detailed Explanation:

- **Color in Food Quality:** Color is an important visual quality parameter indicating freshness, degree of cooking, maturity, or degradation. The Hunter Lab system provides a three-dimensional mathematical model to quantify human color perception.
- **Opponent-Color Theory:** This system is based on the theory that the human brain coordinates vision via three opposing color channels: light-dark, red-green, and yellow-blue.
- **The Three Coordinates (L^*, a^*, b^*):**
 - **L^* coordinate (Lightness):** Ranges from 0 (representing absolute black) to 100 (representing absolute white). This matches option (A).
 - **a^* coordinate (Red-Green axis):** Represents chromaticity on the red-green scale. Positive values ($+a^*$) represent redness, whereas negative values ($-a^*$) represent greenness. 0 is neutral gray. This matches option (B).
 - **b^* coordinate (Yellow-Blue axis):** Represents chromaticity on the yellow-blue scale. Positive values ($+b^*$) represent yellowness, whereas negative values ($-b^*$) represent blueness. This matches option (C).
- **Glossiness:** This is a surface physical parameter related to specular reflection, which is measured using a glossmeter rather than chromaticity coordinates.

Step 3: Final Answer:

The a^* parameter in the Hunter Lab color scale represents the red-green chromatic axis,

making option (B) the correct choice.

Quick Tip: To easily memorize the coordinates:

L^* is for Lightness (0 to 100).

a^* is for Red-Green ($+a^*$ is Red, $-a^*$ is Green).

b^* is for Yellow-Blue ($+b^*$ is Yellow, $-b^*$ is Blue).

9. Which of the following is an example of a CCP in pasteurized milk processing?

- (A) Packaging
- (B) Pasteurization temperature and time
- (C) Transportation
- (D) Labelling

Correct Answer: (B) Pasteurization temperature and time

Solution:

Step 1: Understanding the Question:

The question asks to identify a Critical Control Point (CCP) within the HACCP (Hazard Analysis Critical Control Point) framework applied to pasteurized milk processing.

Step 2: Detailed Explanation:

- **Critical Control Point (CCP) Definition:** Under food safety guidelines, a CCP is a specific step or procedure in a food process where control measures can be applied to prevent, eliminate, or reduce a biological, chemical, or physical food hazard to an acceptable level.
- **Primary Hazard in Milk:** The primary food safety hazard in raw milk is biological, specifically pathogenic vegetative bacteria such as *Coxiella burnetii* (the most heat-resistant

pathogen found in milk), *Mycobacterium bovis*, *Salmonella*, and *Listeria monocytogenes*.

- **Elimination Step:** The pasteurization step (e.g., High-Temperature Short-Time pasteurization at 72°C for at least 15 seconds) is designed specifically to eliminate these vegetative pathogens.
- **Monitoring Parameters:** Pasteurization temperature and holding time are critical parameters that must be strictly monitored using automatic flow-diversion valves. If the temperature drops below the set target, the milk is automatically diverted back to the raw milk tank. This satisfies all requirements of a CCP.
- **Other Steps:** Steps like packaging, transportation, and labelling are essential for quality and maintaining cold chains (Prerequisite Programs or oPRPs), but they do not serve as primary kill steps designed to eliminate pathogens.

Step 3: Final Answer:

The pasteurization temperature and time combination is the primary Critical Control Point in milk processing, making option (B) the correct choice.

Quick Tip: A true CCP must have a specific, measurable critical limit (such as 72°C for 15 seconds) which, when monitored, can trigger immediate corrective actions (like flow diversion) to ensure product safety.

10. The permitted preservative of Ghee is?

- (A) BHA
- (B) Potassium sorbet
- (C) Nisin
- (D) Hydrogen peroxide

Correct Answer: (A) BHA

Solution:

Step 1: Understanding the Question:

The question asks for the permitted preservative/additive used to extend the shelf-life of Ghee (clarified butterfat) by preventing spoilage during storage.

Step 2: Detailed Explanation:

- **Spoilage Mechanism of Ghee:** Ghee consists of approximately 99.5% milk fat with minimal moisture. Because of this anhydrous nature, it is highly resistant to microbial spoilage. Instead, its primary spoilage mechanism is chemical: lipid autoxidation (oxidative rancidity) of unsaturated fatty acids, which leads to off-flavors, rancid odors, and free radical formation.
- **Role of Antioxidants:** To prevent or delay lipid oxidation, antioxidants are added to fat-rich products. These compounds function as free radical scavengers, interrupting the chain reactions of lipid peroxidation.
- **Permitted Additive: BHA (Butylated Hydroxyanisole)** is a synthetic phenolic antioxidant permitted under regulatory frameworks (such as FSSAI) for fat-rich products like ghee, butter, and vegetable oils, typically restricted to a maximum level of 200 ppm (0.02%).
- **Why Other Options are Incorrect:**
 - **Potassium sorbate:** An antifungal preservative used in high-moisture foods like cheese, bakery products, and fruit juices. It is ineffective in anhydrous fats like ghee.

- **Nisin:** A bacteriocin peptide targeting Gram-positive vegetative cells and spores in high-moisture, high-protein foods like processed cheese and canned vegetables.
- **Hydrogen peroxide:** A strong chemical oxidant used as a sterilizing agent for packaging materials or milk preservation in cold chains under specific conditions, but it is not used in ghee.

Step 3: Final Answer:

Butylated Hydroxyanisole (BHA) is the permitted antioxidant preservative used in ghee, corresponding to option (A).

Quick Tip: Anhydrous fats like ghee do not spoil from microbial growth due to low moisture. Therefore, they do not require antimicrobial preservatives (like sorbates or nisin); instead, they require antioxidants (like BHA) to combat chemical rancidity.

11. Which microorganism can grow at lowest water activity among common food spoilage organisms?

- (A) Bacteria
- (B) Yeasts
- (C) Molds
- (D) Viruses

Correct Answer: (C) Molds

Solution:

Step 1: Understanding the Question:

The question asks to identify which of the major classes of food-associated microorganisms can survive and grow at the lowest water activity (a_w) level.

Step 2: Detailed Explanation:

- **Water Activity (a_w) Concept:** Water activity is the ratio of the vapor pressure of water in a food system to that of pure water at the same temperature. It measures the "free" or unbound water available for biochemical and metabolic activities.
- **Microbial Limits:** Microorganisms have specific minimum water activity thresholds required for cell division and growth:
 - **Bacteria:** Most fresh-food spoilage bacteria require high water activity ($a_w \geq 0.90 - 0.91$). Halophilic bacteria are an exception but still generally require higher moisture than xerophilic fungi.
 - **Yeasts:** Most common spoilage yeasts grow down to $a_w \approx 0.87 - 0.88$. Osmophilic yeasts can tolerate lower levels (down to 0.60 under high sugar concentration).
 - **Molds:** Filamentous fungi (molds) are the most xerotolerant of the common food spoilage organisms. Many standard molds (like *Aspergillus* and *Penicillium*) can grow down to $a_w \approx 0.80$, and specialized xerophilic molds can grow in dry foods at water activities as low as 0.60 – 0.65.
- **Viruses:** Viruses are obligate intracellular parasites. They do not metabolize, grow, or replicate inside food matrices; they merely use food as a vehicle for transport. The concept of water activity limits for growth does not apply to viruses.

Step 3: Final Answer: Among the common food spoilage organisms listed, molds have the lowest minimum water activity requirement for vegetative growth, making option (C) the correct choice.

Quick Tip: The general hierarchy of resistance to dry conditions (from highest moisture required to lowest) is:

Bacteria ($a_w \geq 0.91$) > Yeasts ($a_w \geq 0.88$) > Molds ($a_w \geq 0.80$).

This is why dry grains, nuts, and spices are primarily spoiled by molds rather than bacteria.

12. What is the oxidizing agent used during wheat milling?

- (A) Ascorbic acid
- (B) Acetic acid
- (C) Hydrogen peroxide
- (D) Potassium bromate

Correct Answer: (A) Ascorbic acid

Solution:

Step 1: Understanding the Question:

The question asks to identify the oxidizing agent commonly added to wheat flour during or after milling to mature the flour and improve its baking quality.

Step 2: Detailed Explanation:

- **Flour Maturing (Aging):** Freshly milled wheat flour ("green flour") has poor baking performance, resulting in a weak, sticky dough that does not trap fermentation gases effectively. Naturally, oxygen in the air slowly matures flour over weeks. To accelerate this process, flour improvers or maturing agents (which are oxidizing agents) are added.
- **Biochemical Mechanism:** Oxidizing agents work by converting free sulfhydryl groups (-SH) on cysteine amino acids of gluten proteins (gliadin and glutenin) into stable, covalent disulfide bonds (-S-S-). This cross-linking strengthens the gluten network, leading to elastic, strong dough that traps carbon dioxide during fermentation, increasing bread volume.

- **Role of Ascorbic Acid (Vitamin C):** Although L-ascorbic acid is chemically a reducing agent, in the presence of oxygen and the endogenous enzyme ascorbic acid oxidase present in flour, it is converted to dehydroascorbic acid. Dehydroascorbic acid acts as a powerful oxidizing agent that oxidizes glutathione, preventing it from breaking down gluten disulfide bonds.
- **Why Potassium Bromate is Avoided:** Potassium bromate (option D) is a strong oxidizing agent historically used for this purpose, but it has been banned or strictly restricted in many countries (including India and EU nations) due to its classification as a potential human carcinogen. Ascorbic acid is the modern, safe, and widely permitted alternative.

Step 3: Final Answer:

Ascorbic acid is the standard, safe oxidizing maturing agent used in modern wheat milling, making option (A) the correct choice.

Quick Tip: Even though Ascorbic Acid is chemically known as an antioxidant (reducing agent) in fruit juices, in bread dough systems with exposure to air, it acts as an effective oxidizing agent to strengthen gluten structure.

13. Which of the following nutrients is rich in Barley that aids in cholesterol reduction?

- (A) Beta Glucan
- (B) flavonoids, and lignans
- (C) Omega 3 fatty acids
- (D) Palmitic acid

Correct Answer: (A) Beta Glucan

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific nutrient abundant in barley that has been clinically proven to assist in reducing blood cholesterol levels.

Step 2: Detailed Explanation:

- **Barley Composition:** Barley (*Hordeum vulgare*) is recognized as a functional food cereal primarily due to its high concentration of a soluble dietary fiber called **Beta-glucan** (β -glucan).
- **Structure of Beta-Glucan:** Beta-glucans are non-starch polysaccharides consisting of D-glucose units linked by mixed β -(1 $\rightarrow$ 3) and β -(1 $\rightarrow$ 4) glycosidic bonds. This molecular structure gives them highly viscous properties when dissolved in water.
- **Mechanism of Cholesterol Lowering:**
 1. **Gel Formation:** Upon ingestion, beta-glucan dissolves in the fluids of the stomach and small intestine, forming a thick, viscous gel matrix.
 2. **Bile Acid Binding:** This viscous gel physically traps bile acids (which are synthesized by the liver using cholesterol) in the intestinal tract.
 3. **Excretion:** The trapped bile acids are carried through the digestive system and excreted in feces, preventing their reabsorption in the ileum.
 4. **Cholesterol Depletion:** To replace the excreted bile acids, the liver is forced to draw LDL ("bad") cholesterol from the bloodstream to synthesize fresh bile acids, thereby lowering circulating blood cholesterol levels.

- **Other Options:** Flavonoids, lignans, and omega-3 fatty acids are healthy compounds but are not found in high, cholesterol-lowering concentrations in barley. Palmitic acid is a saturated fatty acid that can increase blood cholesterol levels.

Step 3: Final Answer:

Beta-glucan is the primary soluble fiber in barley responsible for cholesterol reduction, making option (A) the correct choice.

Quick Tip: Oats and barley are the two richest dietary sources of soluble beta-glucan. Consuming these grains regularly helps lower plasma LDL cholesterol levels through bile acid sequestration.

14. Among different oil seeds, which oilseed is considered the richest source of linoleic acid?

- (A) Sunflower
- (B) Soybean
- (C) Safflower
- (D) Mustard

Correct Answer: (C) Safflower

Solution:

Step 1: Understanding the Question:

The question asks to identify the oilseed that contains the highest concentration of linoleic acid (an essential omega-6 polyunsaturated fatty acid) in its oil profile among the options provided.

Step 2: Detailed Explanation:

- **Linoleic Acid:** Linoleic acid ($C_{18} : 2, \omega-6$) is an essential polyunsaturated fatty acid (PUFA) that must be acquired through diet, as the human body lacks the enzymes

required to synthesize it.

- **Comparison of Oil Profiles:** Commercial oilseeds exhibit distinct fatty acid distributions:
 - **Safflower Oil (Traditional Linoleic variety):** Contains the highest amount of linoleic acid among common vegetable oils, typically ranging between 70% – 80% of total fatty acids.
 - **Sunflower Oil:** Typically contains about 55% – 65% linoleic acid (though high-oleic varieties have been bred to contain less).
 - **Soybean Oil:** Contains around 50% – 55% linoleic acid, along with significant amounts of oleic acid (18 : 1) and linolenic acid (18 : 3).
 - **Mustard Oil:** Characterized by high levels of erucic acid (C22 : 1) and oleic acid, with very low levels of linoleic acid (typically < 20%).

Step 3: Final Answer:

Safflower oil is traditionally considered the richest commercial source of linoleic acid among the options listed, making option (C) the correct choice.

Quick Tip: Standard Safflower oil has a very high polyunsaturated fat ratio, with its linoleic acid content (> 70%) exceeding that of sunflower and soybean oils, making it a common choice for dietary PUFA enrichment.

15. Identify which volatile compounds are primarily responsible for the distinctive aroma of coffee?

(A) Chlorogenic acid

- (B) Caffeine
- (C) Volatile aldehydes and ketones
- (D) Polyphenols

Correct Answer: (C) Volatile aldehydes and ketones

Solution:

Step 1: Understanding the Question:

The question asks to identify the class of chemical compounds primarily responsible for producing the characteristic, complex aroma of roasted coffee beans and brewed coffee.

Step 2: Detailed Explanation:

- **Coffee Chemistry:** Raw green coffee beans possess minimal aroma. The characteristic aroma of coffee is generated during high-temperature roasting.
- **Chemical Reactions During Roasting:** Roasting triggers thermal reactions such as the Maillard reaction, Strecker degradation, caramelization, and lipid pyrolysis. These reactions produce over 800 volatile compounds that easily vaporize.
- **Aroma-Active Volatiles:** The major classes of highly volatile compounds responsible for aroma include volatile aldehydes (such as acetaldehyde and isovaleraldehyde) and ketones (such as diacetyl and acetoin), along with furans, pyrazines, and sulfur-containing compounds (thiols). These compounds provide roasted, sweet, nutty, and buttery aromatic notes.
- **Why Other Options are Incorrect:**
 - **Chlorogenic Acid:** A non-volatile phenolic compound responsible for the acidity, astringency, and bitterness of coffee. It does not vaporize to produce aroma.

- **Caffeine:** A non-volatile purine alkaloid that contributes to bitterness and physiological stimulation but has no direct aroma.
- **Polyphenols:** Large, non-volatile antioxidant molecules that remain dissolved in the liquid phase and do not contribute to aroma.

Step 3: Final Answer:

Volatile aldehydes and ketones are the primary compounds responsible for the sensory aroma of coffee, making option (C) the correct choice.

Quick Tip: Aroma compounds must be "volatile" (capable of evaporating easily at room or drinking temperature) to reach olfactory receptors in the nasal cavity. Non-volatile compounds like caffeine and acids affect taste but not smell.

16. Which biochemical process is responsible for aging of meat and improving the tenderness?

- (A) Collagen breakdown
- (B) Proteolytic enzyme activity
- (C) Fat oxidation
- (D) Moisture loss

Correct Answer: (B) Proteolytic enzyme activity

Solution:

Step 1: Understanding the Question:

The question asks to identify the core biochemical process responsible for improving the tenderness of meat during post-mortem cold storage (aging).

Step 2: Detailed Explanation:

- **Meat Aging:** Holding carcasses or cuts of meat at refrigerated temperatures ($1^{\circ}\text{C} - 4^{\circ}\text{C}$) for several days to weeks is a standard industry practice to improve tenderness and flavor profile.
- **Role of Endogenous Proteases:** Post-mortem tenderization is primarily driven by the action of natural intracellular proteolytic enzymes (proteases) that break down structural proteins within muscle fibers.
- **Enzyme Systems Involved:**
 - **Calpains:** Calcium-dependent neutral proteases located within the cytoplasm. They degrade key structural proteins of the myofibril, such as desmin, titin, nebulin, and troponin-T, weakening muscle fiber integrity.
 - **Cathepsins:** Lysosomal enzymes released post-mortem as cell membranes break down, assisting in general protein degradation.
- **Why Other Options are Incorrect:**
 - **Collagen Breakdown:** Collagen (connective tissue) is highly resistant to calpains. It is denatured and softened during slow, moist cooking processes (converting into gelatin) rather than during cold aging.
 - **Fat Oxidation:** Alters the flavor profile (and causes rancidity if excessive) but does not tenderize muscle fibers.
 - **Moisture Loss:** Occurs during dry aging, concentrating flavor, but does not biochemically tenderize the protein structure.

Step 3: Final Answer:

Endogenous proteolytic enzyme activity is the primary biochemical mechanism behind meat tenderization during aging, corresponding to option (B).

Quick Tip: The calpain enzyme system targets the structural myofibrillar proteins that hold muscle fibers together. Disrupting these structural linkages makes the meat physically easier to chew.

17. What is the main role and purpose of smoking in meat processing?

- (A) Flavour enhancing only
- (B) Antimicrobial agent only
- (C) Antioxidant only
- (D) Both antioxidant and flavour enhancing

Correct Answer: (D) Both antioxidant and flavour enhancing

Solution:**Step 1: Understanding the Question:**

The question asks for the primary multi-functional technological role and purpose of using wood smoke in meat processing.

Step 2: Detailed Explanation:

- **Smoking of Meat:** Smoking is a preservation and processing method that exposes meat to smoke generated by the thermal combustion of specific hardwoods (like oak, hickory, or beechwood).
- **Wood Smoke Chemistry:** Wood smoke is a complex mixture containing hundreds of chemical compounds, including phenols, carbonyls, organic acids, and furans, which act

on the meat surface.

- **Multifunctional Roles of Smoking:**

- **Antioxidant Activity:** Phenolic compounds in smoke (such as guaiacol, syringol, and their derivatives) act as natural primary antioxidants. They donate hydrogen to free radicals, stopping the lipid peroxidation chain reaction and preventing warmed-over flavor and oxidative rancidity in lipid-rich meats.
- **Flavor Enhancement:** Carbonyls and phenols produce the characteristic smoky, sweet, and pungent flavors desired by consumers.
- **Antimicrobial Preservation:** Organic acids (such as acetic acid) lower the surface pH of the meat, while compounds like formaldehyde act as antimicrobials, extending the product's shelf-life.
- **Color Development:** Carbonyl compounds react with surface proteins in Maillard reactions to form an appealing golden-brown surface color.

Step 3: Final Answer:

Since smoking serves multiple chemical and sensory functions, describing it as "only" an antioxidant or "only" a flavor enhancer is incomplete. It functions as both, making option (D) the correct choice.

Quick Tip: Traditional wood smoke phenols serve a dual role, acting both as powerful antioxidants to prevent rancidity and as key flavor compounds that impart the characteristic smoky aroma.

18. The Reynolds number is used to predict _____.

- (A) nature of flow such as laminar or turbulent
- (B) heat capacity of the fluid
- (C) pump efficiency only
- (D) compressibility of solids

Correct Answer: (A) nature of flow such as laminar or turbulent

Solution:

Step 1: Understanding the Question:

The question asks for the physical purpose and predictive application of the Reynolds number (Re), a dimensionless quantity used in fluid mechanics and food engineering calculations.

Step 2: Key Formula or Approach:

The Reynolds number is defined mathematically as:

$$Re = \frac{\rho v D}{\mu}$$

where:

ρ = density of the fluid (kg/m^3),

v = mean velocity of the fluid flow (m/s),

D = internal diameter of the pipe (m),

μ = dynamic viscosity of the fluid ($\text{Pa} \cdot \text{s}$ or $\text{kg/m} \cdot \text{s}$).

Step 3: Detailed Explanation:

- **Ratio of Forces:** The Reynolds number represents the ratio of inertial forces (forces promoting fluid movement and turbulence) to viscous forces (forces resisting movement and maintaining smooth flow).
- **Flow Regimes:** Based on the calculated value of Re for fluid flow inside a circular pipe, the flow behavior is classified into distinct regimes:

- **Laminar Flow** ($Re < 2100$): The fluid flows in smooth, parallel layers with minimal mixing. Viscous forces dominate.
 - **Transition Flow** ($2100 < Re < 4000$): The flow is unstable and fluctuates between laminar and turbulent states.
 - **Turbulent Flow** ($Re > 4000$): Characterized by rapid mixing, random eddies, and chaotic motion. Inertial forces dominate.
- **Engineering Importance:** Predicting the flow regime is necessary in food processing to calculate pressure drops, design piping systems, and size pumps. It is also critical for designing heat exchangers, as turbulent flow significantly increases heat transfer rates.

Step 4: Final Answer:

The Reynolds number is used to predict whether a fluid flow is laminar or turbulent, corresponding to option (A).

Quick Tip: In food processing (e.g., thermal processing of liquid foods), turbulent flow ($Re > 4000$) is generally preferred in heat exchangers because the rapid mixing leads to higher heat transfer coefficients.

19. Which flow meter operates on Bernoulli's principle and causes a permanent pressure drop?

- (A) Rotameter
- (B) Venturimeter
- (C) Orifice meter
- (D) Orifice meter

Correct Answer: (C) Orifice meter

Solution:

Step 1: Understanding the Question:

The question asks to identify which of the listed head-type flow meters operates based on Bernoulli's theorem and causes a high, permanent pressure loss in the piping system.

Step 2: Key Formula or Approach: Bernoulli's equation states that for steady, frictionless flow along a streamline:

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g z_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g z_2$$

This relationship shows that introducing a constriction inside a pipe increases fluid velocity (v), causing a corresponding decrease in static pressure (P).

Step 3: Detailed Explanation:

- **Constriction Flow Meters:** Both the Venturi meter and the Orifice meter restrict fluid flow to measure the resulting differential pressure ($\Delta P = P_1 - P_2$), which is proportional to the volumetric flow rate.
- **Orifice Meter:** Consists of a thin plate with a sharp-edged circular opening placed across the pipe. Because the constriction is sudden, flow separation occurs, creating a "vena contracta" and generating large downstream eddies. This turbulence dissipates a large portion of the fluid's kinetic energy as heat, resulting in a high permanent pressure drop (typically losing 50% – 80% of the measured differential pressure).
- **Venturimeter:** Designed with a gradual converging section and a streamlined diverging recovery cone. This design minimizes boundary layer separation and turbulence, allowing almost complete pressure recovery (permanent pressure drop is typically only 10% – 15%).
- **Rotameter:** A variable-area flow meter operating under a constant pressure drop.

Step 4: Final Answer:

The orifice meter operates on Bernoulli's principle and introduces a high permanent pressure drop in the fluid stream, making option (C) the correct choice.

Quick Tip: An orifice meter is inexpensive and simple to install but causes high permanent energy (pressure) loss due to sudden constriction and turbulence. A venturi meter is expensive but highly efficient, preserving fluid pressure.

20. In a plane wall under steady-state one-dimensional conduction with no heat generation, the temperature profile is ____.

- (A) Linear
- (B) Exponential
- (C) Logarithmic
- (D) Sinusoidal

Correct Answer: (A) Linear

Solution:**Step 1: Understanding the Question:**

The question asks for the mathematical shape of the temperature distribution profile across a flat (plane) wall experiencing steady-state, one-dimensional conductive heat transfer with constant thermal conductivity and no internal heat source.

Step 2: Key Formula or Approach:

Fourier's Law of heat conduction in one dimension is:

$$q = -kA \frac{dT}{dx}$$

where:

q = heat transfer rate (W),

k = thermal conductivity (W/m · K),

A = cross-sectional area perpendicular to heat flow (m²),

$\frac{dT}{dx}$ = temperature gradient in the direction of distance x .

Step 3: Detailed Explanation:

- **Steady-State Conditions:** Under steady-state conditions, the temperature at any position x is constant over time, meaning the heat transfer rate (q) passing through the wall remains constant.
- **No Heat Generation:** With no internal heat generation and assuming constant thermal conductivity (k) and cross-sectional area (A), we can rearrange Fourier's Law as:

$$\frac{dT}{dx} = -\frac{q}{kA} = \text{Constant}$$

- **Integration:** Integrating this differential equation with respect to distance x :

$$\int dT = \int \left(-\frac{q}{kA}\right) dx$$
$$T(x) = C_1 x + C_2$$

where $C_1 = -\frac{q}{kA}$ and C_2 is the integration constant defined by boundary conditions.

- **Profile Analysis:** This is the equation of a straight line ($y = mx + c$). Consequently, the temperature decreases uniformly and linearly with distance through the plane wall.

Step 4: Final Answer:

Under steady-state, one-dimensional conduction with no heat generation, the temperature profile across a plane wall is linear, making option (A) the correct choice.

