**Egg and Fish Technology**

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**Refresher Points**

**Terminologies related to egg and egg products technology**

1. Candling: The process of examining eggs by passing them over a light source to assess the internal quality, such as the size of the air cell, yolk integrity, and the presence of any defects.
2. Grading: The classification of eggs based on their quality, size, and shell integrity. Grading helps in sorting eggs for different purposes, such as retail or processing.
3. Pasteurization: A heat treatment process used to kill harmful bacteria in liquid egg products without significantly affecting their taste or nutritional value.
4. Albumen: The egg white, which contains water, protein, and minerals. It provides structure and contributes to the overall nutritional content of eggs.
5. Yolk: The yellow, nutrient-rich part of the egg that contains fats, proteins, vitamins, and minerals. It serves as a source of energy for the developing embryo.
6. Emulsification: The process of mixing two immiscible liquids, such as oil and water, to create a stable emulsion. Egg yolks are often used as emulsifying agents in products like mayonnaise.
7. Foaming: The process of incorporating air into egg whites to create a stable foam, used in various culinary applications like meringues and soufflés.
8. Lecithin: A natural emulsifier found in egg yolks, often used in food processing to improve the stability of emulsions.
9. Enzyme: Proteins that catalyze biochemical reactions. In egg technology, enzymes play a role in processes such as the coagulation of proteins during cooking.
10. Lysozyme: An antimicrobial enzyme found in egg whites that has natural preservative properties, inhibiting the growth of certain bacteria.
11. Egg Wash: A mixture of beaten eggs or egg yolk and liquid (water or milk) used to brush onto baked goods for a shiny and golden finish.
12. Freezing: The process of lowering the temperature of egg products to below freezing point to extend their shelf life and maintain quality.
13. Drying: Removing moisture from egg products to create powders or crystallized forms for convenience in storage and transportation.
14. Egg Replacement: Substitutes for eggs in recipes, often used in vegan or allergy-friendly baking. Common egg replacers include applesauce, mashed bananas, and commercial egg replacer products.
15. Eggshell Membrane: The thin layer between the egg white and the eggshell, often used for its potential health benefits and in the production of dietary supplements.
16. Egg Coating: A layer applied to certain food items, such as fried chicken or fish, using beaten eggs and breadcrumbs or batter for added texture and flavor.
17. Egg Subfractionation: The process of separating different components of eggs, such as egg white proteins or egg yolk lipids, for specific applications in food and pharmaceutical industries.
18. Egg Extenders: Substances added to egg products to increase their volume or improve texture, often used in the manufacturing of baked goods.
19. Egg Foam Stability: The ability of whipped egg whites to maintain their volume and structure over time, crucial for recipes like angel food cake or soufflés.
20. Egg Emulsion: A stable mixture of two immiscible liquids, such as oil and water, created by using egg yolks as emulsifying agents.
21. Egg Coagulation: The process of proteins in eggs solidifying when exposed to heat, leading to the formation of a firm texture in cooked eggs.
22. Egg Pasteurization Units (EPU): A measure of the effectiveness of the pasteurization process, indicating the time and temperature combination used to eliminate harmful microorganisms.
23. Ovotransferrin: A protein found in egg whites with antimicrobial properties, contributing to the natural defense mechanisms of eggs.
24. Egg Foaming Agents: Substances that enhance the foaming properties of egg whites, often used in commercial baking to improve the stability of whipped egg whites.
25. Egg Laying Systems: Various methods and technologies used in poultry farming for the efficient collection of eggs.
26. Eggshell Thickness: The measurement of the thickness of an eggshell, an important quality parameter.
27. Egg Grading Machine: Automated equipment used to sort and classify eggs based on size, weight, and quality.
28. Egg Glazing: The application of a thin, protective layer on the surface of eggs to extend their shelf life and prevent moisture loss.
29. Egg White Solids: Dried and powdered egg whites, often used in baking and food manufacturing.
30. Egg Derivatives: Products derived from eggs, such as lecithin, used as emulsifiers in various food applications.

**Egg production statistics and their important insights**

According to DAHD Annual Report 2022-23,

1. The total egg production in the country is 138.38 billion numbers during 2022-23. ™
2. India ranks 3rd in the world in terms of total Egg production. ™
3. The egg production has increased by 6.77% as compared to previous year (2021-22).
4. The per-capita availability of egg is 101 eggs per annum.
5. Top 5 egg producing States are Andhra Pradesh (20.13%), Tamil Nadu (15.58%), Telangana (12.77%), West Bengal (9.93%) and Karnataka (6.51%). They together contribute 64.93% of total egg production in the country.

**Pigments present in egg**

**Eggshell Pigments:**

Protoporphyrin IX: Responsible for the brown coloration in brown eggshells. It is derived from hemoglobin.

Biliverdin: Contributes to the greenish color in blue and green eggshells. It is a byproduct of heme breakdown.

**Yolk Pigments:**

Xanthophylls: Naturally occurring yellow and orange pigments found in green plants. Hens consuming a diet rich in xanthophylls produce yolks with a deeper yellow or orange color.

Canthaxanthin: Used as a synthetic pigment in poultry feed to enhance yolk color.

**Nutritive value of egg (per 100 grams of edible portion)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Nutrient** | **Whole Egg** | **Egg White (Albumen)** | **Egg Yolk** |
| **Proximate Composition** |  |  |  |
| Protein | 12.6 g | 10.9 g | 16.4 g |
| Total Fat | 9.5 g | 0.2 g | 27.5 g |
| Carbohydrates | 0.6 g | 0.6 g | 0.6 g |
| Water | 73.5 g | 88.0 g | 48.5 g |
| Ash | 1.0 g | 0.5 g | 1.3 g |
| Calcium | 56 mg | 2 mg | 245 mg |
| Iron | 1.8 mg | 0.1 mg | 2.0 mg |
| Vitamin C (ascorbic acid) | 0 mg | 0 mg | 0 mg |
| Vitamin B6 (pyridoxine) | 0.1 mg | 0 mg | 0.1 mg |
| Vitamin B12 (cobalamin) | 0.9 µg | 0 µg | 0.3 µg |
| Vitamin A (retinol) | 540 IU | 0 IU | 1490 IU |

