FAQ AND MCQ

SUBJECT:DOWNSTREAM PROCESSING ENGINEERING

CODE: BBTPC6030

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1. Definition of Bioseperations

Bioseparation is the systematic, large-scale separation and purification of biological products (proteins, nucleic acids, metabolites) from complex, dilute, and delicate fermentation broths or cell cultures.

2. What are the key steps followed in bioseperation?

Bioseparation typically involves four stages:

Removal of Insolubles: Separation of cell mass/debris (e.g., filtration, centrifugation).

Isolation of Product: Recovery of the product from the crude broth (e.g., extraction, adsorption).

Purification: Removal of contaminants similar to the product (e.g., high-resolution chromatography).

Polishing: Final purification and formulation for stability (e.g., crystallization, drying).

3. What are the Key Challenges in bioseperation

High Sensitivity: Biological molecules are fragile; temperature and pH must be controlled to prevent denaturation.

Low Concentration: Products are often found in very dilute streams.

High Impurity Levels: Many impurities have similar properties to the desired product.

4. Role and Importance of Bioseparation Process

Role: Bioseparation (downstream processing) is the critical, multi-step, industrial-scale process used to isolate and purify desired biological products (e.g., enzymes, proteins, antibodies) from complex mixtures, such as fermentation broth or cell cultures.

Importance:

1. **Product Purity & Efficacy:** It removes contaminants (host cell proteins, nucleic acids, cell debris), ensuring the final product meets high purity standards, which is vital for pharmaceutical safety and effectiveness.
2. **Economic Viability:** It represents 30–80% of total production costs. Efficient bioseparation increases yield and reduces waste, significantly influencing the cost-effectiveness of industrial biotechnology.
3. **Product Stability:** It involves gentle methods to stabilize the product (e.g., drying, crystallization) while preserving its biological activity.

5. How to Characteristics of Mixtures

Variable Composition & Physical Combination: Components in a mixture (such as blood or soil) are not present in a fixed ratio, and they are not chemically bonded, meaning they retain their individual properties.

Physical Separation & Energy: The constituents can be separated by simple physical methods (e.g., filtration, distillation), and their formation involves no net energy change.

6. What is Fixed Capital Investment (FCI)?
FCI is the capital required to install the complete, operational plant, including all equipment, materials, construction labor, piping, instrumentation, and engineering fees. It is a one-time cost, not including the working capital needed to run the plant.

7. Define Working Capital in Process Economics.
Working capital is the additional investment needed beyond fixed capital to start up the plant and operate it until it becomes self-sustaining (e.g., raw material inventory, cash for salaries, accounts receivable).

8. What is the difference between Direct and Indirect Costs in Capital Investment?
Direct Costs: Directly associated with physical equipment installation (e.g., equipment purchase, piping, insulation, foundations).

Indirect Costs: Expenses not directly related to equipment installation but necessary for project completion (e.g., engineering fees, construction overheads, contractor fees, contingency).

9. What are Operating Costs (OPEX) and their main components?
OPEX are the ongoing, day-to-day expenses incurred to maintain and run a production facility. Key components include raw materials, utilities (steam, electricity), maintenance, labor, and depreciation.

10. Define "Lang Factor" method.
The Lang Factor method is a quick technique to estimate the total fixed capital investment by multiplying the total delivered cost of major equipment by a constant factor (e.g., 4.74 for fluid processing plants).

11. What is the difference between Fixed and Variable Operating Costs?
Fixed Costs: Costs that remain constant regardless of production level (e.g., property taxes, salaries, insurance).

Variable Costs: Costs that change directly with production volume (e.g., raw materials, energy, packaging).

12. Methods for Separating Cells and Insolubles from Fermented Broth

The removal of biomass (microbial cells) and other insoluble components from the fermented broth is the first crucial step in downstream processing (solid-liquid separation). The primary methods include:

1. **Centrifugation:** Used for separating bacterial cells or components with significant density differences from the broth. High-speed continuous centrifuges (e.g., disc-stack or tubular bowl) are commonly used to achieve fast, high-quality separation.
2. **Filtration:** The most common technique for removing molds and filamentous bacteria. Rotary drum vacuum filters are frequently used for large-scale operations. For smaller, finer particles, membrane filters (microfiltration) are used.
3. **Flocculation:** The addition of chemical agents (e.g., inorganic salts, poly electrolytes) to aggregate cells into larger, denser clusters, which settle faster, making them easier to remove by filtration or sedimentation.
4. **Flotation:** A process where gas is passed through the broth; cells adsorb onto the bubbles, rise to the surface, and are removed as foam.