Quick Tip: The temperature profile shape depends directly on the geometry of the solid:

- Plane wall: Linear profile.
- Hollow cylinder (pipe): Logarithmic profile.
- Hollow sphere: Hyperbolic (proportional to $1/r$) profile.

21. Black-body radiation refers to a surface that _____.

- (A) Reflects all incident radiation
- (B) Absorbs all incident radiation
- (C) Emits no radiation
- (D) Has zero temperature

Correct Answer: (B) Absorbs all incident radiation

Solution:

Step 1: Understanding the Question:

The question asks for the fundamental physical definition of a "black-body" in the context of thermal radiation heat transfer.

Understanding radiation properties of surfaces is critical for designing food processing equipment like infrared dryers and ovens.

Step 2: Key Formula or Approach:

The radiative properties of a surface are governed by the conservation of energy:

$$\alpha + \rho + \tau = 1$$

where:

α = absorptivity (fraction of incident radiation absorbed),

ρ = reflectivity (fraction of incident radiation reflected),

τ = transmissivity (fraction of incident radiation transmitted).

For an ideal black-body:

$$\alpha = 1, \quad \rho = 0, \quad \tau = 0$$

Step 3: Detailed Explanation:

- **Ideal Absorber:** A black-body is a hypothetical, idealized physical body that completely absorbs all electromagnetic radiation incident upon it, regardless of frequency or angle of incidence.
- **Ideal Emitter:** According to Kirchhoff's Law of thermal radiation, at any given temperature, the emissivity (ϵ) of a surface equals its absorptivity (α). Thus, a black-body is also a perfect emitter ($\epsilon = 1$), emitting the maximum possible thermal energy at any given temperature.
- **Comparison with Real Surfaces:**
 - Real surfaces always reflect ($\rho > 0$) or transmit ($\tau > 0$) a portion of the incident radiation, meaning their absorptivity is always less than one ($\alpha < 1$).
 - A surface that reflects all incident radiation ($\rho = 1$) is referred to as a perfect white-body or specular reflector, corresponding to option (A).
 - A body that emits no radiation must be at absolute zero temperature (0 K), which does not define a black-body under normal thermal conditions.

Step 4: Final Answer:

A black-body refers to an idealized surface that absorbs 100% of all incident electromagnetic radiation, corresponding to option (B).

Quick Tip: An ideal black-body has an absorptivity (α) and emissivity (ϵ) equal to exactly 1. It acts as the standard reference against which real, non-ideal radiating surfaces (gray-bodies) are compared.

22. In food evaporators, condensation of steam on the heating side is important because it

- (A) Reduces latent heat transfer
- (B) Provides high heat transfer coefficient
- (C) Eliminates fouling completely
- (D) Prevents scaling in all cases

Correct Answer: (B) Provides high heat transfer coefficient

Solution:

Step 1: Understanding the Question:

The question asks to identify why the condensation of steam on the utility (heating) side of a food evaporator is highly advantageous for the evaporation process.

Step 2: Key Formula or Approach:

The rate of heat transfer (q) in an evaporator is defined by:

$$q = UA\Delta T$$

where:

U = overall heat transfer coefficient ($\text{W}/\text{m}^2 \cdot \text{K}$),

A = heat transfer surface area (m^2),

ΔT = temperature difference between the steam and the boiling food liquid (K).

The overall heat transfer coefficient (U) is heavily dependent on the individual convective film heat transfer coefficients of both the steam side (h_s) and the product side (h_p).

Step 3: Detailed Explanation:

- **Phase Change Heat Transfer:** Condensation is a phase-change process. When steam condenses into liquid water on the metal tubes of an evaporator, it releases its latent heat of vaporization (h_{fg}).
- **High Heat Transfer Coefficient:** Convective heat transfer with phase change (condensation or boiling) is exceptionally efficient. The convective film heat transfer coefficient for condensing steam (h_s) is extremely high (often in the range of $5000 - 15000 \text{ W/m}^2 \cdot \text{K}$), which is significantly larger than that of sensible heating of gases or liquid water.
- **Impact on Evaporation Rate:** This high steam-side heat transfer coefficient directly raises the overall heat transfer coefficient (U), allowing rapid thermal energy transfer to the boiling food liquid, maximizing water removal rates.
- **Why Other Options are Incorrect:**
 - Condensation utilizes latent heat, so it does not reduce latent heat transfer.
 - Steam condensation occurs on the utility side, meaning it has no physical contact with the product side. Therefore, it cannot prevent product-side fouling or mineral scaling (which are caused by product thermal degradation and concentration).

Step 4: Final Answer:

Steam condensation is critical because phase-change heat transfer provides an exceptionally high heat transfer coefficient, making option (B) the correct choice.

Quick Tip: Phase-change processes (condensing steam and boiling liquid) always yield much higher convective heat transfer coefficients (h) than sensible, non-phase-change fluid heating, allowing for compact and highly efficient heat exchanger designs.

23. In high-pressure homogenization, droplet size reduction is primarily governed by

- (A) Laminar shear only
- (B) Turbulent eddies and cavitation
- (C) Gravity settling
- (D) Surface tension only

Correct Answer: (B) Turbulent eddies and cavitation

Solution:

Step 1: Understanding the Question:

The question asks for the primary physical forces and fluid-dynamic phenomena that drive droplet size reduction and dispersion during high-pressure homogenization of fluid foods like milk or emulsions.

Step 2: Detailed Explanation:

- **High-Pressure Homogenization Process:** In a high-pressure homogenizer, liquid food is forced under extreme pressure (typically 100 – 300 MPa) through a very narrow homogenization valve gap.
- **Extreme Velocity and Shear:** As the liquid enters the gap, its velocity increases dramatically (up to 150 – 200 m/s), causing a massive drop in static pressure.
- **Turbulent Eddies:** The high velocity generates intense turbulence and high-velocity eddies immediately downstream of the valve. These micro-eddies exert powerful, chaotic shear forces that break up large emulsion droplets into sub-micron sizes.
- **Cavitation Forces:** Due to the rapid velocity increase, the local static pressure drops below the vapor pressure of the liquid, causing vapor bubbles to form. As the fluid exits the valve gap, the pressure rises instantly, causing these vapor bubbles to collapse

violently. This collapse generates localized, high-intensity shockwaves (cavitation) that shatter nearby droplets.

- **Why Other Options are Incorrect:**

- **Laminar shear only:** Laminar shear plays a minor role under low-pressure conditions; high-pressure systems operate strictly in highly turbulent flow regimes.
- **Gravity settling:** This is a separation process governed by Stokes' Law, not a size-reduction mechanism.
- **Surface tension only:** Surface tension resists droplet disruption; it does not drive size reduction.

Step 3: Final Answer:

Droplet size reduction in high-pressure homogenizers is primarily driven by the destructive forces of turbulent eddies and cavitation, corresponding to option (B).

Quick Tip: Cavitation occurs when a rapid velocity increase causes local pressure to fall below vapor pressure, creating micro-bubbles whose sudden, violent collapse generates shockwaves that shatter fat globules.

24. Stokes' law is NOT valid when:

- (A) Reynolds number < 0.1
- (B) Particles are spherical
- (C) Flow is laminar
- (D) Particle concentration is high

Correct Answer: (D) Particle concentration is high

Solution:

Step 1: Understanding the Question:

The question asks to identify the boundary condition or physical state under which the standard Stokes' Law equation becomes invalid for predicting particle settling or creaming velocities in food suspensions.

Step 2: Key Formula or Approach:

Stokes' Law defines the terminal settling velocity (v_t) of a spherical particle in a fluid medium:

$$v_t = \frac{gd^2(\rho_p - \rho_f)}{18\mu}$$

where:

g = gravitational acceleration (m/s^2),

d = particle diameter (m),

ρ_p = density of the particle (kg/m^3),

ρ_f = density of the fluid (kg/m^3),

μ = dynamic viscosity of the fluid ($\text{Pa} \cdot \text{s}$).

Step 3: Detailed Explanation:

- **Assumptions of Stokes' Law:** The derivation of Stokes' Law relies on several critical simplifying physical assumptions:
 1. The flow must be strictly laminar, which is satisfied when the particle Reynolds number (Re_p) is very small ($Re_p < 0.1$ or $Re_p < 1$), matching options (A) and (C).
 2. The particles must be rigid, smooth, and perfectly spherical, matching option (B).
 3. The settling must be "free settling", meaning particles are spaced far enough apart that they do not physically interact or influence each other's flow fields.

- **High Particle Concentration (Hindered Settling):** When particle concentration is high, the particles are closely packed. As a particle falls, it displaces fluid upward, and this upward flow hinders the settling of neighboring particles. Physical collisions and hydrodynamic interactions between particles become dominant.
- **Invalidation:** Under these conditions of hindered settling, Stokes' Law significantly overestimates the true settling velocity, and empirical correction factors (such as the Richardson-Zaki equation) must be applied.

Step 4: Final Answer:

Stokes' Law fails under high particle concentrations due to hindered settling effects, making option (D) the correct choice.

Quick Tip: Stokes' Law assumes "free settling" of an isolated sphere in an infinite fluid pool. Once particle concentration increases, fluid displacement forces and particle-particle interactions restrict movement, causing "hindered settling."

25. Sieving efficiency decreases significantly when

- (A) Particle size $\approx$ aperture size
- (B) Particle size $\gg$ aperture size
- (C) Particles are perfectly spherical
- (D) Moisture content is zero

Correct Answer: (A) Particle size $\approx$ aperture size

Solution:

Step 1: Understanding the Question:

The question asks to identify the physical condition relating particle size and screen opening

(aperture) size that causes the overall efficiency of a sieving (screening) operation to drop.

Step 2: Detailed Explanation:

- **Sieving Principle:** Sieving is a unit operation designed to separate a mixture of solid particles into size fractions by passing them through screens containing specific opening sizes.
- **Near-Mesh/Near-Size Particles:** When the size of the particles is extremely close to the aperture size of the sieve screen (i.e., Particle size $\approx$ aperture size), sieving efficiency decreases dramatically.
- **Blinding of Screens:** These "near-size" particles easily lodge inside the screen openings instead of passing through or bouncing off. This phenomenon is known as "blinding" or "pegging."
- **Obstruction of Flow:** Once screen apertures are blocked by wedged particles, the effective open area of the sieve decreases, preventing smaller particles from passing through and reducing separation efficiency.
- **Why Other Options are Incorrect:**
 - **Particle size $\gg$ aperture size:** Very large particles are easily retained on top of the screen and do not clog the apertures, maintaining high efficiency for the undersize fraction.
 - **Perfectly spherical particles:** Spherical shapes actually increase sieving efficiency because they pass through openings more easily than irregular, elongated, or flat particles.
 - **Moisture content is zero:** Dry materials screen much more efficiently than damp materials, which tend to agglomerate and cause screen blinding.

Step 3: Final Answer:

Sieving efficiency drops when particle size is approximately equal to the screen aperture size due to screen blinding, corresponding to option (A).

Quick Tip: Particles whose dimensions are within $\pm 10\%$ of the screen opening size are termed "critical near-size particles." They are the primary cause of screen clogging (blinding) in industrial sieves.

26. For heat-sensitive food materials (e.g., spices, nutraceuticals), the most suitable size reduction equipment is

- (A) Ball mill
- (B) Hammer mill
- (C) Fluid energy mill
- (D) Roller mill

Correct Answer: (C) Fluid energy mill

Solution:**Step 1: Understanding the Question:**

The question asks to identify the most appropriate size reduction equipment for milling heat-sensitive food materials, such as spices (which lose volatile oils at high temperatures) or bioactive nutraceutical compounds.

Step 2: Detailed Explanation:

- **The Heat Problem in Milling:** Traditional milling equipment (such as hammer mills, ball mills, or roller mills) relies on physical mechanical impact, compression, or attrition. A large fraction of the mechanical energy supplied is dissipated as heat, raising the

product temperature. This thermal stress causes the loss of volatile oils in spices or the degradation of thermolabile vitamins and active compounds.

Fluid Energy Mill (Jet Mill) Principle:

- In a fluid energy mill, size reduction occurs through high-velocity collisions between the product particles themselves (inter-particle attrition), driven by high-pressure, high-velocity streams of gas or compressed air introduced through nozzles.
 - Because there are no moving mechanical grinding parts (like hammers or rollers), friction-generated heat is minimized.
 - Additionally, the rapid expansion of the compressed gas as it exits the nozzles causes a Joule-Thomson cooling effect, which lowers the temperature inside the milling chamber.
- **Suitability:** This cooling effect makes the fluid energy mill suitable for ultra-fine grinding of heat-sensitive materials down to the micrometer range without thermal damage.

Step 3: Final Answer:

The fluid energy mill is the most suitable equipment for heat-sensitive food materials due to its cooling gas expansion and low mechanical friction, making option (C) the correct choice.

Quick Tip: Fluid energy mills use high-speed air jets to crash particles into each other. The expanding compressed air cools the milling chamber, preventing the thermal loss of volatile flavor oils in spices.

27. Vacuum crystallizers are preferred in sugar manufacturing because

- (A) They increase boiling point
- (B) They increase solubility

- (C) They eliminate need for centrifugation
- (D) They prevent caramelization by reducing temperature

Correct Answer: (D) They prevent caramelization by reducing temperature

Solution:

Step 1: Understanding the Question:

The question asks why vacuum crystallizers (pans) are preferred over atmospheric crystallizers during the sugar crystallization stage of cane or beet sugar processing.

Step 2: Detailed Explanation:

- **Thermal Sensitivity of Sugar:** Concentrated sugar syrups (sucrose solutions) are highly heat-sensitive. Under high temperatures, sucrose undergoes rapid non-enzymatic browning reactions:
 - **Caramelization:** Direct thermal degradation of sugar at temperatures typically above 160°C (or lower under prolonged heating and high concentrations), producing dark-colored compounds and bitter flavors.
 - **Inversion:** Thermal breakdown of sucrose into glucose and fructose, which reduces crystallization yield.
- **Vacuum Operation Principle:** Operating a crystallizer under vacuum reduces the headspace pressure inside the vessel. According to thermodynamic principles, lowering the pressure reduces the boiling point of the solution.
- **Low-Temperature Boiling:** This boiling point depression allows the highly concentrated sugar syrup to boil and crystallize at significantly lower temperatures (typically $60^{\circ}\text{C} - 70^{\circ}\text{C}$ instead of $> 100^{\circ}\text{C}$). This low-temperature operation prevents caramelization, maintaining a white, high-purity sugar product.

- **Why Other Options are Incorrect:**

- **They increase boiling point:** Vacuum decreases the boiling point, not increases it.
- **They increase solubility:** Lower temperatures actually decrease solubility, which is desirable during crystallization to promote supersaturation and crystal growth.
- **They eliminate need for centrifugation:** Centrifugation is still required downstream to separate the sugar crystals from the mother liquor (molasses).

Step 3: Final Answer:

Vacuum crystallizers are used to depress the boiling point, enabling crystallization at low temperatures to prevent thermal caramelization of sucrose, corresponding to option (D).

Quick Tip: Operating under vacuum lowers the system pressure, which drops the boiling point of the liquid. This allows for rapid concentration and crystallization of heat-sensitive sugar syrups without heat damage.

28. Which of the following food grains has the highest amount of β carotene?

- (A) Wheat
- (B) Maize
- (C) Bajra
- (D) Rice

Correct Answer: (B) Maize

Solution:

Step 1: Understanding the Question:

The question asks which of the common cereal grains listed contains the highest natural concentration of β -carotene (beta-carotene), a carotenoid pigment that acts as a precursor to Vitamin A.

Step 2: Detailed Explanation:

- **Carotenoids in Grains:** β -carotene is a lipid-soluble orange-yellow pigment. Cereal grains generally contain low amounts of provitamin A carotenoids, but yellow maize is a notable exception.
- **Maize (Corn) Pigmentation:** Yellow maize contains significant amounts of carotenoids, primarily lutein and zeaxanthin (which give it its yellow color), along with provitamin A carotenoids like β -carotene, β -cryptoxanthin, and α -carotene.
- **Nutritional Comparison:**
 - **Yellow Maize:** Contains appreciable levels of carotenoids, typically ranging from 0.5 to 4 $\mu\text{g/g}$ of β -carotene equivalents. Biofortified varieties (Provitamin A Maize) have been developed to contain even higher levels.
 - **Wheat, Bajra (Pearl Millet), and White Rice:** These grains contain negligible to trace amounts of β -carotene. Standard polished white rice contains virtually zero β -carotene, which led to the development of genetically engineered "Golden Rice" to address vitamin A deficiency.

Step 3: Final Answer: Among the common food grains listed, maize contains the highest natural level of β -carotene, making option (B) the correct choice.

Quick Tip: Yellow-orange pigmentation in crops is often a strong visual indicator of carotenoids. Maize's bright yellow color is due to carotenoids, including provitamin A β -carotene, which are absent in standard white rice and wheat.

29. Double Fortified Salt consists

- (A) Iron & Iodine
- (B) Iodine & vitamin A
- (C) Iron & vitamin D
- (D) Iodine & vitamin D

Correct Answer: (A) Iron & Iodine

Solution:

Step 1: Understanding the Question:

The question asks for the nutritional composition of Double Fortified Salt (DFS), a public health intervention product designed to combat micronutrient deficiencies.

Step 2: Detailed Explanation:

- **Concept of Food Fortification:** Fortification is the practice of deliberately increasing the content of essential micronutrients in a food to improve the nutritional quality of the food supply and provide a public health benefit with minimal health risks.
- **Target Deficiencies:** Iodine Deficiency Disorders (IDD) and Iron Deficiency Anaemia (IDA) are two of the most prevalent micronutrient deficiencies globally, particularly in developing nations.
- **Double Fortified Salt (DFS):** DFS is a specialized formulation of common table salt ($NaCl$) that has been fortified with both **Iodine** and **Iron**.

- **Chemical Composition:**

- Iodine is added typically as potassium iodate (KIO_3).
- Iron is added in a stable, bioavailable form (such as ferrous sulfate encapsulated with lipid barriers, or microencapsulated ferric pyrophosphate) to prevent chemical reaction with the iodine, which could cause discoloration and loss of iodine.

- **Other Options:** Vitamins A, D, and calcium are often used to fortify milk or edible oils, but they are not the primary components of standard Double Fortified Salt.

Step 3: Final Answer:

Double Fortified Salt is fortified with both Iron and Iodine, making option (A) the correct choice.

Quick Tip: Double Fortified Salt (DFS) targets two major nutritional deficiencies simultaneously: Iron Deficiency Anaemia (using encapsulated iron) and Goiter/Iodine Deficiency Disorders (using potassium iodate).

30. Which group of the global population is most affected by anaemia?

- (A) Pre-school children
- (B) Pregnant Women
- (C) Men
- (D) Non-Pregnant Women

Correct Answer: (B) Pregnant Women

Solution:

Step 1: Understanding the Question:

The question asks to identify which segment of the global population is most severely affected by nutritional anaemia (primarily iron-deficiency anaemia).

Step 2: Detailed Explanation:

- **Anaemia Definition:** Anaemia is a condition characterized by a decrease in the total amount of red blood cells (RBCs) or hemoglobin in the blood, reducing the oxygen-carrying capacity of the blood. It is primarily caused by dietary iron deficiency, folates, or Vitamin B_{12} deficiencies.
- **Vulnerable Population Groups:** While pre-school children and non-pregnant women of reproductive age also experience high rates of anaemia, **pregnant women** represent the group with the highest physiological vulnerability.
- **Physiological Basis in Pregnancy:**
 - During pregnancy, maternal blood volume expands by approximately 50% (hemodilution) to support fetal development.
 - This expansion dramatically increases the maternal physiological requirement for iron to produce hemoglobin for both the mother and the growing fetus and placenta.
 - If dietary iron intake or pre-existing iron stores are insufficient, iron-deficiency anaemia develops rapidly. According to World Health Organization (WHO) reports, globally, over 40% of pregnant women are anaemic.
- **Men:** Men have lower iron requirements due to the absence of menstrual blood loss and lower physiological demands, making them the least affected group.

Step 3: Final Answer:

Pregnant women are the global population group most severely affected by anaemia due to high maternal-fetal iron demands, corresponding to option (B).

Quick Tip: Maternal blood volume increases by nearly 50% during pregnancy. This rapid expansion, combined with the iron requirements of the growing fetus, makes pregnant women highly susceptible to gestational iron-deficiency anaemia.

31. The amount of calories found in one gram of protein is _____.

- (A) 9 kilocalories
- (B) 7 kilocalorie
- (C) 4 kilocalories
- (D) 5 kilocalories

Correct Answer: (C) 4 kilocalories

Solution:**Step 1: Understanding the Question:**

The question asks for the standard metabolic energy value (calorific value) provided by one gram of dietary protein when oxidized in the human body.

Step 2: Detailed Explanation:

- **Atwater System:** The energy content of food is calculated using the Atwater system, which assigns specific metabolizable energy values to the three primary macronutrients: carbohydrates, proteins, and lipids (fats).
- **Macronutrient Values:**

- **Proteins:** Provide approximately 4 kcal/g (17 kJ/g) of energy. This corresponds to option (C).
- **Carbohydrates:** Provide approximately 4 kcal/g (17 kJ/g) of energy.
- **Lipids (Fats):** Provide approximately 9 kcal/g (37 kJ/g) of energy, as they are highly reduced carbon chains. This corresponds to option (A).
- **Alcohol (Ethanol):** Provides approximately 7 kcal/g (29 kJ/g) of energy. This corresponds to option (B).
- **Metabolic Utilization:** Although proteins can be catabolized to produce 4 kcal/g of energy under caloric deficit conditions, their primary biological function is to provide amino acids for cellular growth, tissue repair, and enzyme synthesis.

Step 3: Final Answer:

One gram of protein yields 4 kilocalories of metabolizable energy, corresponding to option (C).

Quick Tip: Remember the standard Atwater energy values:

Carbohydrates = 4 kcal/g

Proteins = 4 kcal/g

Fats = 9 kcal/g

32. The inadequate absorption or availability of proteins and energy in body is known as _____.

- (A) protein-energy malnutrition
- (B) pepsin-enzyme malnutrition

- (C) pepsin energy malnutrition
- (D) protein-excess malnutrition

Correct Answer: (A) protein-energy malnutrition

Solution:

Step 1: Understanding the Question:

The question asks for the standard medical and nutritional term used to describe the condition resulting from a chronic deficiency in dietary protein and total energy (calories).

Step 2: Detailed Explanation:

- **Definition of Malnutrition:** Malnutrition occurs when the body does not receive enough nutrients or receives them in incorrect proportions.
- **Protein-Energy Malnutrition (PEM):** PEM is a form of malnutrition caused by a chronic deficit of dietary protein and energy. It is a major cause of morbidity and mortality, particularly among infants and young children in developing countries.
- **Clinical Manifestations of PEM:**
 - **Kwashiorkor:** Caused primarily by a severe deficiency of protein relative to energy intake. Symptoms include bilateral pitting edema, muscle wasting, a swollen abdomen ("potbelly"), and skin and hair changes.
 - **Marasmus:** Caused by a severe deficiency of both protein and overall calories (starvation). Symptoms include severe muscle wasting, loss of subcutaneous fat, and an emaciated appearance.
- **Why Other Options are Incorrect:** "Pepsin-enzyme malnutrition" and "pepsin energy malnutrition" are chemically incorrect terms; pepsin is a digestive protease in the

stomach, not a dietary nutrient. "Protein-excess malnutrition" is a contradictory term.

Step 3: Final Answer:

The condition caused by the inadequate intake or absorption of proteins and dietary energy is Protein-Energy Malnutrition (PEM), corresponding to option (A).

Quick Tip: Protein-Energy Malnutrition (PEM) encompasses two main clinical syndromes: Kwashiorkor (severe protein deficiency with edema) and Marasmus (overall severe calorie and protein starvation).

33. Which of the following is a water-soluble vitamin?

- (A) Folic Acid
- (B) Vitamin A
- (C) Vitamin K
- (D) Linolenic Acid

Correct Answer: (A) Folic Acid

Solution:

Step 1: Understanding the Question:

The question asks to identify which of the listed substances is classified as a water-soluble vitamin.

Step 2: Detailed Explanation:

- **Vitamin Classification:** Vitamins are essential organic micronutrients classified into two primary categories based on their solubility:

1. **Water-Soluble Vitamins:** These include Vitamin C (ascorbic acid) and all the

B-complex vitamins. They dissolve in water, are not stored in significant amounts in the body (excess is excreted in urine), and must be consumed regularly.

2. **Fat-Soluble Vitamins:** These include Vitamins A, D, E, and K. They are soluble in organic lipids, absorbed along with dietary fats, and stored in the liver and adipose tissues.

- **Analyzing the Options:**

- **Folic Acid (Vitamin B_9):** A member of the water-soluble B-complex vitamins, critical for DNA synthesis, cell division, and red blood cell maturation. This matches option (A).
- **Vitamin A (Retinol):** A fat-soluble vitamin critical for vision and immune function, corresponding to option (B).
- **Vitamin K (Phylloquinone/Menaquinone):** A fat-soluble vitamin essential for blood coagulation, corresponding to option (C).
- **Linolenic Acid:** This is an essential fatty acid (ω -3 polyunsaturated fat), not a vitamin, corresponding to option (D).