**Protein egg albumen and their % of albumen proteins and characteristics**

|  |  |  |
| --- | --- | --- |
| **Protein** | **Percentage of Albumen Proteins** | **Characteristics** |
| Ovalbumin | 54% | Soluble in water, coagulates when heated |
| Conalbumin (ovotransferrin) | 13% | Heat stable, binds and transports iron |
| Ovomucin | 11% | Forms a gel-like structure, contributes to egg white texture |
| Lysozyme | 3.5% | Antimicrobial properties, helps prevent bacterial growth |
| Globulins | 8% | Includes ovoglobulins and ovomucoids |
| Ovomucoid | 11% | Heat-stable protein, inhibits trypsin (a digestive enzyme) |
| Avidin | Trace amounts | Binds biotin, a B-vitamin, reducing its bioavailability |

**Egg yolk phospholipid fraction and their %**

|  |  |  |
| --- | --- | --- |
| **Phospholipid** | **Percentage of Egg Yolk Phospholipids** | **Characteristics and Functions** |
| Phosphatidylcholine | 40-50% | Emulsifying agent, important for lipid metabolism and transport |
| Phosphatidylethanolamine | 25-30% | Structural component of cell membranes, involved in neurotransmission |
| Phosphatidylinositol | 10-15% | Plays a role in cell signaling and membrane integrity |
| Sphingomyelin | 5-10% | Present in cell membranes, important for nerve cell function |

**Table: Physico-chemical properties of egg proteins**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Protein** | **Solubility** | **Gelation** | **Foaming** | **Emulsification** | **Coagulation** |
| Ovalbumin | Soluble in water | Forms a gel when heated, reversible | Good foaming agent, stable foam | Excellent emulsifier, forms stable emulsions | Coagulates upon heating |
| Conalbumin | Soluble in water, precipitates at isoelectric pH | Does not gel significantly | Poor foaming ability | Can stabilize emulsions, interacts with metal ions | Coagulates upon heating |
| Ovotransferrin | Soluble in water, stable at acidic pH | Does not gel significantly | Poor foaming ability | Can stabilize emulsions, iron-binding capacity | Coagulates upon heating |
| Lysozyme | Soluble in water | Does not gel significantly | Poor foaming ability | Limited emulsification properties | Denatures at high temperatures |
| Ovomucin | Insoluble in water, forms a gel-like structure | Forms a gel, contributes to egg white texture | Limited foaming ability | Limited emulsification properties | Does not coagulate significantly |
| Ovoglobulins | Soluble in water | Gel formation at higher temperatures | Limited foaming ability | Limited emulsification properties | Coagulates upon heating |
| Ovomucoid | Insoluble in water, stable at a wide pH range | Does not gel significantly | Poor foaming ability | Limited emulsification properties | Does not coagulate significantly |

**Functions of egg in foods**

|  |  |
| --- | --- |
| **Food Application** | **Function of Eggs** |
| **Baking (Cakes, Cookies)** | Provides structure and stability through protein coagulation |
|  | Contributes to leavening and aeration in baked goods |
|  | Enhances flavor and color |
|  | Acts as an emulsifier in batters and doughs |
| **Breading and Coating** | Forms a protective and crispy coating when fried |
|  | Helps breading adhere to the food surface |
| **Emulsions (Mayonnaise)** | Acts as an emulsifying agent, stabilizing oil and water |
| **Quiches and Frittatas** | Adds structure and richness to the filling |
|  | Contributes to the overall texture |
| **Meatloaf and Meatballs** | Acts as a binder, holding the mixture together |
|  | Enhances moisture retention |
| **Pasta and Noodles** | Adds richness and color to pasta dough |
|  | Contributes to the texture and tenderness |
| **Soufflés and Meringues** | Provides structure and stability through protein coagulation |
|  | Aids in creating a light and airy texture |
| **Egg Wash for Glazing** | Gives a golden and shiny appearance to baked goods |
|  | Enhances the overall visual appeal |
| **Thickening in Sauces** | Acts as a thickening agent in sauces and custards |
|  | Provides a smooth and velvety texture |
| **Protein Source in Salads** | Adds protein and richness to salads |
|  | Enhances the nutritional content |
| **Thickening in Sauces** | Acts as a thickening agent in sauces and custards |

**AGMARK standard for table eggs**

The Agricultural Produce (Grading and Marking eggs) Rules, 1937, require that the mark on each egg shall consist of the word `AGMARK’ together with the grade designation placed centrally in a circle of not less than ½ inch diameter by means of a rubber stamp.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Grade** | **Weight (g)** | **Shell** | **Air cell** | **White** |
| A-Extra large A-Large A-Medium A-Small | 60 & above 53-59 45-52 38-44 | Clean,unbroken And sound, shape normal | Up to 4 mm in depth practically regular or better | Clear reasonably firm |
| B-Extra large B-Large B-Medium B-Small | 60 & above 53-59 45-52 38-44 | Clean to moderately, stained, sound and slightly abnormal | 8 mm in depth, may be free and slightly bubbly | Clear,may be slightly weak |

**Standards for Weight Classification of Shell Eggs**

|  |  |  |
| --- | --- | --- |
| **S no.** | **Size** | **Weight per egg (gms)** |
| 1 | Extra large | 60 and above |
| 2 | Large | 53 to 59 |
| 3 | Medium | 46 to 52 |
| 4 | Small | 38 to 44 |

**Bacterial spoilage or egg rots**

|  |  |
| --- | --- |
| **Bacterial Egg Rots** | **Causative Organism** |
| **Green Whites** | Pseudomonas fluorescens |
| **Black Rot** | Proteus vulgaris, Pseudomonas fluorescens |
| **Red Rot** | Serratia marcescens, Pseudomonas spp. |
| **Purple Rot** | Arthrobacter spp., Pseudomonas spp. |
| **Pink Rot** | Serratia marcescens, Enterobacter spp. |
| **Yellow Rot** | Moraxella spp., Pseudomonas spp. |

**Table: Fungal egg spoilage or pin spot**

|  |  |  |
| --- | --- | --- |
| **Fungal Spoilage (Pin Spot Rot)** | **Color Characteristics** | **Causative Organism** |
| **Aspergillus Mold** | Black, dark green, or gray spots | Aspergillus spp. |
| **Penicillium Mold** | Blue or green spots | Penicillium spp. |
| **Other Molds/Fungi** | Various colors, powdery or fuzzy appearance | Various molds and fungi |