13. What is Chromatography in Bioseparation?

Chromatography is a physical technique used to separate, purify, or identify individual components (proteins, nucleic acids, metabolites) from a complex biological mixture. It relies on the differential distribution of analytes between a **stationary phase** (solid/gel matrix) and a **mobile phase** (solvent) as they move through a column.

14.Mention the Principle of Chromatography.

The core principle is the differential partitioning or binding affinity of components in a mixture. As the mobile phase carries the sample through the stationary phase, compounds with higher affinity for the stationary phase move slower, while those with lower affinity move faster, resulting in separation.

15. What is the difference between Stationary and Mobile Phase?

- **Stationary Phase:** The fixed bed, packed inside a column, which can be solid or a liquid supported on a solid (e.g., Resin, Silica Gel).
- **Mobile Phase:** The solvent or buffer (liquid or gas) that flows through the stationary phase, transporting the sample components.

16.Name four main types of chromatography used in bioseparation.

1. **Ion-Exchange Chromatography (IEX):** Separates based on charge.
2. **Size-Exclusion Chromatography (SEC/Gel Filtration):** Separates based on molecular size.
3. **Affinity Chromatography:** Separates based on specific binding (e.g., antigen-antibody).
4. **Hydrophobic Interaction Chromatography (HIC):** Separates based on hydrophobicity.

17. Define Rf cap R sub f Rf Value.

The Retardation factor (Rfcap R sub f Rf) is the ratio of the distance moved by the solute to the distance moved by the solvent front, calculated as:

Rf=Distance travelled by substance Distance travelled by solvent[0.1.8]cap R sub f equals the fraction with numerator Distance travelled by substance and denominator Distance travelled by solvent end-fraction open bracket 0.1 .8 close bracket

Rf=Distance travelled by substance Distance travelled by solvent[0.1.8]

18. Define the saponification process and name the alkali used for making hard soap.

Saponification is the chemical reaction in which fats or oils (triglycerides) are hydrolyzed by an alkali (like Sodium Hydroxide) to form glycerol and soap (salts of fatty acids).

Alkali: Sodium Hydroxide (NaOH) is used for producing hard, solid laundry soaps.

19.What is the chemical nature of synthetic detergents, and how are they different from soaps?

Synthetic detergents are sodium salts of long-chain alkyl hydrogen sulphates or sodium salts of long-chain benzene sulphonic acids.

- **Difference:** Unlike soaps, detergents do not precipitate (form scum) in hard water because they do not form insoluble calcium or magnesium salts.

20. Explain the role of alkali in cleaning with soap.

Alkalis (like NaOH) saponify fatty acids, reducing the surface tension of water and emulsifying oils/grease. The alkaline environment helps break down fats and oils into soluble substances that are easily washed away.

21. What is the difference between hard soap and soft soap based on the alkali used.

- **Hard Soap:** Produced using Sodium Hydroxide (NaOH), used in laundry and bar soaps.
- **Soft Soap:** Produced using Potassium Hydroxide (KOH), often used in shaving creams and liquid soaps due to higher solubility.

22. Semipermeable Membranes in UF

- **Definition:** Ultrafiltration (UF) uses asymmetric porous membranes, typically made of polymers like Polyethersulfone (PES), Polyvinylidene fluoride (PVDF), or Cellulose Acetate.
- **Function:** They act as a physical barrier, separating macromolecules (10

23. What is Membrane Geometry

- **Hollow Fiber:** Thin tubes (0.2–3 mm) with high packing density; allows backwashing, commonly used for water purification.

- **Spiral Wound:** Flat sheets wrapped around a center tube; cost-effective, high surface area, but prone to blockage with high solids.
- **Tubular:** Large channels (5–25 mm); excellent for high-suspended solids, easily cleaned, low packing density.
- **Plate & Frame:** Flat membranes on plates; used for viscous solutions, easy to replace.

24. Ultrafiltration Module Configuration

- **Pressurized (Pressure Vessel):** Membranes are in tubes (e.g., PVDF/PVC) housed in a pressure vessel; can operate as dead-end or cross-flow (inside-out or outside-in).
- **Immersed (Submerged):** Membranes are submerged in a tank; vacuum-driven. Common in Membrane Bioreactors (MBR).