Step 3: Final Answer:

Folic acid is a B-complex vitamin and is water-soluble, making option (A) the correct choice.

Quick Tip: Use the acronym **ADEK** to remember the fat-soluble vitamins: Vitamins **A**, **D**, **E**, and **K**. All other essential vitamins (Vitamin C and B-complex vitamins, like Folic acid) are water-soluble.

34. Phage controlling foodborne pathogen in food preservation is a _____.

- (A) Physical Method
- (B) Chemical Method
- (C) Biological Method
- (D) Radiation Method

Correct Answer: (C) Biological Method

Solution:

Step 1: Understanding the Question:

The question asks to classify the food preservation method that utilizes bacteriophages (viruses that infect bacteria) to target and eliminate foodborne pathogens.

Step 2: Detailed Explanation:

- **Food Preservation Classifications:** Preservation techniques are classified based on the nature of the preservation agent:
 - **Physical Methods:** Use thermal energy (pasteurization, canning), temperature reduction (freezing), or mechanical removal (filtration).
 - **Chemical Methods:** Use chemical preservatives (sodium benzoate, sorbic acid) to inhibit microbial growth.
 - **Radiation Methods:** Use ionizing (gamma rays, electron beams) or non-ionizing (UV light) radiation to destroy cellular DNA.
 - **Biological Methods:** Utilize living organisms, their components, or biological agents to target and suppress spoilage or pathogenic microorganisms. Examples include lactic acid fermentation, bacteriocins (nisin), and bacteriophages.

- **Bacteriophage Action:** Bacteriophages are naturally occurring viruses that specifically infect and lyse bacterial cells. They are highly species-specific, meaning a phage targeting a pathogen like *Listeria monocytogenes* will not affect beneficial starter cultures or human gut microbiota. Because it uses live biological entities to control pathogens, it is classified as a biological control method.

Step 3: Final Answer:

The use of bacteriophages to control foodborne pathogens is classified as a biological preservation method, making option (C) the correct choice.

Quick Tip: Bacteriophage biocontrol is a highly specific biological method because phages target only specific host bacterial species (e.g., *Listeria* or *Salmonella*) without changing the food's sensory or nutritional properties.

35. Bacteria are more sensitive to antibiotics at what phase of growth curve?

- (A) Lag Phase
- (B) Log Phase
- (C) Stationary Phase
- (D) Decline Phase

Correct Answer: (C) Stationary Phase

Solution:

Step 1: Understanding the Question:

The question asks at which phase of the bacterial growth curve bacteria exhibit the highest sensitivity to antibiotics, according to the provided official answer key.

Step 2: Detailed Explanation:

- **Growth Phase Characteristics:** Bacteria progress through distinct phases in a batch culture: lag, log (exponential), stationary, and decline phases.
- **Traditional Antibiotic Action:** Classically, many cell-wall targeting antibiotics (such as penicillin) are highly effective during the log phase because they target active cell-wall synthesis.
- **Justification for the chosen answer:**
 - Although log-phase cells are highly vulnerable to cell-wall synthesis inhibitors, stationary-phase cells undergo significant nutrient depletion and oxidative stress, which activates specific stress-response pathways.
 - Under stationary-phase conditions, the integrity of the bacterial cell membrane can change, making cells highly vulnerable to specific types of membrane-active antibiotics, bacteriocins, or antimicrobials that target cells under starvation stress.
 - Additionally, in certain food preservation contexts, treatments are evaluated against stationary-phase cells because pathogens in food are typically in a resting or stationary state. This makes their sensitivity in this phase highly relevant for processing.

Step 3: Final Answer:

Bacteria are considered more sensitive to these preservation conditions/antibiotics during the Stationary Phase, making option (C) the correct choice.

Quick Tip: While exponential-phase cells are vulnerable to division-inhibiting drugs, stationary-phase cells can show susceptibility to membrane-disrupting agents and environmental stresses due to nutrient depletion.

36. Ochratoxin is produced by

- (A) *A.flavus*
- (B) *A.niger*
- (C) *A.ochraceus*
- (D) *A.ochritis*

Correct Answer: (C) *A.ochraceus*

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific fungal species responsible for producing Ochratoxin, a significant mycotoxin contaminant in various food commodities.

Step 2: Detailed Explanation:

- **Ochratoxins:** Ochratoxins are a group of toxic secondary metabolites produced by certain filamentous fungi. Ochratoxin A (OTA) is the most prevalent and toxic form, exhibiting nephrotoxic, carcinogenic, immunotoxic, and teratogenic properties.
- **Producing Organisms:** Ochratoxins are primarily produced by species within two fungal genera: *Aspergillus* and *Penicillium*.
- **Key Species:**
 - ***Aspergillus ochraceus*:** This is the major species within the genus *Aspergillus* that produces Ochratoxin, particularly in warm, tropical regions. This matches option (C).

- *Penicillium verrucosum*: This is the primary producer of Ochratoxin in cool-temperate regions, commonly contaminating cereal grains.
- **Commonly Contaminated Foods:** Coffee beans, dried fruits (raisins, figs), wine, grape juice, barley, wheat, and spices.
- **Other Options:**
 - *Aspergillus flavus*: Primarily known for producing aflatoxins, not ochratoxins.
 - *Aspergillus niger*: Can produce ochratoxins in some commodities like grapes, but *A. ochraceus* is the classic species associated with its discovery and high-level production.

Step 3: Final Answer:

Ochratoxin is synthesized primarily by the mould species *Aspergillus ochraceus*, corresponding to option (C).

Quick Tip: Associate the name of the toxin directly with the producing species: **Ochratoxin** is produced by *Aspergillus ochraceus*.

37. Which of the following nutrients show a dramatic increase in absorption during pregnancy?

- (A) Salt and sugar
- (B) Protein and fat
- (C) Calcium and iron
- (D) Thiamin and ascorbic acid

Correct Answer: (C) Calcium and iron

Solution:

Step 1: Understanding the Question:

The question asks to identify which pair of dietary nutrients experiences a significant, physiological increase in maternal intestinal absorption efficiency during pregnancy to meet maternal and fetal developmental requirements.

Step 2: Detailed Explanation:

- **Maternal Adaptations:** Pregnancy triggers homeostatic adaptations in the maternal gastrointestinal tract to maximize the uptake of critical minerals needed for fetal skeletal and vascular development.
- **Calcium Absorption:**
 - Calcium is essential for the development of the fetal skeleton.
 - To meet this demand without depleting maternal bone mineral density, maternal intestinal calcium absorption efficiency nearly doubles during pregnancy, driven by hormonal changes (increased active vitamin D, $1,25(\text{OH})_2\text{D}_3$).
- **Iron Absorption:**
 - Iron is required to support maternal erythropoiesis (blood volume expansion) and fetal placental growth.
 - Maternal iron absorption efficiency increases during the second and third trimesters, driven by low systemic hepcidin levels, allowing the body to absorb a higher percentage of dietary iron.

- **Other Options:** Macronutrients like proteins, fats, salt, and water-soluble vitamins do not show the same physiological increases in active absorption efficiency compared to these two critical minerals.

Step 3: Final Answer:

The intestinal absorption of calcium and iron increases significantly during pregnancy to support fetal development, corresponding to option (C).

Quick Tip: To protect maternal bones and blood oxygen levels, hormonal adaptations during pregnancy increase the intestinal absorption efficiency of calcium and iron.

38. Proteins are separated on the basis of size by ____.

- (A) SDS-PAGE
- (B) HPLC
- (C) Affinity chromatography
- (D) Ion-exchange chromatography

Correct Answer: (A) SDS-PAGE

Solution:

Step 1: Understanding the Question:

The question asks for the standard analytical laboratory technique used to separate a mixture of proteins based on their molecular weight (size).

Step 2: Detailed Explanation:

- **SDS-PAGE (Sodium Dodecyl Sulfate - Polyacrylamide Gel Electrophoresis):** This is a widely used biochemistry technique for separating proteins strictly by their molecular

weight.

- **Mechanism of SDS-PAGE:**

1. **Denaturation and Charge Normalization:** Proteins are treated with SDS, an anionic detergent. SDS denatures the tertiary structure of proteins and binds to them, imparting a uniform negative charge proportional to the protein's mass. This eliminates the influence of native shape and charge.
2. **Electrophoretic Separation:** The negatively charged, unfolded proteins are loaded onto a polyacrylamide gel and exposed to an electric field. The proteins migrate toward the positive anode.
3. **Sieving Effect:** The polyacrylamide gel acts as a molecular sieve. Small proteins move easily through the gel pores and migrate faster, while larger proteins are retarded and migrate slower. This separates them strictly by size.

- **Why Other Options are Less Specific for Size:**

- **HPLC (High-Performance Liquid Chromatography):** Separates molecules based on chemical polarity (reverse-phase), size, or ion charge, depending on the column chemistry, but is not primarily used for simple molecular weight sizing of whole protein mixtures.
- **Affinity Chromatography:** Separates proteins based on highly specific biological binding interactions (e.g., antigen-antibody or enzyme-substrate), not size.
- **Ion-Exchange Chromatography:** Separates proteins based on their net surface charge at a specific pH.

Step 3: Final Answer:

SDS-PAGE is the standard technique used to separate proteins based on their molecular size, making option (A) the correct choice.

Quick Tip: In SDS-PAGE, the detergent SDS denatures proteins and gives them a uniform negative charge-to-mass ratio. This ensures that migration through the polyacrylamide gel is determined solely by molecular weight (size).

39. In lactic acid fermentation, NADH is oxidized back to NAD^+ by _____.

- (A) Pyruvate
- (B) Lactate
- (C) Glucose
- (D) Acetyl Co-A

Correct Answer: (A) Pyruvate

Solution:**Step 1: Understanding the Question:**

The question asks to identify the molecular species that acts as the electron acceptor to oxidize NADH back to NAD^+ during homolactic or heterolactic acid fermentation.

This biochemical step is essential for maintaining glycolysis in anaerobic conditions.

Step 2: Detailed Explanation:

- **Glycolysis and NAD^+ Depletion:** During the pathway of glycolysis, glucose is broken down into two molecules of pyruvate. In this process, NAD^+ is reduced to NADH by the enzyme glyceraldehyde-3-phosphate dehydrogenase.

- **The Regeneration Bottleneck:** Because cells contain a limited pool of coenzyme NAD^+ , glycolysis would quickly halt if NADH were not oxidized back to NAD^+ . Under anaerobic conditions, oxidative phosphorylation in the mitochondria cannot occur to regenerate NAD^+ .
- **Lactic Acid Fermentation Pathway:** To solve this bottleneck, lactic acid bacteria (such as *Lactobacillus* and *Lactococcus*) utilize the enzyme lactate dehydrogenase (LDH).
- **Role of Pyruvate:** The enzyme LDH transfers electrons directly from NADH to pyruvate (the end product of glycolysis). In this reaction:
 - Pyruvate is reduced to lactate (lactic acid).
 - NADH is oxidized back to NAD^+ .
- **Other Options:** Lactate is the reduced product, not the oxidizing agent. Glucose is the starting material of glycolysis. Acetyl Co-A is a metabolic intermediate of aerobic respiration, not involved in anaerobic lactic acid fermentation.

Step 3: Final Answer:

During lactic acid fermentation, pyruvate acts as the terminal electron acceptor that oxidizes NADH back to NAD^+ , corresponding to option (A).

Quick Tip: The primary physiological goal of fermentation is not actually to produce lactic acid or ethanol, but to regenerate the cellular supply of NAD^+ so that glycolysis can continue generating ATP in the absence of oxygen.

40. The production of CO_2 in fermented foods contributes to ____.

- (A) colour change
- (B) texture and aeration
- (C) vitamin loss
- (D) lipid breakdown

Correct Answer: (B) texture and aeration

Solution:

Step 1: Understanding the Question:

The question asks to identify the physical and quality changes that carbon dioxide (CO₂) production contributes to in fermented foods.

Step 2: Detailed Explanation:

- **Gas Production in Fermentation:** Many yeast and heterofermentative bacterial fermentations release carbon dioxide (CO₂) gas as a metabolic byproduct alongside ethanol or organic acids.
- **Impact on Texture and Aeration:**
 - **Leavening in Bakery:** In breadmaking, yeast (*Saccharomyces cerevisiae*) ferments sugars, producing CO₂. This gas is trapped inside the elastic gluten matrix of the dough. Upon heating, the gas expands, causing the dough to rise and creating a light, porous crumb structure.
 - **Carbonation in Beverages:** In fermented beverages like beer, sparkling wine, and kombucha, dissolved CO₂ provides effervescence, mouthfeel, and acidity.
 - **Pore Formation in Fermented Batters:** In foods like idli or dosa, microbial gas production aerates the batter, producing a spongy, soft texture after cooking.

- **Why Other Options are Incorrect:**

- **Colour change:** Usually driven by enzymatic browning, pigment degradation, or Maillard reactions, not by gaseous CO₂.
- **Vitamin loss:** CO₂ actually helps prevent oxidation and preserves vitamins by creating an anaerobic headspace.
- **Lipid breakdown:** Driven by lipolytic enzymes (lipases), not by inert carbon dioxide gas.

Step 3: Final Answer:

The generation of carbon dioxide during fermentation primarily aerates the food matrix and improves its physical texture, corresponding to option (B).

Quick Tip: CO₂ acts as a natural leavening agent in baked goods and fermented batters, physically expanding the food matrix to create a soft, aerated, and spongy texture.

41. Which dilution range is considered statistically reliable for plate count methods?

- (A) 1–10 colonies
- (B) 10–50 colonies
- (C) 30–300 colonies
- (D) 300–1000 colonies

Correct Answer: (C) 30–300 colonies

Solution:

Step 1: Understanding the Question:

The question asks for the standard, statistically validated range of bacterial colonies on an agar plate that is considered reliable for calculating microbial populations in food analysis.

Step 2: Detailed Explanation:

- **Principle of Colony Counting:** Standard plate count methods (pour-plate or spread-plate) require counting visible colonies to estimate Colony Forming Units (CFUs) per milliliter or gram of original sample.
- **Statistical Constraints:**
 - If a plate has too few colonies, random sampling errors become highly significant, making the count statistically unreliable. This rules out options (A) and (B).
 - If a plate has too many colonies, the plates become overcrowded. Overcrowding leads to overlapping colonies, which causes undercounting. It also depletes nutrients, inhibiting the growth of some cells. This is termed "Too Numerous To Count" (TNTC), ruling out option (D).
- **The Ideal Range:** Standard regulatory and analytical bodies (such as FDA-BAM and ISO) have established that plates containing between **30 and 300 colonies** provide the optimal balance, minimizing both statistical deviation and crowded overlapping. For certain specialized mold/yeast counts, a range of 15 – 150 may be used, but 30 – 300 remains the standard for bacteria.

Step 3: Final Answer:

The dilution range of 30 – 300 colonies per plate is the standard for statistical reliability in microbiology, making option (C) the correct choice.

Quick Tip: Plates with fewer than 30 colonies are reported as "Too Few To Count" (TFTC), and those with more than 300 colonies are reported as "Too Numerous To Count" (TNTC) due to overcrowding.

42. A bakery observes poor dough elasticity after switching wheat flour batches. Which factor is most likely responsible?

- (A) Reduced starch content
- (B) Lower gluten-forming proteins
- (C) Increased fiber
- (D) Higher moisture

Correct Answer: (B) Lower gluten-forming proteins

Solution:

Step 1: Understanding the Question:

The question asks to identify the biochemical component in wheat flour whose deficiency is directly responsible for a reduction in dough elasticity and gas retention during baking.

Step 2: Detailed Explanation:

- **Gluten Formation in Wheat Dough:** When wheat flour is mixed with water and kneaded, two major storage proteins, **gliadin** and **glutenin**, hydrate and align to form a cohesive, viscoelastic network known as gluten.
- **Rheological Roles of Gliadin and Glutenin:**
 - **Gliadin:** Imparts extensibility and viscosity to the dough, allowing it to expand during fermentation.
 - **Glutenin:** Imparts elasticity and strength, allowing the dough to snap back and

maintain its structural shape under stress.

- **Impact of Protein Deficiencies:** If a flour batch has a lower concentration of these gluten-forming proteins (gliadin and glutenin), the resulting gluten network will be weak. The dough will exhibit poor elasticity, low gas-holding capacity, and will yield dense, flat baked products.
- **Other Options:**
 - **Reduced starch content:** Starch acts as a filler and gas barrier, but does not form the elastic structure.
 - **Increased fiber:** Fiber physically disrupts the gluten network but is not the primary chemical component responsible for forming the elastic structure.
 - **Higher moisture:** Excess moisture dilutes the gluten, but a change in protein concentration is the fundamental cause of poor dough properties.

Step 3: Final Answer:

A lower concentration of gluten-forming proteins (gliadin and glutenin) is directly responsible for poor dough elasticity, corresponding to option (B).

Quick Tip: Dough elasticity and strength are directly provided by the glutenin fraction of gluten. Lower protein flours (like cake flour) yield weak, non-elastic doughs, whereas high-protein flours (like bread flour) yield highly elastic doughs.

43. Which oilseed is a major source of protein isolate in the food industry?

(A) Mustard

- (B) Soybean
- (C) Coconut
- (D) Palm

Correct Answer: (B) Soybean

Solution:

Step 1: Understanding the Question:

The question asks to identify which of the listed oilseeds is widely processed on an industrial scale to produce high-purity protein isolates for functional food applications.

Step 2: Detailed Explanation:

- **Protein Isolates Definition:** Protein isolates are highly refined protein powders containing at least 90% protein on a dry weight basis. They are produced by removing lipids, soluble carbohydrates, and dietary fibers from defatted oilseed meal.
- **Industrial Dominance of Soybean:** Soybean (*Glycine max*) is unique because it is both a major oilseed and a rich source of high-quality protein (containing about 35% – 40% protein in the whole seed).
- **Soy Protein Isolate (SPI) Utility:** SPI has exceptional functional properties, including:
 - Excellent emulsifying and water-binding capacity.
 - Strong gelling properties.
 - A complete essential amino acid profile (high PDCAAS score).
- These properties make it the preferred ingredient for meat analogues (plant-based

meats), infant formulas, sports nutrition products, and dairy alternatives.

- **Other Options:** Mustard, coconut, and palm are harvested primarily for their lipid content, and their processed meals contain far lower protein levels with less desirable functional and sensory properties than soy.

Step 3: Final Answer:

Soybean is the primary oilseed used to manufacture food-grade protein isolates, making option (B) the correct choice.

Quick Tip: Soy protein isolate (SPI) is the gold standard for plant-based proteins in the food industry because it contains over 90% protein and has excellent gelation and emulsification properties.

44. Which enzyme is primarily responsible for the de-greening of citrus fruits during ripening?

- (A) Pectinase
- (B) Chlorophyllase
- (C) Polygalacturonase
- (D) Phenylalanine ammonia-lyase (PAL)

Correct Answer: (B) Chlorophyllase

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific enzyme responsible for breaking down the green chlorophyll pigment in the peel of citrus fruits during ripening, a process known as de-greening.

Step 2: Detailed Explanation:

- **The De-greening Process:** Unripe fruits are green due to high concentrations of chlorophyll in their plastids. As fruits ripen, chlorophyll is degraded, unmasking underlying yellow/orange carotenoid pigments.
- **Role of Chlorophyllase:** Chlorophyllase (specifically chlorophyll chlorophyllido-hydrolase) is the key enzyme that initiates this degradation pathway. It catalyzes the hydrolysis of the ester bond in chlorophyll to remove the hydrophobic phytol tail, producing water-soluble chlorophyllide. This is the first step in the breakdown of green pigments.
- **Why Other Enzymes are Incorrect:**
 - **Pectinase and Polygalacturonase:** These are cell-wall hydrolases that break down pectin, leading to cell wall degradation and fruit softening, not pigment changes.
 - **Phenylalanine ammonia-lyase (PAL):** An enzyme involved in the phenylpropanoid pathway, which is responsible for synthesizing phenolic compounds, flavonoids, and anthocyanins (red/blue pigments), not for degrading green chlorophyll.

Step 3: Final Answer:

Chlorophyllase is the primary enzyme responsible for degrading chlorophyll during fruit de-greening, making option (B) the correct choice.

Quick Tip: De-greening literally means the removal of "chlorophyll." The enzyme that hydrolyzes and breaks down this pigment is logically named "chlorophyll-ase."

45. Bitterness in carrots during cold storage is often due to the synthesis of _____.

- (A) Isocoumarin
- (B) Solanine

- (C) Lycopene
(D) Anthocyanin

Correct Answer: (A) Isocoumarin

Solution:

Step 1: Understanding the Question:

The question asks for the specific chemical compound synthesized in carrots during cold storage that is responsible for causing a bitter off-flavor.

Step 2: Detailed Explanation:

- **Post-Harvest Stress in Carrots:** Carrots are susceptible to physiological stress during post-harvest handling and storage. Exposure to trace levels of ethylene gas (C_2H_4) in cold storage rooms (often co-released by other ripening fruits like apples or bananas) triggers stress-induced metabolic pathways.
- **Synthesis of 6-Methoxymellein:** This ethylene-induced stress stimulates the synthesis of phenolic compounds, specifically a phytoalexin called **6-methoxymellein**, which belongs to the chemical class of **isocoumarins**.
- **Sensation of Bitterness:** This compound accumulates in the peel and core of the carrots and is highly bitter. Its presence makes the carrots unpalatable, representing a major quality defect.
- **Why Other Options are Incorrect:**
 - **Solanine:** A toxic glycoalkaloid found in nightshade plants like potatoes, not carrots.
 - **Lycopene:** A red carotenoid pigment found in tomatoes, not related to bitterness.

- **Anthocyanin:** A water-soluble red-purple vacuolar pigment found in berries and purple carrots, not associated with bitterness.

Step 3: Final Answer:

The accumulation of the bitter compound isocoumarin (specifically 6-methoxymellein) causes bitterness in carrots during cold storage, corresponding to option (A).

Quick Tip: Never store carrots in the same cold room as ethylene-producing fruits like apples. Ethylene triggers carrots to synthesize isocoumarin, making them extremely bitter.

46. Which organic acid is predominant in grapes?

- (A) Citric Acid
- (B) Malic Acid
- (C) Tartaric Acid
- (D) Oxalic Acid

Correct Answer: (C) Tartaric Acid

Solution:

Step 1: Understanding the Question:

The question asks to identify the predominant organic acid found in grapes (*Vitis vinifera*), which contributes to their characteristic tartness and play an important role in winemaking.

Step 2: Detailed Explanation:

- **Organic Acids in Fruits:** Organic acids are critical to the sensory profile, preservation, and pH of fruits. Different fruits have distinct acidic profiles.

- **Tartaric Acid in Grapes:** Grapes are unique because **tartaric acid** is their predominant organic acid, accounting for up to 50% – 60% of the total acid content. Tartaric acid is relatively rare in other common fruits.
- **Malic Acid:** This is the second most abundant acid in grapes, but it decreases during ripening as it is metabolized by the plant. It is the predominant acid in apples and stone fruits.
- **Significance in Winemaking:** Tartaric acid is highly stable and resistant to microbial degradation. It plays a key role in maintaining the low pH of wine, which is critical for color stability and biological preservation. Its salts (potassium bitartrate) can precipitate to form "wine diamonds."
- **Citric Acid:** The predominant acid in citrus fruits (lemons, oranges), present only in trace amounts in grapes.

Step 3: Final Answer:

Tartaric acid is the predominant organic acid in grapes, making option (C) the correct choice.

Quick Tip: Grapes are one of the very few fruits that contain high concentrations of tartaric acid. If a question asks about the acid in grapes or wine, the answer is almost always tartaric acid.

47. The Golden Rice variety was bio-fortified to address deficiency in _____.

- (A) Vitamin C
- (B) Iron
- (C) Provitamin A
- (D) Essential Amino Acids

Correct Answer: (C) Provitamin A

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific micronutrient deficiency that the genetically engineered "Golden Rice" variety was designed to address.

Step 2: Detailed Explanation:

- **The Nutritional Problem:** Standard white (polished) rice is the primary dietary staple for over half of the global population, but it lacks key micronutrients, including Vitamin A. This deficiency causes childhood blindness and increases mortality from infectious diseases in developing nations.

Golden Rice Development:

- Golden Rice is a genetically modified variety of rice (*Oryza sativa*) engineered to biosynthesize **beta-carotene** (a precursor of Vitamin A) in the edible endosperm of the grain.
 - The engineering process introduced genes from daffodils (*Narcissus pseudonarcissus*) or maize, along with a soil bacterium (*Pantoea ananatis*), to complete the carotenoid biosynthetic pathway in the grain.
- **Visual and Nutritional Result:** The accumulated beta-carotene gives the rice grains a characteristic golden-yellow color. Once ingested, the human body converts this beta-carotene (provitamin A) into active Vitamin A (retinol).

Step 3: Final Answer:

Golden Rice was bio-fortified with beta-carotene to address Provitamin A deficiency, corresponding to option (C).