**Pasteurization methods of eggs and their characteristics**

1. **Lactic acid aluminium sulphate pasteurization-** In this pasteurization process, one ounce (1 oz) of aluminum sulfate is thoroughly blended with 1 lb of 25% lactic acid and then incorporated at a rate of 6.5 lb per 1000 lb of liquid egg. This addition must be carried out gradually, with vigorous stirring of the egg whites, to prevent protein coagulation caused by localized high concentrations of acid and aluminum. The egg mixture is heated to a temperature of 62°C for 3.5 to 4.0 minutes, and it is crucial to maintain the product pH within the range of 6.6-7.0.
2. **Heat in combination with hydrogen peroxide pasteurization-** In this procedure, the pH of the egg product is kept within the standard range prior to heating it to 52-53°C for 1.5 minutes, effectively deactivating the catalase enzyme. Subsequently, a 10% hydrogen peroxide solution is introduced into the liquid egg at levels ranging from 0.075 to 0.10 percent. The chemical reaction occurs over a period of 2 minutes, after which the mixture is cooled, and catalase enzyme is added to eliminate any remaining hydrogen peroxide.
3. **Heat cum vacuum pasteurization-** This setup employs a standard high-temperature short-time plate pasteurizer that incorporates a vacuum chamber. Within this chamber, liquid whole egg undergoes heating to 57°C for a duration of 3.5 minutes at a low vacuum level ranging from 17 to 20 inches.
4. ***Dr. Ros’s method of treatment*:** preheating fresh liquid whole egg in a plate heat exchanger, raising its temperature from chilled (2 °C) to approximately 50-55 °C. Subsequently, the liquid is directed through a nozzle into the FSH equipment, where it descends in small, thin streams within the chamber. Steam rapidly heats the liquid egg to 78-85 °C in 0.6 seconds or less. Upon reaching the bottom of the chamber, the liquid is released through a discharge valve into a vacuum flash cooler, reducing its temperature to 35-40 °C. This process helps remove water absorbed during steam infusion. Following this, the liquid undergoes pasteurization in a conventional tube pasteurizer at 60-65 °C for 2.5 to 3 minutes, followed by cooling to 2 °C before being packaged in unit packs. The resulting product boasts a shelf life of up to 10 weeks when stored at 2 °C.
5. ***Ultra pasteurization and aseptic packaging*:** Subjecting liquid eggs to high-temperature pasteurization, typically at 70-72 °C for 30 seconds using a process known as High-Temperature Short-Time (HTST), is followed by aseptic packaging. This method is employed to prolong the shelf life of liquid eggs to approximately one month when stored at refrigeration temperature (4 °C).
6. ***Hyperpasteurization*:** To eliminate microflora, several oxygen species, including molecular oxygen (O2), ozone (O3), and nascent oxygen (O2), are applied under controlled conditions and at the proper amounts. As a source of oxygen, filtered or purified air is combined with nascent oxygen (O), O2, and O3 in a predetermined ratio at hyper- or hypobaric conditions, that is, below or above one atom. Alternating between hyperbaric and hypobaric conditions increases the effectiveness of oxygen species mixing on bacterial killing.

**BIS specifications for egg powder**

|  |  |
| --- | --- |
| **Characteristic** | **Requirement** |
| Moisture content, % by mass, Max | 2 |
| Protein (N\*6.68), % by mass, Min | 45 |
| Lecithin and fat, % by mass, Min | 40 |
| Total ash, % by mass, Max | 3.6 |
| Total plate count, per g, Max | 75000 |
| Yeast and mould count, per g, Max | 50 |
| Coliform count, per g, Max | 100 |
| Salmonella | Absent |

IS: 4723 - 1978, Reaffirmed 2020

**BIS specifications for egg albumen powder (edible quality)**

|  |  |
| --- | --- |
| **Characteristic** | **Requirement** |
| Moisture content, % by mass, Max | 7 |
| Protein (N\*6.68), % by mass, Min | 79 |
| pH, Max | 8 |
| Solubility (Haenni method), % by mass, Min | 80 |
| Total plate count, per g, Max | 25000 |
| Yeast and mould count, per g, Max | 50 |
| Coliform count, per g, Max | 10 |
| Salmonella | Absent |

IS: 10382-1982, Reaffirmed 2020

**Fish production statistics and their important insights**

Highest fish producing state is Andhra Pradesh.

According to 20th Livestock Census (2020). DADF, DADF, Ministry of Fisheries, Animal Husbandry & Dairying, GoI.,

1. Length of Indian coastline 8118 kms
2. Total fish production in India 16.24 MT
3. Value of fisheries export Rs. 57,586.48 crores
4. Major importer of Indian seafood USA
5. Marine fish production 4.12 MT (25.36%)
6. Inland fish production 12.12 MT (74.64%)
7. Per capita fish availability 6.31 kg

**Terminologies related to fish technology.**

**Fishery Science:**

1. Ichthyology: The branch of zoology that deals with the study of fishes.
2. Fisheries Management: The practice of ensuring sustainable fisheries by regulating fishing activities and conserving fish populations.

**Processing and Preservation:**

1. Fish Processing: The various methods employed to transform raw fish into a more marketable form, including cleaning, filleting, and packaging.
2. Fishery Products: Processed or unprocessed products derived from fish or fisheries.
3. Fish Fillet: The flesh of fish, especially when it has been removed from the bones.

**Preservation Techniques:**

1. Fish Canning: The process of preserving fish by sealing it in a can with various additives.
2. Smoking: The method of preserving fish by exposing it to smoke from burning wood or other materials.
3. Freezing: The process of preserving fish by reducing its temperature to below freezing point.

**Quality and Safety:**

1. Fish Inspection: The evaluation of fish and fish products to ensure they meet quality and safety standards.
2. HACCP (Hazard Analysis and Critical Control Points): A systematic preventive approach to food safety that addresses physical, chemical, and biological hazards in the production process.
3. Sensory Evaluation: The analysis of the appearance, flavor, texture, and overall acceptability of fish products.

**Aquaculture:**

1. Aquaculture: The cultivation of aquatic organisms, including fish, under controlled conditions.
2. Fish Farming: The breeding and rearing of fish for commercial purposes.

**Fishery Management:**

1. Stock Assessment: The evaluation of fish populations to determine their abundance, structure, and dynamics.
2. Quota: A specific quantity of fish allocated for harvesting within a specified period.

**Seafood Marketing:**

1. Seafood Labeling: The practice of providing information about the origin, species, and production methods of seafood products.
2. Traceability: The ability to trace the history, location, or application of a product through the supply chain.