25. Distillation (Bioseparation Application)

Definition: Separation of liquid mixtures based on differences in their boiling points/volatility.

Application: In bioprocessing, it is primarily used for the purification of fermentation products like ethanol or solvent recovery. It is generally used for thermally stable compounds.

26. What is Absorption

Definition: A unit operation where a soluble component (solute) moves from a gas or liquid phase into a bulk liquid absorbing medium (solvent).

Principle: Solubility of the component in the absorbent.

27. What isAdsorption

Definition: A surface phenomenon where molecules (adsorbate) from a bulk fluid (liquid or gas) adhere to the surface of a solid agent (adsorbent).

Application: Used for recovering high-value, low-concentration products, such as protein purification using packed bed adsorption.

27. Precipitation

Definition: The process of reducing the solubility of a component, causing it to form solid particles (precipitate) from a solution.

Key Example: Cohn fractionation method, which uses ethanol to precipitate plasma proteins like albumin.

28. What is Dialysis

Definition: A membrane separation technique based on the diffusion of small solutes across a semi-permeable membrane, driven by a concentration gradient.

Application: Used for buffer exchange, desalting (removing salts), or purification of proteins.

29. What is Electro-dialysis
Definition: A separation process that uses a membrane and an electric potential to move ionic species across the membrane.

Principle: It is used to remove or concentrate ions (e.g., desalination of broth) without using as much phase change as traditional evaporation.

30. What is Liquid Electrophoresis
Definition: The separation of charged particles (proteins, nucleic acids) in a liquid medium under the influence of an electric field.

Application: High-resolution separation based on charge-to-mass ratio.

31. What is crystallisation? Why is it important?

Crystallisation is a purification technique under which an atom or molecule arranges itself in a well-defined three-dimensional lattice and minimises the system's overall energy.

- It is essential because it enables us to prepare substances of the highest purity.

32. What is the water of crystallisation?

Water of crystallisation is the substantial number of water molecules present in a loose combination with a formula unit of the compound.

Multiple Choice Questions (MCQs)

Q1. Which of the following is considered the first step in downstream processing?

a) Chromatography
b) Extraction
c) Removal of Insolubles
d) Drying

Answer: c) Removal of Insolubles

Q2. What is the main, frequently used technique in bioseparation for purification of protein based on its solubility?

a) Filtration
b) Precipitation
c) Distillation
d) Crystallization

Answer: b) Precipitation

Q3. Which technique is used to remove water and concentrate the product at the end of the process?

a) Centrifugation
b) Chromatography
c) Lyophilization (Freeze drying)
d) Filtration

Answer: c) Lyophilization (Freeze drying)

Q4. The method of bioseparation based on the partition of a solute between two immiscible phases is:

a) Filtration
b) Extraction
c) Centrifugation
d) Crystallization

Answer: b) Extraction

Q5. Which of the following has high resolution but low throughput in bioseparation?

a) Filtration
b) Centrifugation

c) Chromatography
d) Sedimentation
Answer: c) Chromatography
Q6. The Cohn fractionation method is used for?
a) Cell disruption
b) Protein purification (precipitation)
c) Product drying
d) Filtration
Answer: b) Protein purification (precipitation)
Q7. Which of the following parameters is used for the separation of proteins in ion-exchange chromatography?
a) Size
b) Density
c) Charge
d) Volatility
Answer: c) Charge
Q8. The "k-factor" is an empirical correlation used for the estimation of which process?
a) Filtration
b) Chromatography
c) Centrifugation
d) Precipitation
Answer: c) Centrifugation
Q9. What is the main objective of bioseparation processes in industry?
a) To increase the growth rate of microorganisms
b) To isolate and purify biological products from a complex mixture
c) To prepare the nutrient medium for fermentation
d) To genetically modify the microorganisms
Answer: b) To isolate and purify biological products from a complex mixture
Q10. Which of the following is often the most significant contributor to the total cost of a bioprocess?
a) Upstream processing
b) Media sterilization
c) Downstream processing (Bioseparation)
d) Inoculum development
Answer: c) Downstream processing (Bioseparation)
Q11. What does the "RIPP" scheme stand for in downstream processing?
a) Removal, Isolation, Purification, Polishing
b) Recovery, Isolation, Purification, Polishing
c) Recovery, Inactivation, Processing, Polishing

d) Reduction, Isolation, Purification, Packaging

Answer: b) Recovery, Isolation, Purification, Polishing

Q12. Which of the following techniques is commonly used for the initial "harvesting" of cells from a fermentation broth?