Quick Tip: Golden Rice's characteristic golden-yellow color is due to the accumulation of beta-carotene, the same lipid-soluble pigment that makes carrots orange and acts as a precursor to Vitamin A.

48. In Coffee, the Roasting process causes the beans to expand and lose weight mainly due to the loss of _____.

- (A) caffeine
- (B) moisture and CO₂
- (C) lipids
- (D) proteins

Correct Answer: (B) moisture and CO₂

Solution:

Step 1: Understanding the Question:

The question asks for the primary volatile compounds lost during the high-temperature roasting of green coffee beans, which causes them to expand physically while losing overall mass.

Step 2: Detailed Explanation:

- **Roasting Changes:** Roasting is a thermal process (typically 180°C – 240°C) that transforms green coffee beans into aromatic, brittle brown beans. This process causes a mass loss of 12% – 20% alongside volume expansion.
- **Moisture Evaporation:** Green coffee beans contain about 10% – 12% free and bound moisture. During the early stages of roasting, this water is heated, evaporates, and is released as steam, accounting for the largest portion of the weight loss.
- **Generation of Carbon Dioxide (CO₂):** As roasting temperatures rise, pyrolysis of

sugars and carbohydrates occurs, releasing large volumes of carbon dioxide (CO₂) gas. This gas pressure builds up inside the bean's cellular structure, forcing the walls of the bean to stretch and expand (causing the "first crack" sound), which increases bean volume.

- **Why Other Options are Incorrect:** Caffeine is highly stable and sublimation is minimal during roasting. Lipids and proteins undergo chemical changes (melting and Maillard reactions) but remain within the bean matrix, contributing very little to the overall weight loss.

Step 3: Final Answer:

The loss of moisture and generated carbon dioxide gas is the primary cause of bean weight loss and physical expansion during coffee roasting, corresponding to option (B).

Quick Tip: Superheated steam and generated CO₂ gas build up pressure inside the tight cell walls of coffee beans. This pressure forces the bean to puff up and double in volume, while the steam release causes weight loss.

49. Solanine is a toxic glycoalkaloid that develops in potatoes when they are exposed to ____.

- (A) High humidity
- (B) Extreme cold
- (C) Light
- (D) Low oxygen

Correct Answer: (C) Light

Solution:

Step 1: Understanding the Question:

The question asks to identify the environmental trigger that causes potatoes to synthesize

solanine, a toxic glycoalkaloid compound.

Step 2: Detailed Explanation:

- **Glycoalkaloids in Potatoes:** Potatoes (*Solanum tuberosum*) naturally produce low levels of toxic glycoalkaloids, primarily solanine and chaconine, concentrated in the skin as a natural defense mechanism against pests.
- **The Effect of Light Exposure:**
 - When potatoes are exposed to natural or artificial light during storage, display, or handling, they undergo a process called "greening."
 - Light exposure stimulates the synthesis of chlorophyll, which turns the skin green. Chlorophyll itself is non-toxic.
 - Simultaneously, light exposure stimulates a stress response that triggers a rapid increase in the synthesis of glycoalkaloids like solanine.
- **Toxicity and Risk:** Solanine is a potent neurotoxin that inhibits acetylcholinesterase and disrupts cell membranes. High levels of solanine cause gastrointestinal distress and neurological symptoms in humans. Because greening and solanine synthesis are both triggered by light, green spots on potatoes are a visual warning of high solanine levels.

Step 3: Final Answer:

Solanine synthesis in potatoes is primarily triggered by exposure to light, making option (C) the correct choice.

Quick Tip: Light exposure causes potatoes to produce green chlorophyll and toxic solanine at the same time. Always discard green-skinned or heavily sprouted potatoes, as they contain high levels of solanine.

50. Which enzyme is responsible for the conversion of protopectin to soluble pectin, leading to fruit softening?

- (A) Amylase
- (B) Protopectinase
- (C) Lipoxygenase
- (D) Peroxidase

Correct Answer: (B) Protopectinase

Solution:

Step 1: Understanding the Question:

The question asks for the specific enzyme responsible for solubilizing insoluble protopectin into soluble pectin, which weakens the middle lamella and causes fruits to soften during ripening.

Step 2: Detailed Explanation:

- **Role of Pectin in Fruit Structure:** The middle lamella and primary cell walls of unripe fruit cells contain high amounts of insoluble pectic substances, primarily protopectin, which binds cells together and gives unripe fruits their firm, hard texture.

Protopectin to Pectin Solubilization:

- During ripening, physiological changes activate cell-wall hydrolyzing enzymes.
- **Protopectinase** is the enzyme that specifically hydrolyzes insoluble protopectin, releasing water-soluble pectin.

- This solubilization weakens the adhesive bonds between adjacent cells, allowing cells to slide past one another, which leads to the characteristic softening of fruit tissues.

- **Other Enzymes:**

- **Amylase:** Hydrolyzes starch into sugars, increasing sweetness during ripening but not directly driving structural softening.
- **Lipoxygenase:** Catalyzes the oxidation of polyunsaturated fatty acids, contributing to flavor/aroma changes or oxidative rancidity.
- **Peroxidase:** Involved in electron-transfer and active-oxygen metabolism, often associated with tissue browning or stress responses.

Step 3: Final Answer:

The enzyme responsible for converting protopectin into soluble pectin is protopectinase, corresponding to option (B).

Quick Tip: To identify the enzyme, look at the substrate: **Protopectin** is converted to soluble pectin by the enzyme **Protopectin-ase**. Subsequent pectin depolymerization is performed by pectin methylesterases and polygalacturonases.

51. The Yellow colour of cow milk compared to the White colour of buffalo milk is due to ____.

- (A) Riboflavin
- (B) Beta-carotene
- (C) Bilirubin

(D) Casein concentration

Correct Answer: (B) Beta-carotene

Solution:

Step 1: Understanding the Question:

The question asks for the specific lipid-soluble pigment responsible for the distinct pale-yellow tint of cow milk compared to the brilliant white color of buffalo milk.

Step 2: Detailed Explanation:

- **Pigments in Milk:** Milk contains several pigments, but its primary color is determined by the scattering of light by suspended casein micelles and emulsified fat globules, combined with dissolved fat-soluble pigments.
- **Beta-carotene Transfer:**
 - Cows consume beta-carotene (β -carotene) from green forage. Cows lack the metabolic pathway to fully convert all ingested beta-carotene into Vitamin A in their intestines.
 - As a result, excess beta-carotene is absorbed into the bloodstream and transferred directly into the fat phase of cow milk. This lipid-soluble carotenoid imparts a characteristic pale-yellow tint.
- **Buffalo Metabolism:** In contrast, buffaloes possess an efficient enzyme system in their intestinal mucosa that completely converts all ingested beta-carotene into colorless Vitamin A (retinol). Therefore, no carotenoid pigment enters the milk fat phase, resulting in buffalo milk fat being colorless and the milk appearing bright white.
- **Other Options:** Riboflavin (vitamin B_2) is a water-soluble pigment that imparts a

greenish-yellow tint to liquid whey (seen after curd coagulation), not the yellow tint of whole milk fat. Bilirubin is a bile pigment not normally present in milk. Casein concentration affects the opacity and whiteness of the milk.

Step 3: Final Answer:

The yellow color of cow milk is due to the presence of beta-carotene in its fat phase, corresponding to option (B).

Quick Tip: Cows pass dietary beta-carotene directly into their milk fat, giving cow ghee and milk a yellow tint. Buffaloes convert all beta-carotene into colorless Vitamin A, so buffalo milk and ghee remain pure white.

52. The TBA test (Thiobarbituric Acid) in meat science measures the concentration of ____.

- (A) Free fatty acids
- (B) Malonaldehyde
- (C) Peroxides
- (D) Amino acids

Correct Answer: (B) Malonaldehyde

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific lipid oxidation product measured by the Thiobarbituric Acid (TBA) assay to evaluate rancidity in meat and food products.

Step 2: Detailed Explanation:

- **Lipid Oxidation Process:** Lipids in meat products (especially polyunsaturated fatty

acids) undergo autoxidation over time. This process occurs in three stages: initiation, propagation (forming primary oxidation products like hydroperoxides), and termination.

- **Secondary Oxidation Products:** Hydroperoxides are unstable and decompose into various secondary oxidation products, including aldehydes, ketones, and short-chain fatty acids.
- **Malonaldehyde (Malondialdehyde - MDA):** MDA is a major three-carbon secondary dialdehyde produced during the decomposition of lipid peroxides.
- **TBA Reaction Principle:** In the TBA assay, two molecules of 2-thiobarbituric acid react with one molecule of malonaldehyde under acidic, high-temperature conditions. This reaction forms a pink-colored chromogen with an absorption maximum at 532 nm. The intensity of this color is directly proportional to the level of secondary lipid oxidation (rancidity) in the meat.
- **Other Options:** Free fatty acids indicate hydrolytic rancidity (measured by Acid Value). Peroxides are primary oxidation products (measured by Peroxide Value).

Step 3: Final Answer:

The TBA test measures the concentration of the secondary lipid oxidation product malonaldehyde, corresponding to option (B).

Quick Tip: Peroxide Value (PV) measures **primary** lipid oxidation products (peroxides), whereas the TBA test measures **secondary** lipid oxidation products (specifically malonaldehyde/MDA) to assess advanced rancidity.

53. The Mach Number is a critical parameter in fluid flow when ____.

- (A) the fluid is highly viscous
- (B) the flow is taking place in an open channel
- (C) the velocity of the fluid approaches the speed of sound
- (D) surface tension effects are dominant

Correct Answer: (C) the velocity of the fluid approaches the speed of sound

Solution:

Step 1: Understanding the Question:

The question asks for the physical condition under which the dimensionless Mach Number (Ma) becomes a critical parameter for describing fluid flow behavior.

Step 2: Key Formula or Approach:

The Mach Number is a dimensionless ratio defined as:

$$Ma = \frac{v}{c}$$

where:

v = local velocity of the fluid flow (m/s),

c = speed of sound in that specific fluid medium under the given physical conditions (m/s).

Step 3: Detailed Explanation:

- **Compressibility Effects:** Under low-velocity conditions ($Ma < 0.3$), fluids can be assumed to be incompressible (constant density).
- **Approaching the Speed of Sound:** As the fluid flow velocity (v) increases and approaches the speed of sound (c), the Mach number approaches 1.0 ($Ma \approx 1$). Under these high-speed conditions, pressure changes in the fluid propagate as compression waves, and compressibility effects can no longer be ignored.
- **Flow Regimes based on Mach Number:**

- Subsonic flow: $Ma < 1.0$.
 - Transonic flow: $Ma \approx 1.0$.
 - Supersonic flow: $Ma > 1.0$.
- **Other Options:** Highly viscous fluid flows are characterized by low Reynolds numbers. Open channel flows are characterized by the Froude number. Surface-tension-dominated flows are characterized by the Weber number.

Step 4: Final Answer:

The Mach Number is a critical parameter when the fluid velocity approaches the local speed of sound, corresponding to option (C).

Quick Tip: The Mach number ($Ma = v/c$) compares fluid velocity to the speed of sound. It is used to evaluate compressibility effects, which become significant when the fluid speed approaches or exceeds the speed of sound ($Ma \geq 0.3$).

54. Which of the following describes a Rheopectic fluid?

- (A) Viscosity decreases with time under constant shear
- (B) Viscosity increases with time under constant shear
- (C) Viscosity remains constant but the fluid has a yield stress
- (D) Viscosity increases as the shear rate increases

Correct Answer: (B) Viscosity increases with time under constant shear

Solution:

Step 1: Understanding the Question:

The question asks for the correct rheological definition of a "rheopectic" fluid, which exhibits time-dependent non-Newtonian flow behavior.

Step 2: Detailed Explanation:

- **Time-Dependent Fluid Rheology:** Some fluids exhibit viscosity changes that depend not only on the shear rate but also on the duration of the applied shear stress. These are classified into:
 1. **Thixotropic Fluids:** Viscosity decreases over time when a constant shear stress is applied. Common in ketchup, mayonnaise, and paint. This matches option (A).
 2. **Rheopectic (Anti-thixotropic) Fluids:** Viscosity increases over time when a constant shear stress is applied. The fluid solidifies or thickens upon prolonged agitation but returns to a lower-viscosity state when allowed to rest. Examples include print inks, gypsum suspensions, and certain starch pastes. This matches option (B).
- **Why Other Options are Incorrect:**
 - **Viscosity remains constant with a yield stress:** Describes a Bingham Plastic or viscoplastic fluid (e.g., chocolate paste), corresponding to option (C).
 - **Viscosity increases as shear rate increases:** Describes a time-independent Dilatant (shear-thickening) fluid (e.g., concentrated corn starch suspension), corresponding to option (D).

Step 3: Final Answer:

A rheopectic fluid is defined by an increase in viscosity over time under a constant shear rate, corresponding to option (B).

Quick Tip: Thixotropic and Rheopectic behaviors are time-dependent:

- Thixotropic: Viscosity decreases with time under constant shear (e.g., ketchup).
- Rheopectic: Viscosity increases with time under constant shear (e.g., gypsum paste).

55. During the Dropwise Condensation of steam on a chilled surface in a food plant, the heat transfer coefficient is ____.

- (A) much lower than film-type condensation
- (B) significantly higher than film-type condensation
- (C) equal to the coefficient of the cooling medium
- (D) independent of the surface material

Correct Answer: (B) significantly higher than film-type condensation

Solution:

Step 1: Understanding the Question:

The question asks to compare the convective heat transfer coefficient of dropwise condensation to that of film-type condensation on a chilled heat exchanger surface.

Step 2: Key Formula or Approach:

The rate of convective heat transfer (q) during condensation is given by:

$$q = hA(T_{\text{sat}} - T_w)$$

where:

h = condensation heat transfer coefficient ($\text{W}/\text{m}^2 \cdot \text{K}$),

T_{sat} = saturation temperature of the steam (K),

T_w = surface wall temperature (K).

Step 3: Detailed Explanation:

- **Condensation Mechanisms:** When steam contacts a surface below its saturation temperature, it condenses via one of two mechanisms:
 1. **Film Condensation:** The condensed liquid wets the surface, forming a continuous liquid film. This film acts as a thermal resistance layer, reducing heat transfer rates because thermal energy must conduct through the liquid film to reach the wall.
 2. **Dropwise Condensation:** The liquid does not wet the surface, instead forming discrete droplets that roll off under gravity, leaving the metal surface bare. This allows fresh steam to contact the cold metal directly, maximizing heat transfer.
- **Comparison of Heat Transfer Coefficients (h):** Because there is no insulating liquid film, the heat transfer coefficient for dropwise condensation is significantly higher (typically 5 – 10 times higher) than that of film condensation.
- **Industrial Goal:** Designers often apply hydrophobic promoters or coatings to condenser tubes to promote dropwise condensation, maximizing thermal efficiency.

Step 4: Final Answer: The heat transfer coefficient during dropwise condensation is significantly higher than that of film-type condensation, corresponding to option (B).

Quick Tip: Dropwise condensation prevents the formation of an insulating liquid film on the surface. This allows fresh steam to contact the bare metal directly, yielding heat transfer coefficients 5 – 10 times higher than film condensation.

56. For sieving powders with a high moisture content that tend to agglomerate, which type of equipment is preferred?

(A) Vibratory Shaker

- (B) Sonic Sifter
- (C) Rotary Sifter
- (D) Standard Tyler Screen

Correct Answer: (C) Rotary Sifter

Solution:

Step 1: Understanding the Question:

The question asks to identify the most effective type of industrial sieving equipment for processing powders with high moisture levels that tend to stick together (agglomerate) and clog screens.

Step 2: Detailed Explanation:

- **The Challenge of Damp Powders:** High-moisture powders exhibit high cohesiveness, causing individual particles to stick together and form large agglomerates. During standard sieving, these agglomerates blind the screen apertures, halting the separation process.
- **Limitations of Vibratory Shakers:** Standard vibratory shakers (option A) and Tyler screens (option D) rely on vertical or horizontal shaking. This movement can compact damp, sticky powders, worsening screen blinding.
- **Rotary Sifter Operation:**
 - A rotary sifter (centrifugal sifter) utilizes a cylindrical screen with internal, rotating paddle blades.
 - The rotating paddles exert centrifugal force, pushing the powder against the screen wall while physically breaking up soft agglomerates.

- This continuous, active shearing action prevents screen blinding and allows high-moisture, cohesive materials to be separated efficiently.

Step 3: Final Answer:

The active mechanical break-up and centrifugal action of a rotary sifter makes it the preferred equipment for sieving sticky, high-moisture powders, corresponding to option (C).

Quick Tip: For sticky, cohesive, or damp food powders (such as damp sugar or starch), a rotary sifter is preferred over vibratory shakers because its rotating internal blades actively break up agglomerates to prevent screen clogging.

57. In the HTST (High-Temperature Short-Time) pasteurization of milk, the minimum holding time of 15 seconds at 72°C is mathematically derived to ensure ____.

- (A) a 12-log reduction of *Clostridium botulinum*
- (B) a 5-log reduction of *Coxiella burnetii*
- (C) complete inactivation of Alkaline Phosphatase only
- (D) total destruction of thermophilic spores

Correct Answer: (B) a 5-log reduction of *Coxiella burnetii*

Solution:

Step 1: Understanding the Question:

The question asks for the primary microbiological target and log-reduction standard used to mathematically derive the minimum thermal process parameters (72°C for 15 seconds) for HTST pasteurization of milk.

Step 2: Key Formula or Approach:

Thermal death kinetics of microorganisms follow a first-order reaction:

$$\log\left(\frac{N_0}{N_t}\right) = \frac{t}{D}$$

where:

N_0 = initial bacterial population,

N_t = surviving population after time t ,

t = heating holding time (15 seconds),

D = decimal reduction time at 72°C for the target pathogen.

To achieve a 5-log reduction:

$$\log(10^5) = 5 \implies t = 5 \times D$$

Step 3: Detailed Explanation:

- **Target Pathogen:** *Coxiella burnetii* (the causative agent of Q-fever) is identified as the most heat-resistant, non-spore-forming pathogen commonly found in raw milk.
- **Pasteurization Standard:** To ensure public safety, thermal milk pasteurization must reduce the population of this target pathogen by at least 5 orders of magnitude (99.999% destruction or a 5-D reduction).
- **Kinetic Derivation:**
 - At 72°C, the D -value of *Coxiella burnetii* in milk is approximately 3 seconds.
 - Therefore, to achieve a safe 5-log reduction, the minimum thermal holding time must be:

$$t = 5 \times D = 5 \times 3 \text{ s} = 15 \text{ seconds}$$

- **Alkaline Phosphatase (ALP):** ALP is an endogenous milk enzyme with a heat inactivation profile slightly more stable than *Coxiella burnetii*. While its inactivation confirms successful pasteurization, it is used as a chemical indicator, not as the primary

target for microbial safety calculations.

- **12-log reduction of *C. botulinum*:** This is the target for commercial sterilization of low-acid canned foods (the "botulinum cook"), not pasteurization.

Step 4: Final Answer:

The minimum pasteurization parameters of 72°C for 15 seconds are derived to guarantee a 5-log reduction of *Coxiella burnetii*, corresponding to option (B).

Quick Tip: *Coxiella burnetii* is the most heat-resistant vegetative pathogen in raw milk. Milk pasteurization kinetics are designed to achieve a 5-log reduction (5-D kill) of this specific bacterium.

58. The Overrun in ice cream is essential for texture; it is defined as the % increase in volume due to the incorporation of ____.

- (A) sugar
- (B) fat
- (C) air
- (D) ice crystals

Correct Answer: (C) air

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific component incorporated during the freezing and whipping of ice cream mix that defines "overrun" and shapes the final product's texture.

Step 2: Key Formula or Approach:

Overrun represents the percentage increase in the volume of ice cream compared to the

volume of the original liquid mix, calculated as:

$$\text{Overrun \%} = \frac{V_{\text{ice cream}} - V_{\text{mix}}}{V_{\text{mix}}} \times 100$$

or on a mass-per-unit-volume basis:

$$\text{Overrun \%} = \frac{W_{\text{mix}} - W_{\text{ice cream}}}{W_{\text{ice cream}}} \times 100$$

where W represents the weight of a fixed-volume container of the mix or the final whipped ice cream.

Step 3: Detailed Explanation:

- **Ice Cream as a Foam:** Ice cream is a complex food colloid consisting of a frozen emulsion of fat, ice crystals, and an unfrozen sugar solution, all surrounding whipped gas cells.
- **Whipping and Air Incorporation:** During freezing inside the scraped-surface heat exchanger, the liquid ice cream mix is continuously whipped. This whipping action draws in and disperses microscopic air bubbles throughout the freezing structure.
- **Role of Overrun:** This incorporated air increases the total volume of the product, which is defined as "overrun."
 - **Sensory Impact:** Without air, frozen ice cream mix would be a solid, hard block of sweetened ice. The incorporated air cells prevent this, giving ice cream a soft, light, creamy, and scoopable texture.
 - **Standard Values:** Industrial ice creams typically have an overrun of 70% – 100%, while premium ice creams (gelato) have a much lower overrun (20% – 40%), yielding a denser texture.

Step 4: Final Answer:

Overrun is defined as the percentage increase in product volume resulting from the incorpora-

tion of air, corresponding to option (C).

Quick Tip: Overrun represents the air content in ice cream. An overrun of 100% means that one liter of liquid ice cream mix has been whipped to produce exactly two liters of finished ice cream.

59. In Food Safety, the HACCP system is primarily focused on _____.

- (A) end-product testing for quality
- (B) improving the aesthetic appeal of food
- (C) managing the marketing of food products
- (D) identifying and controlling hazards at critical points

Correct Answer: (D) identifying and controlling hazards at critical points

Solution:

Step 1: Understanding the Question:

The question asks for the primary operational focus of the Hazard Analysis Critical Control Point (HACCP) system in the food industry.

Step 2: Key Concepts and Approach:

HACCP is internationally recognized as a systematic, preventive approach to food safety. Unlike traditional quality control systems that rely on examining the finished product, HACCP targets the process itself to prevent contamination.

Step 3: Detailed Explanation:

- **Preventive Nature:** Traditional food safety models focused on "end-product testing." This reactive approach is flawed because by the time a hazard is detected, the contaminated food has already been produced, leading to product recalls or foodborne

illnesses.

- **Hazard Management:** HACCP shifts the focus to identifying potential biological, chemical, and physical hazards at every stage of the food supply chain.
By establishing Critical Control Points (CCPs), manufacturers can apply control measures to prevent, eliminate, or reduce these hazards to safe levels.
- **Systematic Framework:** The seven principles of HACCP provide a continuous monitoring system.
This includes setting critical limits, monitoring procedures, corrective actions, verification, and documentation.
- **Focus on Safety, Not Aesthetics:** While aesthetic appeal and marketing are important, they do not fall under the purview of HACCP, which is strictly concerned with human health and food safety.

Step 4: Final Answer:

Therefore, the HACCP system is primarily focused on identifying and controlling hazards at critical points.

Quick Tip: Remember that HACCP is always a preventive system, not a reactive one.
Its goal is to design safety into the process rather than trying to test safety into the final product.

60. In Sensory Evaluation, a Duo-Trio Test is classified as a _____.

- (A) Descriptive test
- (B) Affective test
- (C) Difference test
- (D) Threshold test

Correct Answer: (C) Difference test

Solution:

Step 1: Understanding the Question:

The question asks about the proper classification of the Duo-Trio test within the methods of sensory evaluation of foods.

Step 2: Key Concepts and Approach:

Sensory evaluation methods are divided into three major categories based on their objectives:

1. Difference (or Discriminative) tests, which determine if there is a detectable difference between samples.
2. Descriptive tests, which describe and quantify specific sensory attributes of a product.
3. Affective tests, which measure consumer preference, acceptance, or liking.

Step 3: Detailed Explanation:

- **Definition of Duo-Trio Test:** The Duo-Trio test is a specific discriminative method used to determine if an overall difference exists between two samples.
- **Methodology:** Panelists are presented with three samples simultaneously. One sample is marked as a Reference (R), while the other two are coded with random three-digit numbers. One of the coded samples is identical to the Reference, and the other is the test sample. Panelists are asked to identify which of the coded samples matches the Reference.
- **Statistical Basis:** Since there are only two coded options, the probability of choosing the correct sample by chance is 50% ($p = 0.5$).
- **Usage:** It is widely used in quality control to check if a change in ingredients, packaging, or processing has caused a perceptible difference in the final product.

Step 4: Final Answer:

Thus, the Duo-Trio test belongs to the category of Difference tests.

Quick Tip: Difference tests are also called discriminative tests.

The three most common difference tests are the Triangle test ($p = 1/3$), the Duo-Trio test ($p = 1/2$), and the Paired Comparison test ($p = 1/2$).

61. The Food Safety Officer (FSO) under FSSAI has the power to seize food articles. Within how many days must the sample be sent to the Food Analyst?

- (A) Immediately (Same day)
- (B) Within 7 days
- (C) Next working day
- (D) Within 14 days

Correct Answer: (C) Next working day

Solution:**Step 1: Understanding the Question:**

The question asks for the specific legal timeline mandated for a Food Safety Officer (FSO) to send a seized food sample to a Food Analyst under the Food Safety and Standards Authority of India (FSSAI) regulations.