**FSSAI standard for fish and fish products**

**Total Volatile Base (Nitrogen)**

|  |  |  |
| --- | --- | --- |
|  | Requirements in RawProduct | Requirement in CookedProduct |
| Frozen Shrimps or Prawns | Not more than 30 mg/100 gm | Absent in 25gm |
| Frozen Lobsters | Not more than 30 mg/100 gm | Absent in 25gm |
| Frozen squid | Not more than 30 mg/100 gm | - |
| Frozen finfish | Not more than 30 mg/ 100gm | - |
| Canned finfish | - | Not more than 30mg/ 100gm |

**Histamine**

|  |  |
| --- | --- |
|  | Requirements |
| Canned Tuna | Not more than 20mg/100 gm |
| Canned Sardine or Sardine type product | Not more than 20 mg/100 gm |
| Canned finfish | Not more than 20 mg/100 gm |
| Frozen finfish | Not more than 20 mg/100 gm |

**Fill in the blanks**

1. Sodium silicate solution is used in the ­­\_\_\_\_\_\_\_\_ method of preservation of shelled eggs.
2. Albumen is secreted in the \_\_\_\_\_\_\_\_ part of the oviduct.
3. In eggs, black rot (type-2) is caused by \_\_\_\_\_\_\_\_\_.
4. An egg that is inedible, smashed or broken so that contents are leaking is called as \_\_\_\_\_\_.
5. A heat resistant enzyme present in egg yolk which acts as antibacterial agent is \_\_\_\_\_\_\_\_\_.
6. Eggs are pasteurized to destroy bacteria pathogenic to humans, especially \_\_\_\_\_\_\_\_\_\_\_\_.
7. The enzyme activity assay used to test the efficiency of pasteurization of egg white is \_\_\_\_\_.
8. The discolouration of dried whole egg is due to the reaction between a cephalin amino group and \_\_\_\_\_\_\_\_\_\_\_.
9. \_\_\_\_\_\_\_\_\_ is the inspection of eggs by passing them over a bright light, usually in a dark room, to assess the quality for grading purpose.
10. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is used for visual comparison of yolk colour with reference colour standards like Roche colour fan.
11. The \_\_\_\_\_\_\_\_\_\_ shows relationship between the height of thick albumen and egg weight.
12. Green rots in eggs is caused chiefly by *\_\_\_\_\_\_\_\_\_\_\_\_\_\_.*
13. \_\_\_\_\_\_\_\_\_ is the major constituent of albumen and generally decreases from outer to inner albumen layers.
14. In coloured eggs the colour is due to pigment \_\_\_\_\_\_\_\_\_ deposited on shell surface.
15. \_\_\_\_\_\_\_\_\_\_\_ is water insoluble, fibrous (microscopic fibres) glycoprotein (muco protein) and is responsible for jelly like structure of thick albumen.
16. The shape index of chicken eggs varies from 65-82 with a value of \_\_\_\_\_\_ for normal shaped eggs.
17. A Haugh unit (H.U.) value of \_\_\_\_\_\_\_ and above indicates fairly good albumen quality.
18. \_\_\_\_\_\_\_\_\_\_\_\_ binds with biotin in raw egg and renders biotin (B complex vitamin) unavailable.
19. Egg shell contributes \_\_\_\_\_\_\_\_\_\_\_\_\_ % of egg weight.
20. Hay odour in eggs is caused by *\_\_\_\_\_\_\_\_\_.*
21. The most abundant protein in egg shell membrane is \_\_\_\_\_\_\_\_\_\_\_.
22. Angel cake is a cake prepared from \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ part of the egg.
23. In control bacterial fermentation, *\_\_\_\_\_\_\_\_\_\_* @ 1% by weight is used for desugaring liquid whole eggs.
24. Dr. Ros’s method of treatment for pasteurization of eggs is also known as \_\_\_\_\_\_\_\_\_\_\_\_\_\_.
25. A \_\_\_\_\_\_\_\_\_ is a classic Italian breakfast egg dish made with beaten and fried egg yolks, and they are filled with a variety of toppings such as cheese, meats and vegetables.

#### 26. Eggs which are packed as they come from the production facilities without having been washed, sized and candled for quality are known as \_\_\_\_\_\_\_\_\_\_\_\_\_\_.

27. The concentration of chlorine in water for washing fish should be \_\_\_\_\_\_\_\_.

28. The process of curing fish by putting Malabar tamarind inside the fish cavities for pickling is known as \_\_\_\_\_\_\_\_\_\_\_\_\_.

29. \_\_\_\_\_\_\_\_\_\_\_ is the process of sprinkling fish with a layer of ice or dipped in cold water (0 to 3°C) to provide an ice coating of around 2mm over then fish.

30. During whole egg powder manufacturing, \_\_\_\_\_\_\_\_\_ is added to egg liquid to retain whipping quality (loss of foaming power) before drying.

Q. **Multiple choice questions**

1. Shell eggs contains about \_\_\_\_\_\_ % of yolk.

a) 23.6

b) 27.5

c) 29.5

d) 33.0

2. The hardness of shell is directly related to the increase in

a) calcium content

b) magnesium content

c) phosphorus content

d) none of the above

3. As per BIS solubility of albumen flakes should be

a) 57

b) 67

c) 77

d) 87

4. Conalbumen causes chelation of

a) iron

b) aluminium

c) phosphorus

d) copper

5. In case of spray drying of egg liquid the inlet air temperature should be

a) 165°C

b) 175°C

c) 185°C

d) 195°C

6. \_\_\_\_\_\_\_\_\_\_\_ sterilization of egg powder is very effective in destroying salmonella without damaging the product.

a) gaseous

b) thermal

c) ultra violet

d) radiation

7. Egg contains ­­­­\_\_\_\_\_\_\_\_\_\_% of unsaturated triglycerides

a) 55

b) 60

c) 66

d) 70

8. Egg shell contains ­­\_\_\_\_\_\_\_\_\_\_% of calcium in the form of calcium carbonate

a) 84

b) 88

c) 94

d) 98

9. Red rots is caused by

a) Pseudomonas sp.

b) Serratia sp.

c)Staphylococcus sp.

d) Bacillus sp.