a) High-performance liquid chromatography (HPLC)

b) Lyophilization

c) Centrifugation or Filtration

d) Affinity chromatography

Answer: c) Centrifugation or Filtration

Q13. The "polishing" step in bioseparation is primarily used for:

a) Removing large cell debris

b) Breaking open the cells

c) Final removal of trace impurities and ensuring product stability

d) Initial separation of product from broth

Answer: c) Final removal of trace impurities and ensuring product stability

Q14. Which of the following is considered a "Downstream Processing" step?

a) Inoculum preparation

b) Media sterilization

c) Cell disruption

d) Fermentation

Answer: c) Cell disruption

Q15. The main challenge in purifying intracellular proteins is:

a) High contamination by cell debris

b) Low viscosity

c) High stability

d) They are easily filtered

Answer: a) High contamination by cell debris

Q16. Which technique is commonly used to separate proteins based on their molecular charge?

a) Size-exclusion chromatography

b) Ion-exchange chromatography

c) Filtration

d) Distillation

Answer: b) Ion-exchange chromatography

Q17. What is the primary purpose of using "filter aids" in bioprocessing?

a) To lower the pH

b) To increase the viscosity

c) To improve filtration efficiency by reducing cake compressibility

d) To sterilize the product

Answer: c) To improve filtration efficiency by reducing cake compressibility

Q18. Why is downstream processing often called the "bottleneck" in biomanufacturing?
a) Because it happens before fermentation
b) Because it is cheap and simple
c) Because it is expensive and limits overall product yield
d) Because it requires very little time
Answer: c) Because it is expensive and limits overall product yield
Q19. Which of the following is a key characteristic of a mixture?
(a) Fixed melting point
(b) Components are chemically combined
(c) Variable composition
(d) Components cannot be separated physically
Answer: (c) Variable composition
Q20. Which of the following is an example of a biological mixture?
(a) Glucose
(b) Blood
(c) Sodium chloride
(d) Distilled water
Answer: (b) Blood (As it is a mixture of plasma, cells, proteins, etc.)
Q21. The components of a mixture can be separated by:
(a) Only chemical methods
(b) Physical methods
(c) Cannot be separated
(d) None of the above
Answer: (b) Physical methods
Q22. A homogeneous mixture with a uniform composition throughout is called a:
(a) Compound
(b) Suspension
(c) Solution
(d) Heterogeneous mixture
Answer: (c) Solution
Q23. Which of the following is NOT a property of a mixture?
(a) It retains the properties of its components.
(b) It has a fixed boiling point.
(c) It can be homogeneous or heterogeneous.
(d) Components are not in a fixed ratio.
Answer: (b) It has a fixed boiling point. (Mixtures have variable, not fixed, melting/boiling points)
Q24. Which of the following is considered a Fixed Capital Investment component?
A. Raw material inventory
B. Cost of piping and instrumentation

C. Salaries of operators
D. Utilities cost
Answer: B. Cost of piping and instrumentation
Q25. The cost of raw materials, energy, and labor are classified as:
A. Fixed capital
B. Working capital
C. Operating costs
D. Land cost
Answer: C. Operating costs
Q26. Which of the following is a non-depreciable capital cost?
A. Process machinery
B. Buildings
C. Land
D. Insulation
Answer: C. Land
Q27. As the capacity of a plant increases, the capital cost per unit of capacity typically:
A. Increases
B. Decreases (Economy of Scale)
C. Remains constant
D. Becomes zero
Answer: B. Decreases (Economy of Scale)
Q28. The "total capital investment" for a project is defined as:
A. Fixed Capital + Working Capital
B. Fixed Capital - Depreciation
C. Operating Cost + Maintenance
D. Total Revenue - Total Cost
Answer: A. Fixed Capital + Working Capital
Q29. Which of the following is NOT an operating cost?
A. Depreciation
B. Maintenance
C. Raw materials
D. Initial plant design fee
Answer: D. Initial plant design fee (This is capital expenditure)
Q30. Which method is commonly used for a quick, preliminary estimation of capital cost?
A. Detailed item-by-item accounting
B. Lang Factor method
C. Market valuation
D. Sunk cost analysis
Answer: B. Lang Factor method