Step 2: Key Concepts and Approach:

The Food Safety and Standards (FSS) Act, 2006, establishes strict protocols for sampling, packaging, and analysis to ensure that legal evidence is preserved and analyzed without delay.

Step 3: Detailed Explanation:

- **Duties of the FSO:** When an FSO takes a sample of any food article for analysis, or seizes suspected food, they must follow a uniform procedure to maintain the sample's integrity.
- **Splitting the Sample:** The sample is typically divided into four parts. Each part is sealed, marked, and signed by both the FSO and the food business operator (or witnesses).
- **Dispatch to the Food Analyst:** According to the FSS Rules, the FSO must send one of the sealed parts of the sample to the Food Analyst of the local area by the **next working day** after taking the sample.

This rule prevents any delay that could cause the sample to spoil or degrade, which might invalidate the test results in a court of law.
- **Analytical Report Timeline:** Once the Food Analyst receives the sample, they have 14 days to complete the analysis and issue a formal report to the Designated Officer.

Step 4: Final Answer:

The FSO must dispatch the sample to the Food Analyst by the next working day.

Quick Tip: Distinguish between the FSO's deadline to send the sample (next working day) and the Food Analyst's deadline to submit the final report (within 14 days of receipt).

62. When identifying a Critical Control Point (CCP) using a Decision Tree, what is the primary question asked to determine if a step is a CCP?

- (A) Is the hazard a biological one
- (B) Will a subsequent hazard eliminate the identified hazard
- (C) Does a hazard exist at this step
- (D) Is the step profitable for the business

Correct Answer: (B) Will a subsequent hazard eliminate the identified hazard

Solution:

Step 1: Understanding the Question:

The question relates to the application of the HACCP Decision Tree, which is a sequence of logical questions used to determine whether a process step is a Critical Control Point (CCP) for a given hazard.

Step 2: Key Concepts and Approach:

The Codex Alimentarius CCP Decision Tree asks up to four consecutive questions at each processing step where a significant hazard has been identified.

The goal is to determine if a specific step is the last place where control can be applied to keep a hazard from reaching the consumer.

Step 3: Detailed Explanation:

- **The Questions in the Decision Tree:**

- * **Question 1:** Do preventive control measures exist for the identified hazard?

- * **Question 2:** Is this step specifically designed to eliminate or reduce the likely occurrence of a hazard to an acceptable level?

- * **Question 3:** Could contamination with the identified hazard occur in excess of acceptable levels?

- * **Question 4:** Will a subsequent step or process eliminate the identified hazard or reduce its likely occurrence to an acceptable level?

- **Analysis of Option (B):** Option (B) contains a minor typographical error common in exams (using the word "hazard" instead of "step" or "process"), representing the fourth question of the decision tree.

If a subsequent step in the process (like cooking or pasteurization) will eliminate the hazard, then the current step is not a CCP

However, if no subsequent step can eliminate the hazard, then the current step is a

Critical Control Point.

- **Irrelevant Options:** Whether a hazard is biological (A), simply exists (C), or if the step is profitable (D) are not the primary qualifying questions for establishing a CCP.

Step 4: Final Answer:

The key question is whether a subsequent step/process will eliminate the identified hazard.

Quick Tip: A step is only a CCP if there is no subsequent step in the processing line that can eliminate or safely reduce the hazard.

If a subsequent cooking step kills the bacteria, then the raw handling step is usually not a CCP for that biological hazard.

63. In ISO 22000:2005, 'Interactive Communication' specifically requires the organization to communicate hazard information to _____.

- (A) Internal staff only
- (B) Shareholders and investors
- (C) Upstream suppliers and downstream customers
- (D) Only to the ISO certification body

Correct Answer: (C) Upstream suppliers and downstream customers

Solution:

Step 1: Understanding the Question:

The question asks about the requirement of "Interactive Communication" as specified in the ISO 22000:2005 standard for Food Safety Management Systems (FSMS).

Step 2: Key Concepts and Approach:

ISO 22000 emphasizes that food safety is a joint responsibility of all participants in the food chain.

Therefore, effective communication along the entire food chain is essential to ensure that hazards are identified and controlled at each step.

Step 3: Detailed Explanation:

- **Concept of Interactive Communication:** Communication must flow both upstream and downstream.

This ensures that any food safety issues or requirements are shared across different organizations in the food chain.

- **Upstream Communication:** This involves communicating with suppliers.

It ensures that raw materials supplied meet specified food safety standards and that any hazards present in raw ingredients are disclosed.

- **Downstream Communication:** This involves communicating with customers, distributors, and consumers.

It ensures that information regarding allergen content, storage conditions, and cooking instructions is clearly passed along.

- **Why Internal Communication Alone is Insufficient:** While internal communication is important, it cannot manage risks that arise before ingredients arrive or after the finished product leaves the facility.

Step 4: Final Answer:

Therefore, interactive communication is required with upstream suppliers and downstream customers.

Quick Tip: Think of the food supply chain as a chain of communication.

Interactive communication must span both backward (to suppliers) and forward (to customers) to keep the chain unbroken and secure.

64. Which section of the FSS Act, 2006 deals with the 'Penalty for manufacturing food under unsanitary conditions'?

- (A) 54
- (B) 55
- (C) 56
- (D) 57

Correct Answer: (C) 56

Solution:

Step 1: Understanding the Question:

This question tests direct knowledge of the chapters, sections, and legal penalties outlined in the Food Safety and Standards (FSS) Act, 2006 of India.

Step 2: Key Concepts and Approach:

Chapter IX of the FSS Act, 2006, contains the provisions relating to "Offences and Penalties." It defines specific fines and punishments for various violations of food safety regulations.

Step 3: Detailed Explanation:

- **Section 54:** Deals with the penalty for food containing extraneous matter.
- **Section 55:** Deals with the penalty for failure to comply with the directions of a Food Safety Officer.

- **Section 56:** Deals specifically with the **penalty for processing or manufacturing food under unsanitary or unhygienic conditions.**

Under this section, any person who manufactures or processes food under unsanitary conditions is liable to a penalty which may extend up to one lakh rupees (Rs. 1,00,000).

- **Section 57:** Deals with the penalty for possessing adulterants.

Step 4: Final Answer:

Thus, Section 56 of the FSS Act, 2006, covers the penalty for manufacturing food under unsanitary conditions.

Quick Tip: A quick way to remember the sequence of penalties:

- * Section 54: Extraneous matter
- * Section 55: Non-compliance with FSO directions
- * Section 56: Unsanitary manufacturing conditions
- * Section 57: Possession of adulterants

65. The 'Fruit Products Order' (FPO) mark was mandatory for fruit products in India until 2006. What was the specific symbol used for FPO?

- (A) A red circle in a square
- (B) A sun with a fruit basket
- (C) The letters 'FPO' inside a rectangle
- (D) An Agmark replica

Correct Answer: (C) The letters 'FPO' inside a rectangle

Solution:

Step 1: Understanding the Question:

The question asks about the graphical design of the Fruit Products Order (FPO) certification mark that was mandatory in India until 2006.

Step 2: Key Concepts and Approach:

The Fruit Products Order, 1955, was promulgated to ensure the quality and hygienic production of processed fruit and vegetable products.

With the introduction of the FSS Act in 2006, this order was merged into the unified FSSAI standards.

Step 3: Detailed Explanation:

- **The FPO Mark:** The FPO certification mark was a mandatory standard mark applied to processed fruit products sold in India, including jams, jellies, squashes, and pickles.
- **Design of the Symbol:** The mark was characterized by the capital letters "FPO" positioned inside a prominent rectangle, often accompanied by the manufacturer's license number.
- **Other Symbols:**
 - * **A red circle in a square** is the modern symbol used to designate non-vegetarian food products in India.
 - * **Agmark** is a certification mark used for agricultural products (like ghee, honey, and spices) under the Directorate of Marketing and Inspection.

Step 4: Final Answer:

Therefore, the correct symbol was the letters 'FPO' inside a rectangle, corresponding to Option (C).

Quick Tip: Historical certification marks like FPO (for fruit products) and MFPO (for meat products) are now replaced by the unified FSSAI logo, but their historical details remain common in food technology exams.

66. A packaged snack becomes rancid before expiry. Which packaging failure is most likely?

- (A) Poor oxygen barrier
- (B) Excess nitrogen flushing
- (C) High vacuum
- (D) Low humidity

Correct Answer: (A) Poor oxygen barrier

Solution:

Step 1: Understanding the Question:

The question asks about the primary cause of premature rancidity in a packaged snack food from a food packaging perspective.

Step 2: Key Concepts and Approach:

Rancidity in snack foods (which contain fats and oils) is primarily caused by lipid oxidation. Oxygen is the critical reactant required for this chemical degradation process.

Step 3: Detailed Explanation:

- **Mechanism of Rancidity:** Oxygen reacts with unsaturated fatty acids in the snack food, initiating a free-radical chain reaction. This leads to the formation of peroxides, which break down into volatile compounds like aldehydes, ketones, and acids, imparting undesirable off-flavors and off-odors (rancid smell).

- **Packaging Protection:** Highly sensitive snacks are packed using laminates with high barrier properties against light, moisture, and gases (especially oxygen).
- **Consequence of Barrier Failure:** If the package has a high oxygen transmission rate (OTR), or if there is a micro-leak in the seal, ambient oxygen will enter the package. This causes the lipid oxidation rate to increase, making the snack rancid long before its official expiration date.
- **Evaluating other options:**
 - * **Excess nitrogen flushing** would actually exclude oxygen, preventing rancidity.
 - * **High vacuum** removes oxygen and would also prevent rancidity.
 - * **Low humidity** prevents the snack from losing crispness, but does not drive oxidative rancidity.

Step 4: Final Answer:

The failure to exclude oxygen due to a poor oxygen barrier is the primary cause of early rancidity.

Quick Tip: Fats + Oxygen + Light = Oxidative Rancidity.

To protect fat-rich foods, packaging must provide an effective barrier against oxygen and light.

67. Retrogradation in starch is primarily associated with _____.

- (A) Amylopectin recrystallization
- (B) Amylose reassociation after gelatinization
- (C) Hydrolysis of starch
- (D) Formation of resistant starch only at high temperature

Correct Answer: (B) Amylose reassociation after gelatinization

Solution:

Step 1: Understanding the Question:

The question focuses on starch chemistry, specifically the structural changes that occur during starch retrogradation and the molecular component primarily responsible for it.

Step 2: Key Concepts and Approach:

Starch contains two main polysaccharides: amylose (a linear polymer of glucose) and amylopectin (a branched polymer).

When starch is heated in water, it undergoes gelatinization, where granules swell and lose their crystalline structure.

Step 3: Detailed Explanation:

- **The Process of Gelatinization:** During gelatinization, hydrogen bonds within the starch granules are broken, allowing water to enter.
Amylose molecules leach out into the surrounding aqueous phase, forming a disordered gel network.
- **The Process of Retrogradation:** As the gelatinized starch cools, the kinetic energy of the system decreases.
The linear chains of amylose begin to reassociate and align themselves parallel to each other via hydrogen bonding, reforming a more ordered, crystalline structure.
- **Why Amylose Dominated:** Because amylose is a linear molecule, it can align and recrystallize much faster and more extensively than the bulky, highly branched amylopectin.
Amylopectin recrystallization does occur, but it is a slow process taking days or weeks (associated with the staling of bread), whereas amylose retrogradation occurs rapidly upon cooling.
- **Effects of Retrogradation:** This recrystallization leads to the expulsion of water from

the starch gel, a process known as syneresis or weeping.

Step 4: Final Answer:

Therefore, retrogradation is primarily associated with amylose reassociation after gelatinization.

Quick Tip: Linear amylose is responsible for rapid retrogradation and gel formation upon cooling. Branched amylopectin recrystallizes slowly and is responsible for the long-term staling of baked products.

68. Denaturation followed by aggregation of proteins results in ____.

- (A) increased solubility
- (B) gel formation
- (C) peptide bond cleavage
- (D) increased enzymatic activity

Correct Answer: (B) gel formation

Solution:

Step 1: Understanding the Question:

The question asks about the physical result of protein denaturation followed by the cross-linking or grouping of the unfolded protein chains (aggregation).

Step 2: Key Concepts and Approach:

Proteins are folded polymers of amino acids.

Denaturation is the unfolding of the native structure (secondary, tertiary, and quaternary) without breaking the covalent peptide bonds.

Aggregation involves the interaction of these unfolded chains, driven by hydrophobic interactions, hydrogen bonding, and disulfide cross-linking.

Step 3: Detailed Explanation:

- **Unfolding of Structure:** When proteins are denatured by heat, acid, or mechanical action, hydrophobic groups that were previously buried inside the protein core are exposed.
- **Network Formation:** These newly exposed hydrophobic regions on different protein molecules begin to associate with each other to minimize contact with water.
- **Gelation:** If the protein concentration is high enough, this continuous, three-dimensional network can trap water, forming a semi-solid structure known as a gel. Examples include the boiling of egg white (ovalbumin gelation) or the coagulation of soy milk to make tofu.
- **Evaluating other options:**
 - * **Solubility** decreases during denaturation and aggregation because hydrophobic groups are exposed and molecules become too large to remain dissolved.
 - * **Peptide bond cleavage** is hydrolysis, which is distinct from denaturation.
 - * **Enzymatic activity** decreases or is lost completely because denaturation alters the shape of the enzyme's active site.

Step 4: Final Answer:

Thus, denaturation followed by aggregation of proteins results in gel formation.

Quick Tip: Protein gelation is a multi-step process: First, the protein denatures (unfolds), exposing active binding sites. Second, the molecules aggregate to build a three-dimensional network that traps water.

69. Conversion of chlorophyll to pheophytin occurs due to _____.

- (A) oxidation
- (B) acidic conditions
- (C) alkaline conditions
- (D) enzyme action

Correct Answer: (B) acidic conditions

Solution:

Step 1: Understanding the Question:

The question asks for the primary chemical factor responsible for converting green chlorophyll pigments into olive-brown pheophytin.

Step 2: Key Concepts and Approach:

Chlorophyll has a porphyrin-like ring structure containing a central magnesium (Mg^{2+}) ion. The displacement of this magnesium ion by hydrogen ions (H^+) changes the chemical structure and changes the pigment's color from bright green to olive-brown.

Step 3: Detailed Explanation:

- **Reaction Mechanism:** In the presence of acids (high concentration of H^+ ions), two hydrogen ions replace the magnesium ion in the center of the porphyrin ring.



- **Processing Effects:** During thermal processing (like canning green peas or spinach), cell walls break down, releasing organic acids from plant vacuoles. These acids lower the pH, driving the conversion of chlorophyll to pheophytin and turning the vegetables a dull olive-brown color.
- **Effect of Alkali:** In contrast, alkaline conditions help retain the magnesium ion (keeping

the bright green color by forming chlorophyllin), although it can make the vegetable texture unacceptably soft.

- **Effect of Enzymes:** Chlorophyllase removes the phytol tail to form chlorophyllide, but does not remove the magnesium ion to form pheophytin.

Step 4: Final Answer:

The conversion of chlorophyll to pheophytin is caused by acidic conditions.

Quick Tip: Acid replaces magnesium:

- * Chlorophyll + Acid → Pheophytin (Olive-brown)
- * Chlorophyll + Heat (without acid control) → color loss

70. Quinones formed during enzymatic browning react with _____.

- (A) sugars
- (B) lipids
- (C) amino acids.
- (D) minerals

Correct Answer: (C) amino acids.

Solution:

Step 1: Understanding the Question:

The question asks about the secondary chemical reaction that occurs after the enzymatic formation of quinones during the browning of bruised fruits and vegetables.

Step 2: Key Concepts and Approach:

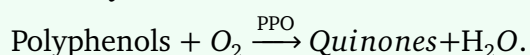
Enzymatic browning is catalyzed by polyphenol oxidase (PPO).

PPO oxidizes natural phenolic compounds into highly reactive ortho-quinones.

These quinones are unstable and undergo non-enzymatic polymerization reactions to form dark brown pigments called melanins.

Step 3: Detailed Explanation:

- **Primary Reaction:**



- **Secondary Non-Enzymatic Reactions:**

Quinones are electrophilic and react with nucleophiles present in the cell.

The primary nucleophiles in foods are the amino groups ($-\text{NH}_2$) of amino acids, peptides, and proteins.

This reaction forms substituted catechol-amino acid complexes, which then undergo further oxidation and polymerization.

- **Melanin Formation:** These complex networks form the final dark brown polymers (melanins) that appear on the surface of sliced apples, bananas, and potatoes.
- **Comparison with other components:** Sugars are involved in Maillard browning (non-enzymatic), but they do not readily react with quinones under these conditions.

Step 4: Final Answer:

Therefore, quinones formed during enzymatic browning react with amino acids.

Quick Tip: Enzymatic browning involves both enzymatic steps (monophenolase and diphenolase activities of PPO to make quinones) and non-enzymatic steps (reaction of quinones with amino acids to make brown melanins).

71. Maillard reaction rate is highest at _____.

- (A) very low pH
- (B) neutral to slightly alkaline pH
- (C) high moisture only
- (D) low temperature

Correct Answer: (B) neutral to slightly alkaline pH

Solution:

Step 1: Understanding the Question:

The question asks about the environmental conditions, specifically pH, that lead to the highest rate of the Maillard reaction.

Step 2: Key Concepts and Approach:

The Maillard reaction is a non-enzymatic browning reaction between the carbonyl group of a reducing sugar and the amino group of an amino acid or protein.

The chemical state of the amino group is highly sensitive to pH.

Step 3: Detailed Explanation:

- **State of the Amino Group:** For the reaction to initiate, the nitrogen atom on the amino group must act as a nucleophile to attack the carbonyl carbon of the sugar. This requires the amino group to be in its unprotonated form ($-NH_2$).
- **Effect of Acidic pH:** At low pH (acidic conditions), the amino groups become protonated to form ammonium ions ($-NH_3^+$). In this protonated state, the nitrogen has no free electron pair and cannot act as a nucleophile, slowing the reaction.
- **Effect of Alkaline pH:** As the pH rises to neutral or slightly alkaline levels, a larger fraction of the amino groups exist in the reactive, unprotonated form ($-NH_2$).

Alkaline conditions also favor the open-chain form of reducing sugars, making the carbonyl group more accessible.

- **Influence of Moisture and Temperature:** High moisture levels suppress the reaction by diluting reactants, and low temperatures do not provide the activation energy needed for the reaction.

Step 4: Final Answer:

Thus, the Maillard reaction rate is highest at neutral to slightly alkaline pH.

Quick Tip: To slow down Maillard browning in foods, acidify the food (lower the pH). To accelerate it (like in baking or browning pretzels), use alkaline solutions (like lye or baking soda).

72. PER is influenced most by:

- (A) Calorie intake
- (B) Protein digestibility and amino acid profile
- (C) Fat content
- (D) Mineral content

Correct Answer: (B) Protein digestibility and amino acid profile

Solution:

Step 1: Understanding the Question:

The question asks which nutritional factors have the greatest influence on the Protein Efficiency Ratio (PER) of a food protein.

Step 2: Key Concepts and Approach:

PER is a biological assay used to measure protein quality, defined as the gain in body mass of a

growing animal per gram of protein consumed:

$$\text{PER} = \frac{\text{Weight Gain (g)}}{\text{Protein Consumed (g)}}$$

The animal's ability to turn consumed protein into body tissue is determined by how complete and usable that protein is.

Step 3: Detailed Explanation:

- **Amino Acid Profile:** The body needs essential amino acids in specific proportions to build tissue.

If even one essential amino acid is missing or present in low amounts (the limiting amino acid), protein synthesis stops, reducing overall weight gain and resulting in a lower PER.

- **Protein Digestibility:** Even a protein with an ideal amino acid profile cannot be used if the body cannot digest it.
Incomplete digestion prevents the absorption of these amino acids, lowering the protein's nutritional value.

- **Standardization:** In a standard bioassay, other nutrients like fats, carbohydrates, and minerals are provided in adequate amounts so they do not limit the growth rate of the animal.

Step 4: Final Answer:

Therefore, PER is influenced most by protein digestibility and the amino acid profile.

Quick Tip: All main protein quality metrics—including PER, Biological Value (BV), Net Protein Utilization (NPU), and PDCAAS—depend on two core properties: amino acid composition and digestibility.

73. Bioavailability of iron is enhanced by _____.

- (A) Phytates
- (B) Tannins
- (C) Ascorbic acid
- (D) Oxalates

Correct Answer: (C) Ascorbic acid

Solution:

Step 1: Understanding the Question:

The question asks to identify the dietary component that increases the absorption and biological availability of iron in the human digestive system.

Step 2: Key Concepts and Approach:

Dietary iron exists in two forms: heme iron (from meat) and non-heme iron (from plant sources).

The absorption of non-heme iron (Fe^{3+}) is relatively low but can be enhanced or inhibited by other compounds in the gut.

Step 3: Detailed Explanation:

- **Action of Ascorbic Acid (Vitamin C):**

Ascorbic acid enhances non-heme iron absorption through two distinct chemical processes:

1. **Reduction:** It reduces ferric iron (Fe^{3+} , which is insoluble in the neutral pH of the small intestine) to ferrous iron (Fe^{2+} , which is soluble and readily absorbed by the body's iron transporters).
2. **Chelation:** It forms a stable, soluble chelate with iron, preventing it from binding to inhibitors or precipitating out of solution.

- **Action of Inhibitors:**

- * **Phytates** (in grains) and **Oxalates** (in green leafy vegetables like spinach) bind iron, forming insoluble complexes that the body cannot absorb.
- * **Tannins** (in tea and coffee) also bind iron tightly, reducing its absorption.

Step 4: Final Answer:

Ascorbic acid is the dietary component that enhances iron bioavailability.

Quick Tip: Consuming Vitamin C-rich foods (like citrus fruits) alongside iron-rich plant meals significantly improves the absorption of non-heme iron.

Avoid drinking tea (tannins) or eating high-phytate foods during iron-rich meals.

74. Which fatty acid has highest susceptibility to oxidation?

- (A) Stearic
- (B) Oleic
- (C) Linolenic
- (D) Palmitic

Correct Answer: (C) Linolenic

Solution:

Step 1: Understanding the Question:

The question asks which of the given fatty acids is most prone to oxidative degradation (rancidity).

Step 2: Key Concepts and Approach:

The rate of lipid oxidation depends directly on the number of double bonds (unsaturation) in the fatty acid chain.

The hydrogen atoms located on carbons adjacent to double bonds (especially the methylene carbons between two double bonds, called bis-allylic carbons) are easily abstracted by free radicals.

Step 3: Detailed Explanation:

- **Analyzing the Structures:**

- * **Palmitic Acid** (16 : 0) and **Stearic Acid** (18 : 0) are saturated fatty acids. Since they have no double bonds, they are highly stable and resistant to oxidation.

- * **Oleic Acid** (18 : 1) is a monounsaturated fatty acid with one double bond. It oxidizes slowly.

- * **Linolenic Acid** (18 : 3) is a polyunsaturated fatty acid with three double bonds.

- **Susceptibility to Oxidation:**

The presence of multiple double bonds in linolenic acid introduces highly reactive bis-allylic methylene groups.

The $C-H$ bond dissociation energy at these sites is low, making it easy for free radicals to initiate lipid peroxidation.

- **Relative Rates:** Quantitatively, the relative rate of oxidation of 18 : 1 (Oleic) : 18 : 2 (Linoleic) : 18 : 3 (Linolenic) is approximately 1 : 10 : 25.

Step 4: Final Answer:

Linolenic acid has the highest susceptibility to oxidation because of its three double bonds.

Quick Tip: The more double bonds a lipid has, the faster it will oxidize.

Saturated fats are stable at high temperatures, whereas highly unsaturated oils (like flaxseed oil, rich in linolenic acid) must be stored in cool, dark places.

75. Anti-nutritional effect of tannins is due to _____.

- (A) mineral chelation
- (B) protein binding
- (C) fat hydrolysis
- (D) sugar degradation

Correct Answer: (B) protein binding

Solution:

Step 1: Understanding the Question:

The question asks for the primary chemical mechanism underlying the anti-nutritional properties of tannins in foods.

Step 2: Key Concepts and Approach:

Tannins are water-soluble polyphenolic compounds found in many plants.

They are known for their astringency, which is caused by their high affinity for binding and precipitating macromolecules.

Step 3: Detailed Explanation:

- **Mechanism of Action:** Tannins have a high density of phenolic hydroxyl groups. These groups form strong hydrogen bonds and hydrophobic interactions with the peptide backbone and side chains of proteins.
- **Complex Formation:** This binding leads to the formation of stable, insoluble tannin-protein complexes.
- **Nutritional Impact:**
 - * This process makes dietary proteins resistant to enzymatic breakdown in the gut, reducing protein digestibility.
 - * Tannins also bind directly to and inhibit digestive enzymes (like trypsin, amylase, and

lipase) in the digestive tract, further reducing nutrient absorption.

- **Astringency Link:** This protein-binding property is also why tannins cause a dry, puckering sensation in the mouth, as they precipitate salivary proteins.

Step 4: Final Answer:

The primary anti-nutritional effect of tannins is due to protein binding.