10. Moisture content of whole egg is

a) 55 %

b) 65 %

c) 75 %

d) 85 %

11. Fat content of an egg is about

a) 2-3 g

b) 5-6 g

c) 10-11 g

d) 15-16 g

12. The egg yolk begins to coagulate at

a) 45°C

b) 55°C

c) 65°C

d) 75°C

13. Haugh index is used to determine the internal quality of\_\_\_\_\_\_\_\_\_\_\_\_\_

a) milk

b) meat

c) paneer

d) egg

14. Sugar is removed from liquid egg by the enzyme

a) glucose oxidase

b) glycosidase

c) phosporelase

d) elastase

15. One of the most commonly occurring defects in eggs are

a) blood spots

b) meat spots

c) stuck yolks

d) mottled eggs

16. As per BIS the permissible level of coliforms in egg powder is

a) 10 / g

b) 50 / g

c) 100 / g

d) 500 /g

17. Eggs contain about \_\_\_\_\_\_\_\_ % water

a)75

b) 65

c) 85

d) 55

18. The pH of freshly laid egg yolk is around

1. 3.0
2. 4.0
3. 5.0
4. 6.0

19. As per BIS the maximum limit for moisture in egg powder is

a) 1.0

b) 1.5

c) 2.0

d) 2.5

20. Compound produced by certain stains of Enterobacteriaceae during fermentation, which destroys salmonella in egg white is

a) nisin

b) colicin

c) pediocin

d) listerin

21. The ability of egg yolk to withstand rupture during egg breaking operation is a function of

a) cuticle

b) shell membrane

c) vitelline membrane

d) chalazeferous layer

22. An average size of egg contains about\_\_\_\_\_\_ g of protein

a) 4

b) 6

c) 8

d) 10

23. Green rot in egg is caused by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Pseudomonas
2. Staphylococcus
3. Serratia
4. Cladosporium

24. What is the range of albumen index in fresh eggs?

1. 0.231 to 0.452
2. 0.728 to 0.815
3. 0.085 to 0.125
4. 2 to 2.258

### 25. Eggs that are tapered at both ends are known as \_\_\_\_\_\_\_ eggs.

1. Uniconial
2. Biconial
3. Triconial
4. Multiconial

### 26. ­\_\_\_\_\_\_\_\_\_ and its zinc chelates are responsible for blue-green egg colors.

1. Biliverdin
2. Bilirubin
3. Haemoglobin
4. Myoglobin

27. The development of black rot indicates that the eggs have been kept at temperatures ­­­\_\_\_\_\_\_\_\_ than ordinarily used for storage

1. Higher
2. Lower
3. Both a and b are correct
4. Both a and b are incorrect

28. Following are some statements regarding blood spots formation in eggs

A. Blood spots are caused by a blood vessel rupturing on the surface of the yolk during formation.

B. Blood spots impact the nutritional or chemical properties of the egg.

C. Most eggs with blood spots are detected and removed before sale.

D. Blood spots in eggs indicate fertilization.

Q. Which of the following statements are correct?

a) A and C only

b) B and D only

c) A, B and D

d) A, C and D

29. The membrane that surrounds the yolk sac and amnion is known as \_\_\_\_\_\_\_.

a) Amnion

b) Chorion

c) Chalaza

d) Vitelline membrane

30. During washing of eggs, egg washing solution should be changed every \_\_\_\_\_\_\_.

a) 20-30 washings

b) 15-20 washings

c) 5-6 washings

d) 2-3 washings

31. The coagulation of eggs can take place due to \_\_\_\_\_\_\_\_.

a) Heat

b) Mechanical means

c) Salts

d) All of the above

32. Cold stored eggs should preferably, be marketed within 5 days while oil coated eggs within 10 days after removal from cold store

a) 15, 30

b) 20, 60

c) 10, 15

d) 5, 10

33. The ante-room built adjacent to cold room to check condensation in eggs before marketing should have a temperature between \_\_\_\_\_\_.

a) 15 to 20 °C

b) 20 to 25 °C

c) 25 to 30 °C

d) 30 to 35 °C

34. Following are some statements regarding colour of eggs.

A. Shell color comes from pigments in the outer layer of the shell and may range from white to deep brown

B. The shell color determines the egg quality, flavor and its nutritive value.

C. The color of eggshell varies according to the breed of hen that laid the egg.

D. Brown shelled eggs have greater shell thickness.

Which of the above statements are correct?

a) A and B only

b) B and C only

c) A and C only

d) C and D only

35. The homogenous mixture of egg contents without shell is known as

1. Egg nog
2. Egg mixture
3. Egg solution
4. Egg mélange

36. The moisture % in spray dried whole egg powder is around

1. 2%
2. 3%
3. 4%
4. 5%

37. Which method of egg drying forms a granular egg product?

1. Foam drying
2. Spray drying
3. Belt drying
4. Freeze drying

38. Which fungus is associated with black rots in fungal spoilage?

a) Sporotrichum spp.

b) Cladosporium herbarum

c) Aspergillus niger

d) Candida albicans

39. What is a major cause of fish spoilage?

a) High fat content

b) Microbial growth and metabolism

c) Excessive protein content

d) Ambient temperature

40. Which bacteria tend to spoil chilled fish, especially when unpreserved?

a) Vibrionaceae

b) Shewanella spp.

c) Micrococcus

d) Alcaligenes

41. What is used universally to determine microbial deterioration leading to fish spoilage?

a) Sulphides

b) Trimethylamine Oxide (TMAO)

c) Biogenic amines

d) Aldehydes

42. Which bacteria can obtain energy by reducing TMAO to TMA, creating ammonia-like off-flavors?

a) Pseudomonas putrifaciens

b) Vibrio spp.

c) Micrococcus

d) Serratia

43. What is the purpose of Trimethylamine Oxide (TMAO) in fish?

a) To increase microbial growth

b) To avoid dehydration in marine environments

c) To produce off-flavors

d) To enhance protein content

44. What is the temperature range for quick freezing the egg liquid in the manufacture of frozen egg products?

a) -5 to -15 °C

b) -20 to -30 °C

c) -30 to -40 °C

d) 0 to -10 °C

45. What is the recommended storage temperature for frozen egg products after quick freezing?

a) -5 °C

b) -18 °C

c) -25 °C

d) -30 °C

46. According to the USDA grading system, what are the possible grades for eggs?

a) A, B, C

b) AA, A, B

c) Grade 1, Grade 2, Grade 3

d) Prime, Choice, Select

47. What is the primary focus when determining the grade of eggs under the USDA system?

a) Size and nutritional value

b) Shell color

c) Interior and exterior quality of eggs

d) Production method

48. What is the typical use of Grade B eggs in the market?

a) Sold as premium eggs

b) Exported to other countries

c) Used to make commercial products

d) Reserved for specialty recipes

49. In the heat cum vacuum pasteurization system, what is the objective of incorporating a vacuum chamber?

a) To increase the temperature of pasteurization

b) To remove air from the albumen

c) To accelerate the pasteurization process

d) To enhance the color of the liquid whole egg

50. What is the temperature and time combination used in the heat cum vacuum pasteurization for liquid whole egg?

a) 70°C for 5 minutes

b) 57°C for 3.5 minutes

c) 80°C for 2 minutes

d) 60°C for 4 minutes

51. What is the purpose of adding catalase enzyme after heating liquid egg in the heat in combination with hydrogen peroxide pasteurization method?