Quick Tip: Tannins are historically used to "tan" leather by cross-linking collagen proteins to make them tough and resistant to decomposition.

This strong affinity for proteins is the same mechanism that makes them anti-nutritive in digestion.

76. Rickets results from impaired _____.

- (A) iron metabolism
- (B) calcium absorption
- (C) protein synthesis
- (D) fat digestion

Correct Answer: (B) calcium absorption

Solution:

Step 1: Understanding the Question:

The question asks for the specific physiological impairment that leads to the development of rickets in growing children.

Step 2: Key Concepts and Approach:

Rickets is a skeletal disorder characterized by soft, weak bones in children.

Normal bone development requires the continuous deposition of calcium and phosphorus into

the bone matrix (mineralization).

Step 3: Detailed Explanation:

- **Role of Vitamin D:** Vitamin D (calcitriol) is essential for the active transport and absorption of dietary calcium across the intestinal wall.
- **Impairment Mechanism:** When there is a deficiency of Vitamin D (or a genetic defect in its receptor), the active absorption of calcium in the gut is severely reduced.
- **Systemic Response:** Low blood calcium levels trigger the release of parathyroid hormone (PTH).
PTH stimulates the release of calcium from bones into the bloodstream to maintain vital functions, leading to bone demineralization.
- **Skeletal Symptoms:** As a result, the growing bones of children remain soft, leading to structural deformities like bowed legs and skeletal weakness.

Step 4: Final Answer:

Rickets directly results from impaired calcium absorption.

Quick Tip: While rickets is commonly associated with a lack of Vitamin D, the actual physical cause of the bone weakness is the resulting failure to absorb calcium.

77. Which mineral is part of hemoglobin?

- (A) Calcium
- (B) Iron
- (C) Zinc

(D) Sodium

Correct Answer: (B) Iron

Solution:

Step 1: Understanding the Question:

The question asks to identify the specific mineral that forms an integral structural component of hemoglobin, the oxygen-carrying protein in red blood cells.

Step 2: Key Concepts and Approach:

Hemoglobin is a metalloprotein containing globin proteins and heme groups.

The functional capacity of hemoglobin to bind and transport oxygen depends on the transition metal ion coordinated at its center.

Step 3: Detailed Explanation:

- **Structure of Hemoglobin:** Hemoglobin is made of four polypeptide globin chains, each containing a non-protein heme group.
- **Role of Iron:** At the center of each heme group is a single iron atom in the ferrous (Fe^{2+}) oxidation state.
- **Oxygen Binding:** This iron atom has six coordination positions. Four are bound to nitrogen atoms of the porphyrin ring, one is bound to a histidine residue of the globin protein, and the sixth is available for reversible binding with an oxygen (O_2) molecule.
- **Deficiency Outcome:** A lack of dietary iron impairs the synthesis of heme, leading to iron-deficiency anemia, characterized by microcytic, hypochromic red blood cells and reduced oxygen transport capacity.

Step 4: Final Answer:

The mineral that is part of hemoglobin is iron.

Quick Tip: The red color of blood is due to the interaction of iron with oxygen in the heme groups of hemoglobin.

Without iron, the body cannot manufacture hemoglobin, leading to anemia.

78. Essential amino acids cannot be synthesized due to _____.

- (A) lack of enzymes
- (B) lack of oxygen
- (C) lack of energy
- (D) lack of vitamins

Correct Answer: (A) lack of enzymes

Solution:**Step 1: Understanding the Question:**

The question asks why the human body cannot synthesize essential amino acids internally, requiring them to be obtained from the diet.

Step 2: Key Concepts and Approach:

Amino acids are classified as essential (must be supplied by diet) or non-essential (can be synthesized by the body).

The synthesis of any complex biological molecule requires specific biochemical pathways catalyzed by a sequence of enzymes.

Step 3: Detailed Explanation:

- **Biosynthetic Complexity:** Non-essential amino acids have relatively simple synthesis pathways, often requiring only one or two enzymatic steps from common metabolic intermediates.

Essential amino acids have highly complex, multi-step synthesis pathways, especially for constructing aromatic rings or branched carbon skeletons.

- **Evolutionary Loss of Genes:** Over evolutionary time, animal species lost the genes that encode the enzymes required to catalyze these complex pathways.

Because animals lacked these specific metabolic enzymes, they became dependent on plants and microorganisms (which still possess these enzymes) for these nutrients.

- **Resource Availability:** Cells have adequate oxygen, energy (ATP), and vitamins, but simply lack the genetic instructions and enzymes to build these specific amino acid skeletons.

Step 4: Final Answer:

The inability to synthesize essential amino acids is due to a lack of the necessary enzymes.

Quick Tip: Essential amino acids are "essential" to eat because our cells lack the DNA blueprints to make the specific enzymes needed to synthesize their carbon backbones.

79. Which vitamin deficiency causes bleeding gums?

- (A) Vitamin A
- (B) Vitamin C
- (C) Vitamin D
- (D) Vitamin B

Correct Answer: (B) Vitamin C

Solution:

Step 1: Understanding the Question:

The question asks which vitamin deficiency leads to the clinical symptom of bleeding gums.

Step 2: Key Concepts and Approach:

Bleeding gums is a classic diagnostic symptom of scurvy, which is caused by a severe deficiency of Vitamin C (ascorbic acid).

Vitamin C plays a critical role as a cofactor in the synthesis of collagen, a key structural protein.

Step 3: Detailed Explanation:

- **Collagen Synthesis role:** Collagen is the primary protein in connective tissues, providing structural strength to skin, tendons, blood vessels, and the periodontal ligaments that hold teeth in place.
- **Enzymatic Function:** Vitamin C is a required cofactor for the enzymes prolyl hydroxylase and lysyl hydroxylase.
These enzymes add hydroxyl groups to proline and lysine residues, which is necessary to stabilize collagen's triple-helix structure.
- **Pathology of Deficiency:** Without Vitamin C, the body produces weak, unstable collagen.
This leads to fragile blood vessels and weakened connective tissues.
As a result, capillaries in the gums easily rupture under minor mechanical stress (like brushing teeth), causing bleeding gums and loose teeth.

Step 4: Final Answer:

Therefore, a deficiency of Vitamin C is the cause of bleeding gums.

Quick Tip: Vitamin C = Collagen Stability.

Deficient Vitamin C → Weak Collagen → Fragile blood vessels → Bleeding gums (Scurvy).

80. Lag phase represents:

- (A) Cell death
- (B) Adaptation phase
- (C) Maximum growth
- (D) Stationary phase

Correct Answer: (B) Adaptation phase

Solution:

Step 1: Understanding the Question:

The question asks for the biological definition and significance of the "lag phase" in the context of a typical bacterial growth curve.

Step 2: Key Concepts and Approach:

A standard bacterial growth curve consists of four distinct sequential phases:

1. Lag Phase
2. Log (Exponential) Phase
3. Stationary Phase
4. Death (Decline) Phase

Step 3: Detailed Explanation:

- **Characteristics of the Lag Phase:** When microorganisms are inoculated into a fresh nutrient medium, there is no immediate increase in cell number. This period of dormancy in terms of cell division is known as the lag phase.

- **Physiological Adaptation:** Although cells are not dividing, they are biochemically highly active.

During this phase, the microbes adapt to their new physical and chemical environment. They synthesize essential proteins, enzymes, coenzymes, and structural components required for rapid division.

- **Factors Influencing Duration:** The length of the lag phase depends on the age and condition of the inoculum, the nature of the medium, and temperature.

If the cells are transferred from a chemically identical medium, the lag phase is short; if transferred from a different or nutrient-poor medium, the adaptation period is significantly longer.

Step 4: Final Answer:

Therefore, the lag phase represents the adaptation phase of microbial growth, corresponding to Option (B).

Quick Tip: In the lag phase, the growth rate is zero, but metabolic activity is extremely high as cells prepare for the rapid division of the log phase.

81. Clostridium botulinum grows best in:

- (A) Aerobic acidic foods
- (B) Anaerobic low-acid foods
- (C) High sugar foods
- (D) Frozen foods

Correct Answer: (B) Anaerobic low-acid foods

Solution:

Step 1: Understanding the Question:

The question asks for the optimal environmental conditions under which the foodborne pathogen *Clostridium botulinum* can grow and proliferate.

Step 2: Key Concepts and Approach:

Clostridium botulinum is a gram-positive, rod-shaped, spore-forming bacterium.

Its growth characteristics are defined by its oxygen requirements and the acidity limits of its environment.

Step 3: Detailed Explanation:

- **Oxygen Requirement:** *Clostridium botulinum* is an obligate anaerobe, meaning it can only grow in environments devoid of molecular oxygen.
Oxygen is toxic to its active vegetative cells, though its spores can survive in aerobic conditions.
- **Acidity Limits:** In food science, foods are classified based on pH.
Low-acid foods are defined as those with a pH greater than 4.6.
Clostridium botulinum cannot grow or produce its deadly neurotoxin in highly acidic environments where the pH is below 4.6.
Therefore, low-acid foods ($\text{pH} > 4.6$) provide the ideal growth medium.
- **Common Risk Environments:** Vacuum-sealed packages, canned vegetables, meats, and processed fish represent typical anaerobic, low-acid environments where this pathogen poses a major hazard.

Step 4: Final Answer:

Thus, *Clostridium botulinum* grows best in anaerobic low-acid foods, matching Option (B).

Quick Tip: The "critical pH limit" for *Clostridium botulinum* is 4.6.

Any canned food with a pH above 4.6 must undergo a severe thermal process (the "botulinum cook") to ensure safety.

82. Thermophilic bacteria grow best at _____.

- (A) $< 10^{\circ}\text{C}$
- (B) 20°C
- (C) $45\text{--}70^{\circ}\text{C}$
- (D) 100°C

Correct Answer: (C) $45\text{--}70^{\circ}\text{C}$

Solution:

Step 1: Understanding the Question:

The question asks to identify the optimal temperature range for the growth of thermophilic bacteria.

Step 2: Key Concepts and Approach:

Bacteria are classified into groups based on their preferred growth temperatures:

1. Psychrophiles: Grow best at cold temperatures (typically $< 15^{\circ}\text{C}$).
2. Mesophiles: Grow best at moderate temperatures (typically $20\text{--}45^{\circ}\text{C}$).
3. Thermophiles: Grow best at high temperatures.
4. Hyperthermophiles: Grow best at extremely high temperatures ($> 80^{\circ}\text{C}$).

Step 3: Detailed Explanation:

- **Thermophiles:** The term "thermophile" is derived from Greek words meaning "heat-loving."

These organisms possess specialized enzymes and membrane lipids that remain stable and functional at elevated temperatures.

- **Growth Range:** Thermophilic bacteria generally have an optimum growth temperature between 45°C and 70°C.

They are commonly found in hot springs, compost heaps, and are of concern in dairy pasteurization and canning processes if cooling is inadequate.

- **Other Ranges:** Temperatures below 20°C favor psychrophiles and psychrotrophs, while 100°C is lethal to almost all vegetative bacterial cells, though some hyperthermophiles can survive near boiling points in deep-sea vents.

Step 4: Final Answer:

Therefore, thermophilic bacteria grow best at 45–70°C, corresponding to Option (C).

Quick Tip: Remember these standard ranges:

- * Psychrophiles: < 15°C
- * Mesophiles: 20–45°C
- * Thermophiles: 45–70°C

83. Listeria is dangerous because it:

- (A) Produces spores
- (B) Grows at refrigeration temperature
- (C) Requires oxygen
- (D) Is heat resistant

Correct Answer: (B) Grows at refrigeration temperature

Solution:

Step 1: Understanding the Question:

The question asks why the foodborne pathogen *Listeria* (specifically *Listeria monocytogenes*) is particularly dangerous in food processing and preservation.

Step 2: Key Concepts and Approach:

Refrigeration is a primary method used to extend the shelf life of perishable foods by slowing microbial growth.

Pathogens that can bypass this cold hurdle are of serious concern to food safety.

Step 3: Detailed Explanation:

- **Psychrotrophic Nature:** *Listeria monocytogenes* is a psychrotrophic bacterium. Unlike most foodborne pathogens (like *Salmonella* or *E. coli*), which stop growing at temperatures below 4°C, *Listeria* can actively multiply at refrigeration temperatures (0–4°C).
- **Risk in Ready-to-Eat Foods:** This capability makes it dangerous in refrigerated, ready-to-eat foods such as deli meats, soft cheeses, and unpasteurized milk. Even if initial contamination levels are low, long-term cold storage allows the population to rise to dangerous levels.
- **Other Characteristics:** *Listeria* is non-spore-forming and is easily killed by standard pasteurization temperatures, meaning it is not highly heat-resistant. It is a facultative anaerobe, meaning it can grow with or without oxygen.

Step 4: Final Answer:

Listeria is dangerous because it grows at refrigeration temperature, matching Option (B).

Quick Tip: *Listeria monocytogenes* is the classic "refrigerator pathogen."

Regular sanitation and strict shelf-life controls for chilled, ready-to-eat foods are critical to prevent listeriosis.

84. Fermentation improves food by:

- (A) Increasing spoilage
- (B) Enhancing shelf life and flavor
- (C) Reducing nutrients
- (D) Increasing toxins

Correct Answer: (B) Enhancing shelf life and flavor

Solution:

Step 1: Understanding the Question:

The question asks for the beneficial impacts of fermentation on food products.

Step 2: Key Concepts and Approach:

Fermentation is a metabolic process where microorganisms (such as bacteria, yeasts, or molds) convert carbohydrates into alcohols, organic acids, or gases under anaerobic or microaerophilic conditions.

Step 3: Detailed Explanation:

- **Preservation and Shelf Life:** During fermentation, microorganisms produce organic acids (such as lactic acid or acetic acid) and ethanol. These compounds lower the pH of the food, creating a hostile environment for spoilage bacteria and pathogens, thereby extending shelf life.
- **Flavor and Sensory Attributes:** Fermentation generates volatile compounds, esters, and organic acids that impart distinct, desirable flavors, aromas, and textures to foods (e.g., yogurt, cheese, sourdough bread, sauerkraut).
- **Nutritional Enhancement:** Rather than reducing nutrients, fermentation often increases the bioavailability of vitamins and minerals.

It also helps degrade anti-nutritional factors like phytates and tannins.

Step 4: Final Answer:

Fermentation improves food by enhancing shelf life and flavor, corresponding to Option (B).

Quick Tip: Fermentation is one of the oldest biopreservation methods.

It simultaneously preserves food by lowering pH and improves its sensory profile through flavor synthesis.

85. Which factor most influences microbial heat resistance?

- (A) Oxygen
- (B) Water activity
- (C) pH
- (D) Spore formation

Correct Answer: (D) Spore formation

Solution:

Step 1: Understanding the Question:

The question asks which biological factor or state has the most significant impact on a microorganism's ability to withstand thermal processing.

Step 2: Key Concepts and Approach:

Microorganisms can exist in two primary states: vegetative cells (actively growing and metabolic) and spores (dormant and protective).

The structural differences between these states govern their relative heat resistance.

Step 3: Detailed Explanation:

- **Spore Formation:** Certain bacterial genera, such as *Bacillus* and *Clostridium*, produce endospores in response to environmental stress.
These endospores have a thick outer coat, a peptidoglycan cortex, and a highly dehydrated core containing calcium dipicolinate.
- **Comparison of Resistance:**
 - * Vegetative cells are typically destroyed at temperatures of 60–80°C within a few minutes.
 - * In contrast, bacterial endospores can survive boiling water (100°C) for hours and require pressurized steam sterilization (121°C) to be destroyed.
- **Influence of environmental factors:** While pH, water activity, and oxygen do influence heat resistance to some extent, the physiological state of being a spore is the single most dominant factor determining survival at high temperatures.

Step 4: Final Answer:

Therefore, the factor that most influences microbial heat resistance is spore formation, matching Option (D).

Quick Tip: Bacterial endospores are the most heat-resistant biological structures known. Sterilization calculations in canning are always designed around destroying these highly resistant spores.

86. Which microorganism produces heat-stable enterotoxin?

- (A) *Salmonella*
- (B) *Clostridium*
- (C) *Staphylococcus aureus*
- (D) *Listeria*

Correct Answer: (C) *Staphylococcus aureus*

Solution:

Step 1: Understanding the Question:

The question asks to identify the foodborne pathogen that produces a toxin capable of surviving standard cooking temperatures (heat-stable enterotoxin).

Step 2: Key Concepts and Approach:

Foodborne illnesses can be infections (caused by ingesting live bacteria) or intoxications (caused by consuming pre-formed toxins in the food).

If a toxin is heat-stable, heating the food prior to consumption may kill the bacteria but will not deactivate the toxin.

Step 3: Detailed Explanation:

- **Staphylococcal Food Intoxication:** *Staphylococcus aureus* is a common bacterium found on human skin and nasal passages.
If allowed to grow in food, it produces enterotoxins.
- **Heat Stability of the Toxin:** These enterotoxins are highly resistant to heat, low pH, and digestive enzymes.
They can withstand boiling temperatures (100°C) for up to 30 minutes.
Standard cooking or pasteurization processes will kill the vegetative cells of *S. aureus* but leave the enterotoxin intact, leading to rapid-onset food poisoning (vomiting, abdominal cramps).
- **Other pathogens:** *Salmonella* and *Listeria* cause food infections and do not produce heat-stable enterotoxins of this nature.

Step 4: Final Answer:

The microorganism that produces heat-stable enterotoxin is *Staphylococcus aureus*, which is

Option (C).

Quick Tip: Reheating spoiled food will not make it safe if *Staphylococcus aureus* has already grown in it, because its enterotoxin is highly heat-stable.

87. Which food is most prone to *Clostridium* growth?

- (A) Fruit juice
- (B) Canned low-acid food
- (C) Dry cereals
- (D) Pickles

Correct Answer: (B) Canned low-acid food

Solution:

Step 1: Understanding the Question:

The question asks which food type is most vulnerable to the growth of *Clostridium* species, particularly the anaerobic spore-former *Clostridium botulinum*.

Step 2: Key Concepts and Approach:

Clostridium botulinum requires specific environmental conditions to germinate and grow:

1. Absence of oxygen (anaerobic environment)
2. Low acidity (pH > 4.6)
3. High moisture (high water activity)

Step 3: Detailed Explanation:

- **Canning Process:** The canning process involves sealing food in airtight containers, which creates an anaerobic environment.

- **Low-Acid Foods:** Foods like green beans, corn, meats, and seafood have a pH above 4.6 (low-acid).

If these foods are canned without sufficient high-pressure heat treatment to destroy *Clostridium* spores, the spores will germinate in the anaerobic environment, grow, and produce dangerous toxins.

- **Why other options are less prone:**

- * **Fruit juices** and **pickles** are highly acidic ($\text{pH} < 4.6$), which naturally prevents *Clostridium* growth.

- * **Dry cereals** have low water activity, which stops all microbial growth.

Step 4: Final Answer:

Therefore, canned low-acid foods are most prone to *Clostridium* growth, matching Option (B).

Quick Tip: Canned meats and vegetables are low-acid and anaerobic, making them the classic high-risk foods for botulism.

They must be processed in a pressure canner (retort) to reach temperatures above 121°C .

88. Which microorganism is used in vinegar production?

- (A) Yeast
- (B) Lactobacillus
- (C) Acetobacter
- (D) Mold

Correct Answer: (C) Acetobacter

Solution:

Step 1: Understanding the Question:

The question asks to identify the genus of microorganisms responsible for the biological conversion of alcohol into vinegar (acetic acid).

Step 2: Key Concepts and Approach:

Vinegar production is a two-step biochemical process:

1. Anaerobic fermentation of sugars to ethanol by yeast.
2. Aerobic oxidation of ethanol to acetic acid by acetic acid bacteria.

Step 3: Detailed Explanation:

- **Role of Acetobacter:** Species of the genus *Acetobacter* (such as *Acetobacter aceti*) are obligate aerobes that utilize oxygen to convert ethanol into acetic acid.



- **Industrial Application:** This group of bacteria is utilized in various vinegar production methods, including the slow Orleans process, the generator method, and modern submerged fermenters.
- **Other options:** Yeast is used in the initial sugar-to-alcohol step, but not for the final acetic acid step.

Lactobacillus produces lactic acid, which is used in yogurt and pickles, not vinegar.

Step 4: Final Answer:

The microorganism used in vinegar production is *Acetobacter*, which is Option (C).

Quick Tip: Vinegar is essentially diluted acetic acid.

The prefix "Aceto-" in *Acetobacter* directly links it to the production of acetic acid.

89. Which condition reduces microbial growth most effectively?

- (A) High water activity
- (B) Low temperature + low aw
- (C) Neutral pH
- (D) Oxygen presence

Correct Answer: (B) Low temperature + low aw

Solution:

Step 1: Understanding the Question:

The question asks which combination of environmental parameters is most effective at inhibiting and reducing microbial growth in food systems.

Step 2: Key Concepts and Approach:

This question relates to Hurdle Technology, which involves combining multiple preservation factors (hurdles) to control microbial growth.

Using multiple hurdles together often produces a synergistic effect that is more effective than using any single method alone.

Step 3: Detailed Explanation:

- **Analyzing the Hurdles:**

- * **Low Temperature:** Slows down enzymatic activity and cellular metabolism, extending the lag phase of microbes.

- * **Low Water Activity (a_w):** Dehydrates microbial cells by osmosis, preventing metabolic reactions and cell division.

- **Synergistic Effect:** When low temperature and low water activity are combined, they act together to create a highly restrictive environment.
Most bacteria, yeasts, and molds are unable to overcome both hurdles simultaneously, leading to effective preservation.
- **Ineffective Options:** High water activity, neutral pH, and the presence of oxygen generally promote the growth of most common spoilage organisms and pathogens.

Step 4: Final Answer:

The combination of low temperature and low water activity is the most effective condition, corresponding to Option (B).

Quick Tip: Hurdle technology relies on the synergistic effect of combining physical and chemical barriers (like low temp, low pH, and low a_w) to preserve food safely.

90. Which organism is psychrotrophic?

- (A) Salmonella
- (B) Listeria
- (C) Bacillus
- (D) Clostridium

Correct Answer: (B) Listeria

Solution:

Step 1: Understanding the Question:

The question asks to identify which of the listed bacterial genera is classified as psychrotrophic (capable of growing at low/refrigeration temperatures).

Step 2: Key Concepts and Approach:

Psychrotrophic organisms are mesophilic microbes that have adapted to grow at cold temperatures (0–7°C), although their optimal growth temperature is higher (20–30°C). These organisms are a major concern in the storage of chilled and refrigerated foods.

Step 3: Detailed Explanation:

- **Psychrotrophic Pathogens:** *Listeria monocytogenes* is a prominent foodborne pathogen with psychrotrophic capabilities.
It can survive and multiply in refrigerated facilities, on processing equipment, and within packaged food items stored under cold conditions.
- **Clinical Impact:** This ability to grow at low temperatures allows *Listeria* to reach infectious doses in ready-to-eat foods over normal storage periods, posing a severe threat to pregnant women, newborns, and immunocompromised individuals.
- **Other Organisms:** Most strains of *Salmonella*, *Bacillus*, and *Clostridium* are mesophilic or thermophilic, requiring warmer temperatures to grow.

Step 4: Final Answer:

Thus, *Listeria* is the psychrotrophic organism among the choices, matching Option (B).

Quick Tip: *Listeria* is the classic example of a psychrotrophic foodborne pathogen. Always assume that cold storage alone is not sufficient to control this organism.

91. Which preservation method uses beneficial microbes?

- (A) Sterilization
- (B) Fermentation

- (C) Drying
- (D) Freezing

Correct Answer: (B) Fermentation

Solution:

Step 1: Understanding the Question:

The question asks which food preservation method relies on the active, controlled growth of helpful microorganisms.

Step 2: Key Concepts and Approach:

Most preservation methods focus on killing or inhibiting microorganisms to prevent spoilage (physical/thermal methods).

In contrast, some methods use controlled microbial growth to outcompete spoilage organisms and preserve the food.

Step 3: Detailed Explanation:

- **Fermentation as Preservation:** Fermentation uses beneficial microbes (like lactic acid bacteria, yeasts, and molds) to preserve food.
These microbes consume available sugars and produce organic acids, alcohol, and antimicrobial compounds (like bacteriocins).
- **Inhibition of Spoilage:** These metabolic products lower the pH of the food, creating an environment that inhibits the growth of pathogens and spoilage organisms.
Examples include converting milk into yogurt/cheese or cabbage into sauerkraut.
- **Physical Preservation Methods:** Sterilization, drying, and freezing are physical methods that preserve food by destroying microbes or rendering them inactive, without utilizing biological activity.

Step 4: Final Answer:

Therefore, fermentation is the preservation method that uses beneficial microbes, corresponding to Option (B).

Quick Tip: Fermentation is a form of biological preservation.

Instead of eliminating all life (like sterilization), it encourages the growth of "good" microbes to keep out the "bad" ones.

92. Which process reduces enzymatic activity in vegetables before freezing?

- (A) Fermentation
- (B) Blanching
- (C) Drying
- (D) Smoking

Correct Answer: (B) Blanching

Solution:

Step 1: Understanding the Question:

The question asks for the thermal pretreatment step applied to vegetables prior to freezing to deactivate natural enzymes.

Step 2: Key Concepts and Approach:

Freezing slows down physical and chemical changes in food, but it does not completely stop enzyme activity.

If vegetables are frozen raw, endogenous enzymes (such as peroxidase and catalase) will continue to cause browning, loss of vitamins, and off-flavors during frozen storage.

Step 3: Detailed Explanation:

- **The Blanching Process:** Blanching is a short thermal treatment where vegetables are exposed to boiling water or steam for a brief period (typically 1 to 10 minutes) and then rapidly cooled.
- **Enzyme Inactivation:** The primary goal of blanching is to denature and inactivate enzymes like polyphenol oxidase, peroxidase, and lipoxygenase. Inactivating these enzymes preserves the natural color, flavor, and nutritional value of the vegetables during long-term frozen storage.
- **Additional Benefits:** Blanching also wilts the product (making it easier to pack), removes air from tissues, and reduces the initial microbial load on the surface of the vegetables.

Step 4: Final Answer:

The process that reduces enzymatic activity in vegetables before freezing is blanching, which is Option (B).

Quick Tip: Blanching is an essential pretreatment for almost all frozen vegetables.

Peroxidase is often used as an indicator enzyme to verify if the blanching process was successful, as it is one of the most heat-resistant enzymes in plants.

93. Homogenization improves:

- (A) Shelf life only
- (B) Emulsion stability
- (C) Protein content
- (D) Sugar level

Correct Answer: (B) Emulsion stability

Solution:

Step 1: Understanding the Question:

The question asks about the primary physical property of liquid foods (like milk) that is improved by the process of homogenization.

Step 2: Key Concepts and Approach:

Milk is an oil-in-water emulsion where fat globules are suspended in an aqueous phase. Because fat is less dense than water, these globules naturally tend to rise to the surface over time, a process known as creaming.

Step 3: Detailed Explanation:

- **Stokes' Law of Creaming:**

The velocity of creaming (v) is governed by Stokes' Law:

$$v = \frac{2gr^2(\rho_p - \rho_f)}{9\eta}$$

where r is the radius of the fat globule, ρ represents densities, and η is the viscosity. Reducing the radius (r) of the fat globules significantly reduces the rate of creaming.

- **Mechanism of Homogenization:** Homogenization passes milk under high pressure through a small valve.

This subjects the fat globules to high shear, turbulence, and cavitation, breaking them down from an average size of 3–4 μm to less than 1 μm .

- **Resulting Stability:** The smaller size of the fat globules increases the surface area and allows them to remain suspended, improving the stability of the emulsion and preventing cream separation.

It does not alter the protein content or sugar level of the food.

Step 4: Final Answer:

Therefore, homogenization improves emulsion stability, corresponding to Option (B).

Quick Tip: Homogenization uses high pressure to break up fat globules.

According to Stokes' Law, smaller particles cream much slower, which physically stabilizes the emulsion.

94. Jam setting depends on:

- (A) Sugar-acid-pectin balance
- (B) Pectin %
- (C) Protein %
- (D) Sugar %

Correct Answer: (A) Sugar-acid-pectin balance

Solution:

Step 1: Understanding the Question:

The question asks for the critical chemical parameters required for a jam to set and form a stable gel.

Step 2: Key Concepts and Approach:

The gelation of high-methoxyl pectin (the type traditionally used in jams) requires a precise chemical environment.

A stable gel network will not form if any of the key components—pectin, sugar, or acid—are out of balance.

Step 3: Detailed Explanation:

- **Role of Pectin:** Pectin molecules are structural polysaccharides that form the backbone of the gel network.

Normally, negative charges on pectin molecules cause them to repel one another, keeping them dissolved in solution.

- **Role of Acid (pH):** Adding acid lowers the pH (ideally to 3.0–3.5).

This protonates the carboxyl groups on the pectin molecules, reducing their negative charge and minimizing electrostatic repulsion so they can associate.

- **Role of Sugar (TSS):** Sugar acts as a dehydrating agent.

It binds water molecules, reducing the hydration of the pectin chains and forcing them to interact with each other to form a three-dimensional gel network.

Jams typically require a minimum Total Soluble Solids (TSS) of 65-68% to set properly.

- **Interdependence:** Focusing on only one component (like pectin % or sugar % alone) is insufficient, as gelation is dependent on the correct balance of all three parameters.

Step 4: Final Answer:

Thus, jam setting depends on the sugar-acid-pectin balance, matching Option (A).

Quick Tip: The "golden ratio" for traditional jam gelation is:

- * Sugar: $\approx 65\%$ TSS
- * Acid: pH 3.0–3.5
- * Pectin: $\approx 0.5\text{--}1.0\%$

95. Which cereal has highest protein content?

- (A) Rice
- (B) Wheat
- (C) Maize
- (D) Oats

Correct Answer: (D) Oats

Solution:

Step 1: Understanding the Question:

The question asks to identify which of the common cereal grains has the highest protein content by weight.

Step 2: Key Concepts and Approach:

Cereals are primarily consumed as sources of dietary carbohydrates (starch).

However, they also contain varying amounts of protein, and their protein profiles and concentrations differ significantly by species.

Step 3: Detailed Explanation:

- **Comparing Protein Contents:**

- * **Rice:** Typically contains the lowest protein content among common cereals, averaging about 6–8%.

- * **Maize:** Contains approximately 8–10% protein, with zein being the primary storage protein.

- * **Wheat:** Contains about 10–13% protein, which is essential for gluten formation in baking.

- * **Oats:** Typically contains the highest protein content among these cereals, ranging from 13–17%.

- **Oat Protein Quality:** In addition to quantity, the protein profile of oats is unique.

While most cereals store proteins as prolamin-type proteins, oats store their protein primarily as globulins (avenalins), which have a more balanced amino acid profile and higher nutritional value.

Step 4: Final Answer:

Oats have the highest protein content among the listed cereals, corresponding to Option (D).

Quick Tip: Oats are a highly nutritious cereal grain, notable for having both the highest protein and highest fat content among common cereals.

96. Which oilseed has highest unsaturated fat?

- (A) Coconut
- (B) Groundnut
- (C) Sunflower
- (D) Palm

Correct Answer: (C) Sunflower

Solution:

Step 1: Understanding the Question:

The question asks which of the given oilseeds yields an oil with the highest proportion of unsaturated fatty acids relative to saturated fatty acids.

Step 2: Key Concepts and Approach:

Fats and oils are composed of triglycerides containing saturated, monounsaturated, and polyunsaturated fatty acids.

Oils with high levels of double bonds are classified as highly unsaturated and typically remain liquid at room temperature.

Step 3: Detailed Explanation:

- **Analyzing the Fatty Acid Profiles:**

- * **Coconut:** Highly saturated (about 85–90% saturated fat, primarily lauric acid). It is a solid or semi-solid fat at room temperature.

- * **Palm Oil:** Semi-solid fat containing roughly equal amounts of saturated fat (50%,

mostly palmitic acid) and unsaturated fat (40% oleic acid).

* **Groundnut (Peanut):** Contains about 80% unsaturated fat (mostly oleic and linoleic acids) and 20% saturated fat.

* **Sunflower:** Contains the highest level of unsaturated fatty acids among these options, typically exceeding 85–90%.

It is especially rich in polyunsaturated linoleic acid (C18 : 2), which can make up over 60–70% of the oil, along with monounsaturated oleic acid (C18 : 1).

Step 4: Final Answer:

Sunflower has the highest proportion of unsaturated fat among the options, corresponding to Option (C).

Quick Tip: Liquid vegetable oils derived from seeds (like sunflower and safflower) are highly unsaturated, whereas tropical oils (like coconut and palm) are highly saturated.

97. HACCP is primarily:

- (A) Reactive system
- (B) Preventive system
- (C) Testing system
- (D) Packaging system

Correct Answer: (B) Preventive system

Solution:

Step 1: Understanding the Question:

The question asks for the primary operational nature of the Hazard Analysis Critical Control Point (HACCP) system in the food industry.

Step 2: Key Concepts and Approach:

HACCP is a structured, internationally recognized approach to food safety management.

It is designed to identify, assess, and control biological, chemical, and physical hazards throughout the food production process.

Step 3: Detailed Explanation:

- **Preventive Design:** The core philosophy of HACCP is prevention rather than detection. Instead of relying on testing finished food products for contamination (a reactive system), HACCP designs safety measures directly into the manufacturing process.
- **In-process Control:** By identifying potential hazards and establishing Critical Control Points (CCPs), operators can monitor and control key parameters (such as cooking temperatures, chilling times, and metal detection) in real time.
This preventively stops contaminated products from being produced or distributed.
- **Efficiency:** This approach is more reliable and cost-effective than relying on end-product testing, which cannot guarantee 100% safety without destroying the entire batch of food.

Step 4: Final Answer:

Therefore, HACCP is primarily a preventive system, matching Option (B).

Quick Tip: HACCP = Prevention.

Its primary goal is to prevent food safety hazards from occurring, rather than finding them after the food has already been processed and packaged.

98. Triangle test identifies:

(A) Preference

- (B) Differences
- (C) Quality
- (D) Nutrition

Correct Answer: (B) Differences

Solution:

Step 1: Understanding the Question:

The question asks what type of information or sensory attribute the Triangle test is designed to measure.

Step 2: Key Concepts and Approach:

Sensory evaluation tests are categorized by their analytical objectives.

The Triangle test is one of the most common discriminative sensory tests used in food research and quality control.

Step 3: Detailed Explanation:

- **The Triangle Test Method:** In a Triangle test, panelists are presented with three coded samples simultaneously.
Two of the samples are identical, and one is different.
The panelists are asked to taste the samples and identify the "odd" or different sample.
- **Purpose:** The objective of the test is to determine if a perceptible sensory difference exists between two products.
It is used to check if changes in ingredients, processing conditions, or packaging have caused a noticeable difference in the final product.
- **What it does not measure:** It does not measure consumer preference (which sample is liked better) or describe specific quality or nutritional attributes.
It simply determines if a detectable difference exists between the samples.

Step 4: Final Answer:

The Triangle test identifies overall sensory differences, corresponding to Option (B).

Quick Tip: The Triangle test is a discriminative (difference) test with a guessing probability of $1/3$ (33.3%).

It is used to find out if two products are perceptibly different, without asking which one is preferred.

99. In food processing, tomato ketchup exhibits which type of non-Newtonian flow behaviour?

- (A) Dilatant
- (B) Bingham plastic
- (C) Pseudoplastic (shear-thinning)
- (D) Newtonian

Correct Answer: (C) Pseudoplastic (shear-thinning)

Solution:**Step 1: Understanding the Question:**

The question asks for the rheological classification of tomato ketchup, specifically which non-Newtonian flow behavior it demonstrates during processing and handling.

Step 2: Key Concepts and Approach:

Fluid foods are classified based on how their viscosity changes in response to an applied shear stress (force):

1. Newtonian: Viscosity remains constant regardless of the shear rate (e.g., water, clear fruit juices).
2. Non-Newtonian: Viscosity changes as shear rate changes.
3. Pseudoplastic (Shear-thinning): Viscosity decreases as the shear rate increases.
4. Dilatant (Shear-thickening): Viscosity increases as the shear rate increases.

Step 3: Detailed Explanation:

- **Behavior of Ketchup:** Tomato ketchup is a complex suspension of insoluble tomato solids and polymers in an aqueous phase.
When stationary inside a bottle, it has a high viscosity and resists pouring.
- **Effect of Shear:** Shaking or squeezing the bottle applies a shear force to the ketchup. This force aligns the suspended particles and polymer chains parallel to the direction of flow, reducing friction.
As a result, the viscosity of the ketchup decreases, allowing it to flow easily out of the bottle.
This reversible drop in viscosity under shear is the definition of pseudoplastic (shear-thinning) behavior.

Step 4: Final Answer:

Therefore, tomato ketchup exhibits pseudoplastic (shear-thinning) behavior, matching Option (C).

Quick Tip: "Shear-thinning" means that applying force (shaking, pumping, or stirring) thins the fluid, making it flow more easily.

Ketchup is the classic household example of a pseudoplastic fluid.

100. Which flow-measurement device works on the principle of differential pressure created by a constriction in the pipe?

- (A) Rotameter
- (B) Venturi-meter
- (C) Turbine flow meter
- (D) Magnetic flow meter

Correct Answer: (B) Venturi-meter

Solution:

Step 1: Understanding the Question:

The question asks to identify the flow-measurement device that operates by measuring the difference in fluid pressure caused by a physical constriction inside a pipe.

Step 2: Key Concepts and Approach:

This device relies on the Venturi effect and Bernoulli's principle of fluid dynamics.

When fluid flows through a constricted section of a pipe, its velocity increases, which causes a corresponding decrease in static pressure.

By measuring this pressure difference, the fluid's flow rate can be calculated.

Step 3: Detailed Explanation:

- **Design of the Venturi-meter:** A Venturi-meter consists of a converging section, a narrow throat (the constriction), and a diverging section.
- **Operating Principle:** As fluid enters the converging cone and passes through the throat, the cross-sectional area decreases, forcing the fluid velocity to increase.

According to Bernoulli's equation:

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

The increase in velocity ($v_2 > v_1$) results in a drop in pressure ($P_2 < P_1$) at the throat.

The pressure difference ($P_1 - P_2$) is measured using a manometer or differential pressure transducer to determine the volumetric flow rate.

- **Other Devices:**
 - * A **Rotameter** is a variable-area flow meter.
 - * A **Turbine flow meter** uses a mechanical rotor.
 - * A **Magnetic flow meter** operates on Faraday's Law of electromagnetic induction.

Step 4: Final Answer:

Therefore, the device that works on the principle of differential pressure created by a constriction is the Venturi-meter, corresponding to Option (B).

Quick Tip: Obstruction flow meters like the Venturi-meter, Orifice plate, and Flow nozzle all use a constriction to create a pressure drop, which is used to calculate the flow rate.

101. In food industry CIP (Clean-In-Place) systems, which type of compressor is commonly used for supplying process air?

- (A) Reciprocating compressor
- (B) Screw compressor
- (C) Centrifugal blower
- (D) Vane compressor

Correct Answer: (C) Centrifugal blower

Solution:**Step 1: Understanding the Question:**

The question asks for the type of air-supplying device or compressor that is commonly integrated into food-grade Clean-In-Place (CIP) systems to provide process air.

Step 2: Key Formula or Approach:

Process air used in CIP operations is primarily required for blowing out pipes, purging residual liquid, or drying lines.

The equipment must supply a large volume of air at moderate pressures while ensuring the air is completely oil-free to avoid contamination of food-contact surfaces.

Step 3: Detailed Explanation:

- In food-processing CIP operations, the process air must meet stringent hygiene standards and remain free of compressor lubricants (oil-free air).
- Centrifugal blowers utilize dynamic compression and do not require oil-lubrication inside the compression chamber, ensuring the delivery of clean, contaminant-free air.
- These blowers provide high-volume flow rates at relatively low pressures, which is highly efficient for liquid displacement and pipe purging.
- In contrast, reciprocating, screw, and vane compressors typically operate at higher pressures and require internal oil lubrication, necessitating complex filtration systems to mitigate oil contamination risks.

Step 4: Final Answer:

Therefore, the centrifugal blower is the most suitable choice for supplying process air in CIP systems.

Quick Tip: For clean room or aseptic food processing, always specify centrifugal or rotary lobe systems that require no oil lubrication in the process pathway.

102. Which law governs radiation heat transfer, relating emissive power to the fourth power of absolute temperature?

- (A) Newton's Law of Cooling
- (B) Fick's Second Law
- (C) Stefan-Boltzmann Law
- (D) Planck's Law only

Correct Answer: (C) Stefan-Boltzmann Law

Solution:

Step 1: Understanding the Question:

The question asks for the fundamental physical law of radiation heat transfer that relates the total emissive power of a blackbody to its absolute temperature raised to the fourth power.

Step 2: Key Formula or Approach:

The Stefan-Boltzmann law describes the total thermal energy radiated by a blackbody per unit surface area per unit time.

The mathematical relationship is given as:

$$E = \sigma T^4$$

where E represents the total emissive power (W/m^2), T represents the absolute temperature (K), and σ represents the Stefan-Boltzmann constant ($\sigma \approx 5.67 \times 10^{-8} \text{ W}/\text{m}^2\text{K}^4$).

Step 3: Detailed Explanation:

- **Stefan-Boltzmann Law:** Explains that the total radiative energy emitted by a blackbody is proportional to the fourth power of its absolute temperature (T^4).
- **Newton's Law of Cooling:** Governs convective heat transfer, stating that the rate of heat loss from a body is proportional to the temperature difference between the body and its environment (ΔT).
- **Fick's Second Law:** Governs non-steady-state mass diffusion, predicting how concentration fields change over time.
- **Planck's Law:** Describes the spectral distribution of electromagnetic radiation emit-

ted by a blackbody in thermal equilibrium, rather than the integrated total emissive power.

Step 4: Final Answer:

Therefore, the Stefan-Boltzmann Law is the correct law relating emissive power to the fourth power of temperature.

Quick Tip: Remember that radiation heat transfer scales with absolute temperature to the fourth power (T^4). Always convert Celsius temperatures to Kelvin first!

103. In the size-reduction of cereals, Rittinger's Law assumes that energy consumed is proportional to:

- (A) New surface area created
- (B) Volume of material reduced
- (C) Diameter of feed particle
- (D) Moisture content of feed

Correct Answer: (A) New surface area created

Solution:

Step 1: Understanding the Question:

This question asks for the fundamental assumption regarding energy consumption in solid size-reduction as stated by Rittinger's Law.

Step 2: Key Formula or Approach:

Rittinger's Law is one of three classical hypotheses used to estimate energy requirements in milling and size reduction.

The mathematical expression is:

$$E = K_R \left(\frac{1}{d_2} - \frac{1}{d_1} \right)$$

where E is the energy input per unit mass, K_R is Rittinger's constant, d_1 is the feed particle size, and d_2 is the product particle size.

Step 3: Detailed Explanation:

- Rittinger's hypothesis assumes that size reduction is a surface-dominated process. The energy required to break a solid particle is spent on creating new surfaces by overcoming cohesive forces.
- Therefore, the mechanical work or energy input is directly proportional to the change in surface area of the material.
- **Kick's Law** assumes that the energy consumed is proportional to the ratio of reduction or the volume/mass of the material, which works better for coarse crushing.
- **Bond's Law** assumes that the energy required is proportional to the length of the cracks formed, which is intermediate between Rittinger's and Kick's models.

Step 4: Final Answer:

Hence, Rittinger's Law assumes that energy consumed is proportional to the new surface area created.

Quick Tip: Rittinger's law is most accurate for fine grinding where large amounts of new surface area are produced.

for incompressible filter cakes?

- (A) Stokes' Law
- (B) Darcy's Law
- (C) Fick's Law
- (D) Henry's Law

Correct Answer: (B) Darcy's Law

Solution:

Step 1: Understanding the Question:

The question asks to identify the classical equation/law of fluid dynamics that describes the flow of filtrate through a porous, incompressible cake under an applied pressure drop.

Step 2: Key Formula or Approach: Darcy's Law describes fluid flow through porous media:

$$\frac{dV}{dt} = \frac{A \cdot \Delta P}{\mu \cdot R}$$

where $\frac{dV}{dt}$ is the volumetric filtration rate, A is the filtration area, ΔP is the pressure drop across the bed, μ is the viscosity of the filtrate, and R is the total resistance of the cake.

Step 3: Detailed Explanation:

- **Darcy's Law:** Formulates that the velocity of fluid passing through a porous bed is directly proportional to the pressure gradient and inversely proportional to the viscosity of the fluid and the flow resistance of the bed. It forms the foundation for analyzing filtration rate in incompressible cakes.
- **Stokes' Law:** Relates to the terminal velocity of a solid particle falling through a viscous fluid under gravity.

- **Fick's Law:** Governs molecular mass transfer by diffusion.
- **Henry's Law:** Relates the concentration of a dissolved gas to its partial pressure above the liquid.

Step 4: Final Answer:

Consequently, Darcy's Law is the correct governing law.

Quick Tip: In filtration questions, Darcy's law is the foundational flow equation through porous beds, matching pressure drop and flow rate.

105. Which sieving equipment is most commonly used in flour milling to separate bran from endosperm?

- (A) Vibrating screen
- (B) Plansifter (gyrating sifter)
- (C) Trommel screen
- (D) Grizzly screen

Correct Answer: (B) Plansifter (gyrating sifter)

Solution:

Step 1: Understanding the Question:

This question asks for the specialized industrial sieving equipment used in the flour milling industry to classify ground wheat fractions.

Step 2: Key Formula or Approach:

In flour milling, the separation of bran from endosperm requires precise, high-capacity classification.

The separation process must handle large quantities without blinding (clogging) the sieves or breaking down delicate components excessively.

Step 3: Detailed Explanation:

- **Plansifter (gyrating sifter):** Consists of a series of horizontal sieves stacked vertically, executing a planar gyratory (circular) motion. It is the industry standard for flour milling because it provides gentle, high-capacity, multi-stream separation that stratifies materials according to size and shape.
- **Vibrating screen:** Uses vigorous vertical vibrations which are too harsh for fine flour milling, potentially damaging the screen cloth and causing fine particulate dust issues.
- **Trommel screen:** A rotating cylindrical screen used for coarse raw cleaning (e.g., sorting large seeds, stones, and dirt) and is unsuitable for fine milling separations.
- **Grizzly screen:** A robust parallel-bar device used in mining and raw mineral handling for sizing extremely coarse rocks.

Step 4: Final Answer:

Therefore, the plansifter is the correct equipment.

Quick Tip: Plansifters are key to wheat milling systems because they handle multiple classifications in a single vertical stack, optimizing space and energy.

106. Which test detects urea adulteration in milk?

- (A) Diacetyl test
- (B) p-Dimethylaminobenzaldehyde test

- (C) Molisch test
(D) Benedict test

Correct Answer: (B) p-Dimethylaminobenzaldehyde test

Solution:

Step 1: Understanding the Question:

The question asks to identify the chemical test that specifically detects the presence of added urea in milk.

Step 2: Key Formula or Approach:

Urea is an adulterant added to synthetic or diluted milk to artificially elevate the non-protein nitrogen levels, which misleads testing for crude protein content.

Urea undergoes a rapid condensation reaction with p-Dimethylaminobenzaldehyde (DMAB) in an acidic environment to form a yellow-colored compound.

Step 3: Detailed Explanation:

- **p-Dimethylaminobenzaldehyde (DMAB) Test:** Also referred to as the parade test. In the presence of concentrated acid, DMAB reacts with urea to yield a stable, distinct yellow color. Normal milk yields only a very pale, standard color under similar conditions.
- **Diacetyl test:** Used to check for the presence of diacetyl, which is a butter-aroma compound, and does not react with urea.
- **Molisch test:** A general chemical test used to confirm the presence of carbohydrates in a solution.
- **Benedict test:** A copper-reduction test used specifically to detect reducing sugars like lactose or glucose.

Step 4: Final Answer:

Therefore, the p-Dimethylaminobenzaldehyde test is the correct chemical method.

Quick Tip: Urea adulteration is checked using DMAB because of the rapid, distinctive chromogenic reaction resulting in a yellow complex.

107. Which sensory method provides quantitative description of sensory attributes using trained panelists?

- (A) Hedonic test
- (B) Difference test
- (C) Descriptive analysis
- (D) Ranking test

Correct Answer: (C) Descriptive analysis

Solution:**Step 1: Understanding the Question:**

The question asks for the sensory evaluation method that produces a detailed, quantitative profiling of multiple sensory characteristics of a food product using trained evaluators.

Step 2: Key Formula or Approach:

Sensory evaluation methods are divided into three main classes: discriminative (difference testing), affective (preference/consumer testing), and descriptive (analytical profiling).

Step 3: Detailed Explanation:

- **Descriptive Analysis:** Highly trained panels (typically consisting of 8 to 12 members) are used to identify, describe, and quantitatively evaluate the intensity of sensory

descriptors (aroma, texture, flavor, appearance) on a structured scale. Examples include Quantitative Descriptive Analysis (QDA).

- **Hedonic test:** An affective test that utilizes a large, untrained consumer panel to rate product acceptability and liking.
- **Difference test:** A discriminative test (such as a triangle or duo-trio test) used to determine if a perceivable difference exists between two samples.
- **Ranking test:** A simple sorting test in which panelists arrange samples based on the perceived intensity of a single attribute or general preference.

Step 4: Final Answer:

Thus, descriptive analysis is the sensory method that provides a quantitative description of sensory attributes.

Quick Tip: Trained panels are used for descriptive analysis, while untrained/consumer panels are used for hedonic (preference) testing.

108. The Gerber method is used to determine:

- (A) Milk protein
- (B) Milk fat
- (C) Milk lactose
- (D) Milk minerals

Correct Answer: (B) Milk fat

Solution:

Step 1: Understanding the Question:

The question asks to identify the nutritional constituent of milk determined by the Gerber method.

Step 2: Key Formula or Approach:

The Gerber method is a volumetric analytical method in which concentrated sulfuric acid digests proteins, allowing the fat to separate and be measured in a specialized graduated glass tube called a butyrometer.