a) To enhance foaming

b) To destroy residual hydrogen peroxide

c) To increase bactericidal activity

d) To improve taste and color

52. What temperature is used in the heat in combination with hydrogen peroxide pasteurization to inactivate catalase enzyme?

a) 45°C

b) 52-53°C

c) 60°C

d) 70°C

53. Why was the heat in combination with hydrogen peroxide pasteurization method not considered commercially practical?

a) It had an unpleasant taste

b) It resulted in heavy foam formation

c) The process was too slow

d) It required high temperatures

54. What is the key element used in hyperpasteurization to destroy microflora?

a) Nitrogen

b) Carbon dioxide

c) Oxygen species

d) Hydrogen peroxide

55. How is the effectiveness of oxygen species mixture on bacterial destruction enhanced in hyperpasteurization?

a) By increasing the concentration of oxygen

b) By applying only hyperbaric conditions

c) By alternating hyperbaric and hypobaric conditions

d) By using ozone as the sole oxygen species

56. What is the key characteristic of inline processing in the context of egg production?

a) Eggs are transported to an off-farm location

b) Processing occurs at a separate facility

c) Eggs are collected and processed at the same location

d) Eggs are manually sorted before processing

57. What is the primary advantage of inline processing over offline processing?

a) Reduced egg production

b) More manual sorting required

c) Efficient egg collection and processing

d) Higher transportation costs

58. What is the role of lecithin in egg yolks concerning sauces and dressings?

a) Acts as a natural emulsifier

b) Enhances color

c) Adds flavor

d) Increases viscosity

59. What is the primary preservative effect of the lime water method on eggs?

a) Formation of a thin film of calcium carbonate

b) Increase in alkalinity

c) Deposition of common salt

d) Introduction of lime juice

60. How long are the eggs dipped in the lime water solution in the lime water method?

a) 8 to 10 hours

b) 12 to 14 hours

c) 16 to 18 hours

d) 20 to 22 hours

61. A. What is the main function of the magnum in the oviduct?

a) Yolk deposition

b) Shell formation

c) Hormone production

d) Albumen deposition around the yolk

62. A. What is the most common capacity for moulded pulp filler flats used in egg packaging?

a) 20 eggs

b) 24 eggs

c) 30 eggs

d) 48 eggs

63. How are eggs positioned in the moulded pulp filler flats?

a) Broader end down

b) Narrower end down

c) Alternating broader and narrower ends

d) Broader end up

64. When was the National Egg Coordination Committee (NECC) established?

a) 1975

b) 1982

c) 1990

d) 2000

65. What is the primary purpose of NECC's Market Intervention Scheme?

a) To promote egg exports

b) To regulate poultry farm practices

c) To prevent traders from exploiting farmers

d) To establish new production centers

66. A. What is the primary purpose of oil coating in the preservation of eggs?

a) To form a thin film to seal the pores

b) To add flavor to the eggs

c) To enhance shell color

d) To increase the size of the eggs

67. What is the purpose of adding butylated hydroxyl toluene (BHT) to vegetable oil in the oil coating process?

a) To improve flavor

b) To increase viscosity

c) To act as a colorant

d) To serve as an antioxidant

68. How are omega-3 enriched eggs produced?

a) By adding omega-3 rich ingredients to a chicken's diet

b) By exposing eggs to UV light

c) By using a special breeding technique

d) By genetic modification of chicken embryos

69. What are common sources of omega-3 fatty acids added to a chicken's diet for omega-3 enriched eggs?

a) High sugar fruits

b) Corn and soybean meal

c) Fish oils, algae, and flaxseed

d) Artificial preservatives

70. What is the predominant protein in egg white, constituting 54% of it?

a) Ovomucin

b) Ovotransferrin

c) Ovoglobulin

d) Ovalbumen

71. What is the primary function of ovoinhibitor in egg albumen?

a) Foaming agent

b) Antibacterial agent

c) Enzyme activator

d) Flavor enhancer

72. What is a notable characteristic of ovoglobulins?

a) Antimicrobial properties

b) Heat resistance

c) Excellent foaming agents

d) High viscosity

73. Which mold causes yellow/blue/green pin spots molding?

a) Penicillium spp.

b) Cladosporium herbarum

c) Sporotrichum carnis

d) P. oxalicum

74. What color of spots does Cladosporium herbarum cause in pin spot molding?

a) Pink

b) Dark green

c) Black

d) Yellow

75. What is the primary purpose of the Roche Yolk Colour Fan?

a) Measuring eggshell thickness

b) Determining yolk color

c) Grading egg size

d) Assessing egg freshness

76. What Roche colour score range for egg yolks is preferred by consumers?

a) 1-5

b) 7-11

c) 12-15

d) 1-15

77. What is the significance of a higher specific gravity in eggs?

a) Thicker egg shell

b) Enhanced flavor

c) Thicker egg yolk

d) Increased protein content

78. At what specific gravity is an egg less prone to breakage?

a) 1.00

b) 1.06

c) 1.08

d) 1.10

79. What is syneresis in the context of coagulatin of egg mixtures?

a) Formation of a soft gel

b) Separation of liquid and curd phases

c) Enhancing flavor and aroma

d) Increasing coagulation time

80. What temperature and duration are commonly used in thermo-stabilization for egg preservation?

a) 50°C for 20 min

b) 62°C for 12 min

c) 58°C for 8 min

d) 54°C for 15 min

81. How is albumen quality measured using the Van Wagenen chart?

a) Through a taste test

b) Based on eggshell color

c) Using a numerical scale with pictures

d) Measuring albumen viscosity

82. What is the primary purpose of the water glass method in egg preservation?

a) Sealing the pores with a silica precipitate

b) Enhancing eggshell color

c) Increasing albumen thickness

d) Adding a desirable taste to the eggs

83. How is the solution prepared in the water glass method for egg preservation?

a) 1 part sodium chloride to 10 parts water

b) 1 part sodium silicate to 5 parts water

c) 1 part sodium carbonate to 15 parts water

d) 1 part sodium silicate to 10 parts water

84. What causes yellow rots in eggs?

a) Penicillium spp.

b) Flavobacterium and Cytophaga spp.