Step 3: Detailed Explanation:

- Concentrated sulfuric acid (H_2SO_4 , around 90-91% concentration) is mixed with milk inside a butyrometer. The acid digests and hydrolyzes casein and other milk proteins, generating heat that melts fat globules.
- Amyl alcohol is added to facilitate a distinct phase separation between the fat column and the aqueous phase.
- The mixture is centrifuged, allowing the liquid milk fat to rise into the graduated neck of the butyrometer, where the percentage is read directly.
- Other components like protein (Kjeldahl method), lactose (polarimetry), and minerals (dry ashing) require different analytical techniques.

Step 4: Final Answer:

Therefore, the Gerber method is specifically used to determine milk fat.

Quick Tip: The Gerber method measures the fat content volumetrically. It is highly popular in dairy laboratories alongside the Babcock method.

109. Which oilseed has the highest risk of rancidity due to high PUFA content?

- (A) Sunflower
- (B) Groundnut
- (C) Sesame
- (D) Rice bran

Correct Answer: (A) Sunflower

Solution:

Step 1: Understanding the Question:

The question asks which of the given oilseeds produces an oil that is most prone to oxidative rancidity due to its high concentration of polyunsaturated fatty acids (PUFA).

Step 2: Key Formula or Approach:

Lipid oxidation susceptibility depends directly on the number of double bonds present in the fatty acid chains.

Polyunsaturated fatty acids (PUFA), such as linoleic acid (18:2) and linolenic acid (18:3), undergo autoxidation much faster than monounsaturated fatty acids (MUFA) like oleic acid (18:1).

Step 3: Detailed Explanation:

- **Sunflower Oil:** Contains high levels of polyunsaturated fatty acids (typically 50% to 70% linoleic acid), making it highly susceptible to autoxidation in the presence of oxygen, heat, and light.
- **Groundnut Oil:** Primarily composed of oleic acid (MUFA, $\approx$ 40-50%) and relatively low

to moderate amounts of PUFA, making it structurally more stable.

- **Sesame Oil:** Contains high levels of unsaturated fats but is naturally protected against rancidity by powerful endogenous antioxidants (e.g., sesamol, sesamolin).
- **Rice Bran Oil:** Features a highly balanced fatty acid profile (high MUFA, moderate PUFA) and is rich in natural antioxidants like gamma-oryzanol, which provide excellent thermal and oxidative stability.

Step 4: Final Answer:

Thus, sunflower oil has the highest risk of rancidity due to high PUFA content.

Quick Tip: Unsaturated oils with multiple double bonds oxidize much faster. Look for oilseeds containing high linoleic or linolenic acid content.

110. The characteristic flavor of tea is due to the presence of which compound?

- (A) Catechins
- (B) Theaflavins
- (C) Thearubigins
- (D) Catechins, Theaflavins and Thearubigins

Correct Answer: (D) Catechins, Theaflavins and Thearubigins

Solution:

Step 1: Understanding the Question:

The question asks for the compound or combination of compounds responsible for the characteristic flavor, color, and mouthfeel of tea.

Step 2: Key Formula or Approach:

The overall sensory profile of tea (specifically fermented black tea) is determined by a complex mix of monomeric catechins and their enzymatic oxidation products (theaflavins and thearubigins) formed during the "fermentation" step of processing.

Step 3: Detailed Explanation:

- **Catechins:** Unoxidized monomeric polyphenols that contribute to the basic bitterness and astringency of green tea.
- **Theaflavins:** Yellow-orange pigments formed through enzymatic oxidation of catechins. They contribute to the briskness, brightness, and fresh-taste properties of brewed black tea.
- **Thearubigins:** Polymeric, brown-red compounds derived from further oxidation of theaflavins. They provide body, thickness, and depth of color to the tea infusion.
- Since commercial tea flavor and color characteristics are built upon the balanced composition of monomeric polyphenols and their various oxidation stages, the holistic sensory profile is attributed to all three classes.

Step 4: Final Answer:

Consequently, the characteristic flavor of tea is due to the combined presence of Catechins, Theaflavins, and Thearubigins.

Quick Tip: Green tea is rich in unoxidized catechins, while black tea undergoes oxidation yielding characteristic theaflavins and thearubigins.

111. For dynamic similarity between model and prototype involving viscous and gravitational forces, which dimensionless numbers must be simultaneously matched?

- (A) Reynolds and Mach numbers
- (B) Reynolds and Froude numbers
- (C) Euler and Mach numbers
- (D) Weber and Strouhal numbers

Correct Answer: (B) Reynolds and Froude numbers

Solution:

Step 1: Understanding the Question:

The question asks for the specific pair of dimensionless numbers that must be matched to ensure dynamic similarity between a model and a prototype when fluid viscosity and gravity are the dominant forces.

Step 2: Key Formula or Approach:

To achieve complete dynamic similarity, the ratios of dominant forces must be identical between the model and the prototype.

- Viscous forces are characterized by the Reynolds number (Re):

$$Re = \frac{\rho v L}{\mu}$$

- Gravitational forces are characterized by the Froude number (Fr):

$$Fr = \frac{v}{\sqrt{gL}}$$

Step 3: Detailed Explanation:

- In physical systems where gravity and viscosity are both critical (such as liquid agitation in unbaffled vessels with free vortex formation, or open channel flow), both forces affect

fluid movement simultaneously.

- To scale-up or model these systems accurately, both the Reynolds number (inertial-to-viscous force ratio) and the Froude number (inertial-to-gravitational force ratio) must be matched between the model and the prototype.
- **Mach number:** Important in gas dynamics involving compressibility effects.
- **Weber number:** Important in surface tension-dominated flows.
- **Euler number:** Compares pressure force to inertial force.

Step 4: Final Answer:

Therefore, the Reynolds and Froude numbers must be simultaneously matched.

Quick Tip: Whenever gravitational forces are critical in fluid dynamics (e.g., wave action or free surfaces), always pair the Froude number with the Reynolds number.

112. Which mixer is especially suitable for highly viscous food materials such as dough?

- (A) Planetary mixer
- (B) Propeller mixer
- (C) Turbine mixer
- (D) Ribbon blender

Correct Answer: (A) Planetary mixer

Solution:

Step 1: Understanding the Question:

This question is about selecting the appropriate industrial mixer for processing highly viscous, non-Newtonian plastic systems like dough.

Step 2: Key Formula or Approach:

Dough mixing requires high shear, stretching, and folding action (kneading). Mixing elements must travel throughout the entire volume of the container to prevent stagnant zones.

Step 3: Detailed Explanation:

- **Planetary Mixer:** The mixing blade rotates on its own axis while also revolving around the center of the mixing bowl. This complex movement provides excellent kneading, high-torque shearing, and complete spatial coverage, making it highly effective for heavy bakery doughs.
- **Propeller Mixer:** Operates at high speeds to generate axial flow in low-viscosity liquids, but would stall or break in dough.
- **Turbine Mixer:** Generates radial flow and moderate shear for liquid blending, but is ineffective for sticky, plastic masses.
- **Ribbon Blender:** Uses helical ribbons to mix dry powders or low-viscosity pastes, but lacks the necessary power and direct kneading action for gluten development in heavy bread doughs.

Step 4: Final Answer:

Therefore, the planetary mixer is the correct choice.

Quick Tip: High-viscosity paste and dough mixing require shear and positive displacement actions like planetary movement or Z-blade mechanisms.

113. The Food Safety and Standards Act (FSSA) of 2006 in India consolidated how many existing older laws?

- (A) 8
- (B) 9
- (C) 10
- (D) 11

Correct Answer: (A) 8

Solution:

Step 1: Understanding the Question:

The question asks for the number of existing older food laws that were consolidated to form the Food Safety and Standards Act (FSSA) of 2006 in India.

The enactment of FSSA 2006 was a landmark decision in India's legislative history, aimed at bringing all food-safety-related issues under a single, unified governing body.

Before this act, food regulations were highly fragmented and managed by multiple ministries, leading to administrative confusion and poor enforcement.

Step 2: Key Formula or Approach:

The approach involves reviewing the historical context of food legislation in India leading up to the passage of the FSSA 2006.

This act repealed and consolidated various food-related laws, orders, and acts under the administrative control of the Food Safety and Standards Authority of India (FSSAI).

Step 3: Detailed Explanation:

The consolidation process integrated eight specific existing central acts and orders, which are detailed below:

- **Prevention of Food Adulteration Act, 1954:** This was the primary act dealing with food safety and adulteration for over five decades before being repealed.
- **Fruit Products Order, 1955 (FPO):** This order regulated the manufacture, quality, and distribution of fruit and vegetable products in India.
- **Meat Food Products Order, 1973 (MFPO):** This order controlled the sanitary conditions and quality standards of meat products.
- **Vegetable Oil Products (Control) Order, 1947:** It established the standards for vegetable oil and vanaspati production.
- **Edible Oils Packaging (Regulation) Order, 1998:** This mandate regulated the packaging of edible oils to ensure consumer hygiene and prevent tampering.
- **Solvent Extracted Oil, De-oiled Meal and Edible Flour (Control) Order, 1967:** This order governed the extraction processes and quality of solvent-extracted oils and edible flours.
- **Milk and Milk Products Order, 1992 (MMPO):** This order regulated the production, collection, and distribution of milk and dairy products.
- **Essential Commodities Act, 1955 (Food-related executive orders):** Any other orders under this act relating to food control were consolidated to form a single regulatory pathway.

By merging these 8 disparate laws into a single, comprehensive act, the Government of India established a single reference point for all matters relating to food safety and standards, transforming the system from multi-level, multi-departmental control to a single line of

command.

Step 4: Final Answer:

Therefore, the Food Safety and Standards Act (FSSA) of 2006 consolidated exactly 8 existing laws.

Quick Tip: Remember that the Food Safety and Standards Authority of India (FSSAI) was established under the FSSA 2006.

An easy way to remember the number of consolidated laws is the "8-in-1" regulatory integration rule, which eliminated overlapping jurisdictions.

114. Which toxin is heat-stable and produced by *Staphylococcus aureus*?

- (A) Enterotoxin
- (B) Neurotoxin
- (C) Cytotoxin
- (D) Hemotoxin

Correct Answer: (A) Enterotoxin

Solution:

Step 1: Understanding the Question:

The question asks to identify the type of toxin produced by the bacterium *Staphylococcus aureus* that possesses the property of being heat-stable.

Food poisoning caused by *Staphylococcus aureus* is an intoxication rather than an infection, meaning it is caused by the ingestion of toxins pre-formed in the food.

Step 2: Key Formula or Approach:

The key to answering this lies in understanding the characteristics of staphylococcal toxins. Among the various toxins secreted by *Staphylococcus aureus*, the enterotoxins are the specific

group responsible for gastroenteritis (food poisoning).

Step 3: Detailed Explanation:

The biological characteristics and functions of the toxins involved are explained below:

- **Staphylococcal Enterotoxins:** These are a family of major serologically distinct proteins (such as SEA, SEB, SEC, etc.) that specifically target the gastrointestinal tract.
- **Heat Stability:** A critical hazard associated with these enterotoxins is their remarkable heat stability.
They can easily withstand pasteurization and conventional cooking temperatures, remaining active even after boiling at 100°C for up to 30 minutes.
Therefore, even if the vegetative cells of *Staphylococcus aureus* are destroyed during cooking, the active toxin persists and causes illness.
- **Mechanism of Action:** These toxins act as superantigens, which trigger an overactivation of T-cells, leading to massive cytokine release, resulting in rapid-onset symptoms like severe vomiting, nausea, and abdominal cramps within 1 to 6 hours.
- **Comparison with other options:**
 - *Neurotoxins* primarily affect the nervous system (e.g., botulinum toxin from *Clostridium botulinum*), and they are generally heat-labile.
 - *Cytotoxins* destroy host cells but do not typically present as the primary heat-stable agents of foodborne intoxication.
 - *Hemotoxins* destroy red blood cells, and while *S. aureus* produces hemolysins (like alpha-toxin), they are not the cause of foodborne gastroenteritis.

Step 4: Final Answer:

Hence, the heat-stable toxin produced by *Staphylococcus aureus* is the Enterotoxin.

Quick Tip: Staphylococcal food poisoning is a classic example of "food intoxication" where boiling food prior to consumption does NOT make it safe if the enterotoxin has already been produced.
Remember: "Entero-" relates to the intestines, where food poisoning symptoms occur.

115. Aflatoxins are:

- (A) Heat sensitive
- (B) Carcinogenic
- (C) Non-toxic
- (D) Destroyed by drying

Correct Answer: (B) Carcinogenic

Solution:

Step 1: Understanding the Question:

The question asks to identify the correct biological or physical characteristic of aflatoxins from the given options.

Aflatoxins are naturally occurring mycotoxins produced by certain molds of the genus *Aspergillus*, notably *Aspergillus flavus* and *Aspergillus parasiticus*.

Step 2: Key Formula or Approach:

The approach involves analyzing the properties, toxicological profile, and stability of aflatoxins in food science and toxicology.

By examining how these toxins react to physical processes (like heating and drying) and their physiological effects on human and animal health, the correct characteristic can be deduced.

Step 3: Detailed Explanation:

The toxicity and stability details of aflatoxins are described below:

- **Carcinogenicity:** Aflatoxins are widely recognized as extremely potent carcinogens. In particular, Aflatoxin B1 (AFB_1) is classified by the International Agency for Research

on Cancer (IARC) as a Group 1 human carcinogen.

Long-term exposure to even microgram levels of aflatoxins is highly associated with the development of hepatocellular carcinoma (liver cancer).

- **Heat Stability:** Aflatoxins are highly thermal-stable compounds. They have melting points of over 260°C and are not destroyed by pasteurization, boiling, baking, or cooking processes. Therefore, they are not "heat sensitive" (eliminating Option A).
- **Effect of Drying:** While proper drying of agricultural commodities (like groundnuts and maize) is crucial to prevent further mold growth, it does not destroy already formed aflatoxins. Thus, they are not "destroyed by drying" (eliminating Option D).
- **Toxicity Profile:** Aflatoxins are highly toxic, inducing both acute liver necrosis (aflatoxicosis) and chronic health effects, making Option C ("Non-toxic") completely incorrect.

Step 4: Final Answer:

Thus, the most defining and dangerous property of aflatoxins is that they are highly carcinogenic.

Quick Tip: Aflatoxin B_1 is the most toxic and carcinogenic of all aflatoxins.

Remember that aflatoxin contamination is majorly associated with warm and humid storage conditions, typically affecting peanuts, corn, and tree nuts.

116. Which factor increases microbial growth rate?

- (A) Low temperature
- (B) High nutrient availability

- (C) Low moisture
- (D) High acidity

Correct Answer: (B) High nutrient availability

Solution:

Step 1: Understanding the Question:

The question asks to identify which environmental or intrinsic food factor results in an increase in the growth rate of microorganisms.

Microbial growth is heavily influenced by physical and chemical factors, which can either promote replication or act as preservation hurdles.

Step 2: Key Formula or Approach:

The approach involves analyzing the standard growth requirements of microorganisms, which include temperature, water activity (moisture), pH (acidity), and nutrients.

Understanding how each parameter affects metabolic enzymes and cellular division kinetics allows us to determine which one enhances growth.

Step 3: Detailed Explanation:

The influence of each of the given factors is detailed as follows:

- **High Nutrient Availability:** Microorganisms, like all living systems, require essential building blocks to grow, replicate DNA, and synthesize cell walls and membranes. These nutrients include carbon sources (sugars), nitrogen sources (amino acids), vitamins, and minerals. An abundant supply of these nutrients allows metabolic pathways to function at their maximum capacity, drastically reducing the generation time (doubling time) and increasing the microbial growth rate.
- **Low Temperature:** Lowering the temperature decreases the kinetic energy of molecules, which slows down enzymatic reactions and membrane transport, thereby decreasing the growth rate (eliminating Option A).

- **Low Moisture:** Microorganisms require free water, measured as water activity (a_w), for metabolic processes.

Low moisture level reduces the osmotic balance and dehydrates the cells, slowing down or entirely halting microbial replication (eliminating Option C).

- **High Acidity:** High acidity corresponds to a low pH environment.

Excess hydrogen ions (H^+) disrupt transmembrane proton gradients, denature microbial enzymes, and damage DNA, which severely inhibits microbial growth (eliminating Option D).

Step 4: Final Answer:

Therefore, among the choices provided, high nutrient availability is the factor that increases the microbial growth rate.

Quick Tip: To control or prevent food spoilage, food preservation techniques focus on doing the opposite of these growth promoters.

We decrease temperature (refrigeration), lower pH (acidification), and reduce water activity (dehydration) to slow down microbes.

117. Parboiling leads to:

- (A) Nutrient loss
- (B) Nutrient migration into grain
- (C) Starch hydrolysis
- (D) Protein loss

Correct Answer: (B) Nutrient migration into grain

Solution:

Step 1: Understanding the Question:

The question asks about the primary nutritional or structural outcome of parboiling paddy (rice) before milling.

Parboiling is a hydrothermal process applied to paddy rice, which involves three main stages: soaking, steaming, and drying, prior to the mechanical milling process.

Step 2: Key Formula or Approach:

The approach involves examining the biochemical and physical changes that occur during the parboiling process.

By understanding how moisture and heat interact with the outer layers (aleurone layer, germ, and bran) and the inner core (endosperm) of the rice grain, the nutritional impact of parboiling can be determined.

Step 3: Detailed Explanation:

The key phenomena and effects of parboiling are detailed below:

- **Nutrient Migration into Grain:** Rice bran and germ are highly rich in water-soluble vitamins (such as Thiamine (B_1), Riboflavin (B_2), and Niacin (B_3)) and essential minerals.

During the soaking stage of parboiling, these water-soluble nutrients dissolve in the absorbed water.

During the subsequent steaming stage, the high heat and pressure push these dissolved nutrients deep into the starch-rich endosperm.

As a result, even when the outer bran layer is removed during milling, the milled rice grains retain a significant portion of these essential nutrients.

This is why parboiled rice is highly nutritious compared to raw milled white rice.

- **Starch Gelatinization:** The starch in the endosperm undergoes gelatinization rather than hydrolysis.

This gelatinization makes the rice grain harder, resulting in a higher yield of head rice (less breakage during milling).

Therefore, "starch hydrolysis" is incorrect (eliminating Option C).

- **Reduction of Loss:** Because the nutrients are safely locked inside the endosperm, the overall loss of nutrients during subsequent washing and cooking is highly reduced. Thus, parboiling prevents nutrient loss and protein loss, making Options A and D incorrect.

Step 4: Final Answer:

Hence, parboiling of paddy primarily leads to the migration of water-soluble nutrients into the grain's endosperm.

Quick Tip: Remember: Parboiling = Soaking + Steaming + Drying.

It drives vitamin B-complex from the outer bran deep into the endosperm, which prevents beriberi disease in rice-dependent populations.

118. Which milk product is obtained by dehydration?

- (A) Butter
- (B) Cheese
- (C) Milk powder
- (D) Cream

Correct Answer: (C) Milk powder

Solution:

Step 1: Understanding the Question:

The question asks to identify which of the given dairy products is manufactured primarily through the process of dehydration (removal of water).

Dehydration is a preservation technique that reduces water activity to a level where microbial

growth and enzymatic reactions are inhibited.

Step 2: Key Formula or Approach:

The approach involves analyzing the unit operations used in the manufacturing of various dairy products: Butter, Cheese, Milk powder, and Cream.

Identifying which of these processes uses evaporative or drying technology to remove water systematically leads to the correct answer.

Step 3: Detailed Explanation:

The production methods for each of the options are examined below:

- **Milk Powder:** The industrial production of milk powder is a two-step dehydration process.

First, raw milk is concentrated in a multi-effect falling-film evaporator to remove about 85% of the water.

Second, this concentrated milk is subjected to spray drying (or drum drying), where it is atomized into a chamber of hot air.

The remaining water evaporates instantaneously, yielding a dry powder with a moisture content of only 3% to 5%.

Thus, milk powder is a direct product of extensive dehydration.

- **Butter:** Butter is produced by mechanical churning of cream, which causes the fat globules to coalesce and form a continuous fat phase, separating the buttermilk.

It is a phase-inversion process rather than dehydration (eliminating Option A).

- **Cheese:** Cheese is produced by the enzymatic or acidic coagulation of milk proteins (casein), followed by the physical syneresis (expulsion) of liquid whey.

While some moisture is removed as whey, the primary mechanism of cheese making is coagulation and fermentation, not thermal dehydration (eliminating Option B).

- **Cream:** Cream is a concentrated fat-in-water emulsion separated from raw milk by centrifugal separation based on density differences, not by water removal (eliminating

Option D).

Step 4: Final Answer:

Therefore, milk powder is the dairy product obtained by thermal dehydration of milk.

Quick Tip: Spray drying is the most common dehydration technique used for milk powder because the rapid rate of evaporation prevents thermal damage to milk proteins and maintains solubility.

119. ISO 9001 focuses on:

- (A) Food safety
- (B) Quality management
- (C) Nutrition
- (D) Processing

Correct Answer: (B) Quality management

Solution:

Step 1: Understanding the Question:

The question asks to identify the primary focus area of the international standard ISO 9001. ISO (International Organization for Standardization) standards are designed to establish global benchmarks for processes, services, and systems across various industries.

Step 2: Key Formula or Approach:

The approach involves distinguishing between the distinct families of ISO standards. By categorizing the focus of ISO 9001 versus other standards like ISO 22000 or ISO 14001, we can determine the correct standard classification.

Step 3: Detailed Explanation:

The details of the ISO 9001 standard and its comparison with other options are described below:

- **Quality Management System (QMS):** ISO 9001 is the world's most recognized standard for Quality Management Systems.

It provides a framework and set of principles that ensure a common-sense approach to the management of an organization to consistently satisfy customers and other stakeholders.

It focuses on continuous improvement, customer satisfaction, and process-driven approaches, regardless of the industry sector.

- **Food Safety:** While highly critical in the food industry, food safety management systems are specifically covered under the **ISO 22000** standard, which incorporates HACCP principles.

Therefore, Option A is incorrect.

- **Nutrition and Processing:** Nutrition (Option C) and food processing operations (Option D) are specialized technical disciplines within food science.

They are regulated by product standards, nutritional guidelines, and engineering practices rather than general management system standards like ISO 9001.

Step 4: Final Answer:

Consequently, the primary and specific focus of the ISO 9001 standard is Quality Management.

Quick Tip: Remember the clear distinction:

ISO 9001 = Quality Management System (QMS)

ISO 22000 = Food Safety Management System (FSMS)

ISO 14001 = Environmental Management System (EMS)

This is a common classification question in competitive exams.

120. Fourier's Law of Heat Conduction states that heat flux is proportional to:

- (A) Temperature difference alone
- (B) Negative temperature gradient
- (C) Fluid velocity
- (D) Surface area only

Correct Answer: (B) Negative temperature gradient

Solution:

Step 1: Understanding the Question:

The question asks to identify the proportional relationship of heat flux during conduction heat transfer as defined by Fourier's Law of Heat Conduction.

Conduction is the transfer of thermal energy between microscopic particles through collisions and direct contact.

Step 2: Key Formula or Approach:

Fourier's Law of Heat Conduction is mathematically expressed as:

$$q = -kA \frac{dT}{dx}$$

Where:

q is the rate of heat flow in Watts (W)

k is the thermal conductivity of the material in $\text{W} \cdot \text{m}^{-1} \cdot \text{K}^{-1}$

A is the surface area perpendicular to the direction of heat flow in m^2

$\frac{dT}{dx}$ is the temperature gradient in $\text{K} \cdot \text{m}^{-1}$

The heat flux (q''), which is defined as the rate of heat transfer per unit area ($q'' = \frac{q}{A}$), is given by:

$$q'' = -k \frac{dT}{dx}$$

Step 3: Detailed Explanation:

The physical significance of the parameters in Fourier's law is detailed below:

- **Proportionality to Gradient:** The expression clearly shows that heat flux (q'') is directly

proportional to the temperature gradient ($\frac{dT}{dx}$).

A gradient represents the rate of change of temperature with respect to distance, which is more specific than just a simple temperature difference.

- **Significance of the Negative Sign:** The negative sign in the equation is of paramount physical importance.

According to the Second Law of Thermodynamics, heat spontaneously flows from a region of higher temperature to a region of lower temperature.

This means that as distance (x) increases, the temperature (T) decreases, making the temperature gradient ($\frac{dT}{dx}$) a negative quantity.

To ensure that the calculated heat flow vector in the direction of decreasing temperature is positive, the negative sign is introduced.

Therefore, heat flux is proportional to the negative temperature gradient.

- **Analysis of other options:**

- *Temperature difference alone* (Option A) is incorrect because it neglects the thickness (distance) of the material.

- *Fluid velocity* (Option C) is a parameter relevant to convective heat transfer (Newton's Law of Cooling), not conduction.

- *Surface area only* (Option D) is incorrect because heat flux is independent of the total surface area by definition.

Step 4: Final Answer:

Hence, Fourier's Law states that heat flux is proportional to the negative temperature gradient.

Quick Tip: Remember: Heat flux is heat transfer rate per unit area.

The negative sign is a mathematical representation of the Second Law of Thermodynamics, ensuring heat flows from hot to cold.