c) Cladosporium herbarum

d) Sporotrichum carnis

85. What is the Yolk Index a measure of in eggs?

a) Eggshell thickness

b) Yolk color intensity

c) Ratio of yolk height to diameter

d) Albumen viscosity

86. In a fresh egg, what is the typical range for the Yolk Index?

a) 0.300 to 0.375

b) 0.420 to 0.495

c) 0.550 to 0.600

d) 0.700 to 0.750

87. How does the Yolk Index value correlate with egg quality?

a) Higher value indicates better quality

b) Lower value indicates better quality

c) Value has no relation to quality

d) Quality is determined solely by yolk color

88. What is the primary impact of autolytic degradation on the quality of fish shortly after capture?

a) Off-odors and off-flavors

b) Textural quality

c) Hypoxanthine production

d) Formaldehyde production

89. Which enzymes contribute to the post mortem degradation of fish muscle and fish products during storage and processing?

a) Lipolytic enzymes

b) Amylolytic enzymes

c) Glycolytic enzymes

d) Proteolytic enzymes

90. What is the consequence of improper storage of whole fish with respect to proteolysis?

a) Off-flavor production

b) Textural quality improvement

c) Degradation of proteins followed by solubilization

d) Hypoxanthine accumulation

91. What causes belly bursting in fish, leading to decomposition?

a) Leakage of proteolytic enzymes from pyloric caeca and intestine

b) Leakage of amylolytic enzymes

c) Leakage of lipolytic enzymes

d) Accumulation of hypoxanthine

92. Why is ice alone not considered effective for long-term preservation of fish?

a) It promotes bacterial growth

b) It accelerates enzymic activities

c) It induces off-flavors in the fish

d) Melting water leaches valuable flesh contents

93. Besides reducing bacterial growth, what additional role does ice play in preserving fish?

a) Accelerating autolytic enzymic activities

b) Washing away bacteria and slime as it melts

c) Increasing the growth rate of bacteria

d) Enhancing the flavor of the fish

94. What is the recommended ratio for making brine in wet salting for preservation of fish?

a) 1 part water to 1 part salt

b) 2 parts water to 1 part salt

c) 3 parts water to 1 part salt

d) 4 parts water to 1 part salt

95. In Dry Salting, how should layers of fish be arranged for effective preservation?

a) Directly stacked on top of each other

b) Separated by layers of salt

c) Covered with leaves and mats

d) Placed in brine solution

96. When is Dry Salting considered a valuable method for fish preservation?

a) When using modern containers

b) When fish are kept in airtight boxes

c) When no containers are available

d) When fish are preserved in brine-filled barrels

97. What type of fire is recommended during the smoking operations in the hot smoking system?

a) Intense flames

b) Slow and steady fire for one hour

c) Brisk fire for six hours

d) No flames, just smoking

98. What is the maximum duration for which fish can be preserved using the hot smoking system?

a) 24 hours

b) 48 hours

c) 72 hours

d) 96 hours

99. Which of the following fish species is mentioned as a traditional source for canned fish?

a) Trout

b) Salmon

c) Tuna

d) Catfish

100. What is the temperature range for freezing fillets in a contact plate freezer during individual quick freezing?

a) -10°C to -15°C

b) -20°C to -25°C

c) 0°C to 5°C

d) -35°C to -40°C

101. What is the key difference between minced fish and surimi?

a) Minced fish is separated from bones and skin, while surimi is washed to remove fat and water-soluble components

b) Minced fish is prepared from marine fish, while surimi is from freshwater fish

c) Minced fish is mechanically deboned, while surimi is not

d) Minced fish is frozen, while surimi is used in diverse fish foods

102. How is fish meal typically obtained?

a) By boiling fish to extract oil

b) By drying and grinding fish or fish trimmings

c) By freezing and packaging fish

d) By fermenting fish with salt

103. What is the key ingredient in fish sauce that imparts an umami flavor to food?

a) Sea salt

b) Fish oil

c) Glutamate

d) Amber coloring

104. In seafood quality grading, what is considered the fundamental determinant of acceptability and price, especially in countries with old traditions in fish consumption?

a) State of freshness

b) Color of the seafood

c) Size of the seafood

d) Packaging of the seafood

105. What characteristic attributes are associated with just-caught fish and shellfish in terms of freshness?

a) Pale hue, red gills, and strong aroma

b) Intensive hue, light-red gills, firm body, and characteristic aroma

c) Dark hue, soft body, and no aroma

d) Silver hue, pink gills, and shellfish aroma

106. What are the primary factors controlling the rate of freshness loss and spoilage in seafood during further storage?

a) Size and color

b) Microbial activity and handling

c) The use of preservatives

d) Cooking methods

107. How can the state of freshness in seafood be determined?

a) Only by using chemical assays

b) Only by sensory assessment

c) By measuring physical properties, using chemical assays, and sensory assessment

d) By relying solely on universal chemical tests

108. What are the three main aspects considered in the sensory grading of seafood freshness?

a) Taste, color, and size

b) Appearance, odor, and texture

c) Packaging, temperature, and weight

d) Location, origin, and price

109. In the sensory grading of seafood, what is subtracted from the highest quality score to determine the final grade?

a) The weight of the seafood

b) Merit points

c) Demerit points

d) Packaging quality

110. What physical properties of fish tissues are commonly examined during the sensory assessment of freshness?

a) Color and weight

b) Texture and aroma

c) Size and shape

d) Taste and appearance

111. What is the working principle of the portable instrument known as Fish Tester?

a) Measuring the capacitate component of the AC resistance of fish tissues

b) Assessing the color changes in the fish

c) Measuring the weight of the fish tissues

d) Evaluating the taste of the fish

112. How does the Fish Tester indicate the freshness of fish?

a) By measuring the weight of the fish

b) By assessing the color changes in the fish

c) By evaluating the taste of the fish

d) By displaying degrees of freshness calibrated for different species

113. What does the Torrymeter measure to assess fish freshness?

a) Weight of the fish

b) Dielectric properties of fish

c) Color changes in the fish

d) Taste of the fish

114. How is the state of freshness or remaining shelf life of fish predicted using instruments like the Torrymeter?

a) By evaluating the taste of the fish

b) By measuring the weight of the fish

c) By assessing the color changes in the fish

d) By considering the time-temperature history after catch

115. Which chemical assay is widely employed for the freshness assessment of wet fish due to its simplicity?

a) Ammonia assay

b) Trimethylamine nitrogen (TMA-N) assay

c) Total volatile base nitrogen (TVB-N) assay

d) Volatile reducing substances assay

116. What does the accumulation of trimethylamine nitrogen (TMA-N) in fish indicate?

a) High urea concentration

b) Presence of Pseudomonas putrefaciens

c) Development of volatile reducing substances

d) Freshness grade of canned fish

117. In sharks and rays, what contributes to the distinct ammoniac odor early after catch?

a) High urea concentration

b) Presence of Pseudomonas putrefaciens

c) Deamination of adenosine and AMP

d) Hydrolysis of urea

118. Why do values of total volatile base nitrogen (TVB-N) in canned fish products tend to be higher than in fresh fish?

a) Canned fish is naturally higher in TVB-N

b) Thermal treatment in canning leads to the generation of volatile bases

c) Canned fish contains more bacteria than fresh fish

d) Canned fish undergoes chemical reactions that increase TVB-N

119. What is the typical acceptable range of salt content in fish products in the UK?

a) 0.5-1.5%

b) 10-15%

c) 5-8%

d) 1 -4%

120. The oldest method of preserving freshness of fish is \_\_\_\_\_\_\_\_.

a) Icing

b) Sun drying

c) Smoking

d) Fermentation

121. The shelf life of canned fish is around ­­­\_\_\_\_\_\_\_ years.

a) 1

b) 2

c) 3

d) 4

122. How is Bombay duck fish usually preserved?

a) Pickling in brine

b) Smoking over open flame

c) Drying and salting whole fish by interlocking jaws of two small fish

d) Canning in oil

123. What should be the moisture % in Surimi to get good texture?

a)25-40%

b)45-60%

c)65-75%

d)75-80 %

**Matching type questions**

**1. Egg Albumen protein and their functions**

|  |  |
| --- | --- |
| List I | List II |
| 1. Ovomacroglobulin | 1. Inhibits trypsin |
| 1. Ovomucoid | 1. Binds biotin |
| 1. Ovotransferrin | 1. Strongly antigenic |
| 1. Avidin | 1. Bind metallic ions |

Choose the correct answer from the options given below:

1. A-III, B-II, C-IV, D-I
2. A-III, B-I, C-IV, D-II
3. A-II, B-I, C-IV, D-III
4. A-II, B-II, C-III, D-IV

**2**. **The grade designation mark colours used by AGMARK for eggs include:**

|  |  |
| --- | --- |
| List I | List II |
| 1. Extra large | 1. Yellow |
| 1. Large | 1. Blue |
| 1. Medium | 1. Red |
| 1. Small | 1. White |

Choose the correct answer from the options given below:

1. A-IV, B-III, C-II, D-I
2. A-IV, B-I, C-III, D-II
3. A-III, B-I, C-IV, D-III
4. A-III, B-II, C-I, D-IV

**3.** **Composition of fish**

|  |  |
| --- | --- |
| List I | List II |
| 1. Edible portion of elliptically shaped fish (e.g. Salmon) | 1. 15-24% |
| 1. Fish meat protein | 1. 60% |
| 1. Moisture | 1. 35-40% |
| 1. Edible portion of large head or bellied fish (e.g. Cod) | 1. 65-80% |

Choose the correct answer from the options given below:

1. A-IV, B-III, C-II, D-I
2. A-I, B-III, C-IV, D-II
3. A-II, B-I, C-IV, D-III
4. None of the above

**4.** **Preservation of fish**

|  |  |
| --- | --- |
| List I | List II |
| 1. Salting + drying | 1. 1:3 |
| 1. Blanching | 1. 1:4 to 1:8 |
| 1. Dry salting salt:fish | 1. hurdle technology |
| 1. Wet salting Salt:fish | 1. Heat preservation |

Choose the correct answer from the options given below:

1. A-I, B-II, C-III, D-IV
2. A-II, B-I, C-III, D-IV
3. A-III, B-IV, C-I, D-II
4. A-III, B-IV, C-II, D-I

**Answer Key**

**Fill in the blanks**

|  |  |
| --- | --- |
| 1. Water glass | 1. 74 |
| 1. Magnum | 1. 70 |
| 1. Proteus sp. | 1. Avidin |
| 1. Loss | 1. 9-11 |
| 1. Lysozyme | 1. *Enterobacter cloacae* |
| 1. Salmonella sp. | 1. Mucin |
| 1. P-nitrophenyl. | 1. Albumen |
| 1. Aldehydes | 1. *Streptococcus lactis* |
| 1. Candling | 1. Fsh (falling stream heating) |
| 1. Roche yolk colour fan | 1. Frittata |
| 1. Haugh unit | 1. Nest-run egg |
| 1. *Pseudomonas fluorescens* | 27. 10ppm |
| 1. Water | 28. Colombo curing |
| 1. Ooporphins | 29. Glazing |
| 1. Ovomucin | 30. Sugar |

**Multiple choice questions**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 1.b | 16.c | 31. d | 46.b | 61.d | 76. b | 91. a | 106. b | 121. b |
| 2.b | 17.a | 32. d | 47.c | 62.c | 77. a | 92. d | 107. c | 122. c |
| 3.d | 18.d | 33.a | 48.c | 63. d | 78. c | 93. b | 108. b | 123. d |
| 4.a | 19.c | 34.c | 49.b | 64. b | 79. b | 94. d | 109. c |  |
| **5.c** | 20.b | 35.d | 50.b | 65. c | 80. d | 95. b | 110. b |  |
| 6.a | 21.c | 36.d | 51.b | 66. a | 81. c | 96. c | 111. a |  |
| 7.c | 22.b | 37.a | 52.b | 67. d | 82. a | 97. d | 112. d |  |
| 8.c | 23.a | 38.b | 53.b | 68. a | 83. d | 98. b | 113. b |  |
| 9.b | 24.c | 39.b | 54.c | 69. c | 84. b | 99. c | 114. d |  |
| 10.b | 25.b | 40.b | 55.c | 70. d | 85. c | 100. d | 115. c |  |
| 11.b | 26.a | 41.b | 56.c | 71. b | 86. b | 101. a | 116. b |  |
| 12.c | 27.a | 42.a | 57.c | 72. c | 87. a | 102. b | 117. d |  |
| 13.d | 28.a | 43.b | 58.a | 73. a | 88. b | 103. c | 118. b |  |
| 14.a | 29.b | 44.c | 59.a | 74. c | 89. d | 104. a | 119. d |  |
| 15.a | 30.c | 45.b | 60.c | 75. b | 90. c | 105. b | 120. a |  |

**Matching type questions**

|  |
| --- |
| 1.b |
| 2.a |
| 3.c |
| 4.d |