Q31. The "Turnover Ratio" is defined as:
A. Operating Cost / Fixed Capital
B. Gross Annual Sales / Fixed Capital Investment
C. Working Capital / Fixed Capital
D. Net Profit / Total Investment
Answer: B. Gross Annual Sales / Fixed Capital Investment
Q32. Which of the following is commonly used for separating filamentous fungi from fermentation broth?
A. Distillation
B. Rotary drum vacuum filter
C. Gas Chromatography
D. Spray drying
Answer: B. Rotary drum vacuum filter
Q33. The process of adding chemical agents to aggregate cells for faster settling is called:
A. Centrifugation
B. Flocculation
C. Distillation
D. Extraction
Answer: B. Flocculation
Q34. Which method is most effective for separating small bacteria with small density differences from the medium?
A. Filtration
B. Sedimentation
C. Centrifugation
D. Evaporation
Answer: C. Centrifugation
Q35. What is the first step in downstream processing to remove biomass from the culture broth called?
A. Polishing
B. Crystallization
C. Solid-Liquid Separation/Harvesting
D. Drying
Answer: C. Solid-Liquid Separation/Harvesting
Q36. In which type of filtration does the flow of broth occur tangentially to the membrane to reduce clogging?
A. Conventional Filtration
B. Cross-flow filtration
C. Dead-end filtration
D. Batch filtration
Answer: B. Cross-flow filtration

Q37. In gel filtration chromatography, separation of proteins is based on their:
a) Size and net charge
b) Shape and net charge
c) Size and shape (Molecular weight)
d) Specific affinity
Answer: c) Size and shape (Molecular weight)
Q38. Which chromatography is used for the separation of proteins based on their specific binding affinity to a ligand?
a) Ion-exchange chromatography
b) Affinity chromatography
c) Gel filtration chromatography
d) Adsorption chromatography
Answer: b) Affinity chromatography
Q39. The component that travels faster in column chromatography usually has:
a) Higher affinity for the stationary phase
b) Lower affinity for the stationary phase
c) Larger molecular weight
d) Higher solubility in the solid phase
Answer: b) Lower affinity for the stationary phase
Q4.0 What does a chromatogram plot?
a) Concentration vs. Time
b) Detector response vs. Time
c) Pressure vs. Flow rate
d) Temperature vs. Volume
Answer: b) Detector response vs. Time
Q41. In Ion Exchange Chromatography, if the stationary phase is negatively charged, it is called:
a) Cation exchanger
b) Anion exchanger
c) Gel filtration
d) Affinity
Answer: a) Cation exchanger (Note: A cation exchanger binds positive ions, therefore it is a negative matrix).
Q42. Which chromatography technique uses porous beads to separate molecules?
a) Adsorption chromatography
b) Affinity chromatography
c) Gel filtration chromatography
d) Paper chromatography
Answer: c) Gel filtration chromatography
Q43. The retardation factor (Rf cap R sub f

Rf) value ranges between:
a) 0 and 1
b) 0 and 10
c) -1 and 1
d) 1 and 100
Answer: a) 0 and 1
Q44. The chemical reaction between fat and alkali to produce soap is called:
a) Neutralization
b) Saponification
c) Hydrogenation
d) Esterification

- **Answer:** b) Saponification

Q45. Detergents are primarily manufactured from:
a) Sodium salts of fatty acids
b) Potassium salts of fatty acids
c) Sodium salts of alkyl benzene sulphonic acids
d) Calcium salts of long-chain acids

Answer: c) Sodium salts of alkyl benzene sulphonic acids

Q46. Which type of detergent is commonly used in hair shampoos?
a) Anionic
b) Cationic
c) Non-ionic
d) Neutral

Answer: b) Cationic detergents

Q48. Synthetic detergents are better cleaners than soap in hard water because they:
a) Are biodegradable
b) Form scum with

Ca2+cap C a raised to the 2 plus power
$Ca2+$
ions
c) Do not form insoluble precipitates with

Ca2+/Mg2+cap C a raised to the 2 plus power / cap M g raised to the 2 plus power
$Ca2+/Mg2+$
ions
d) Are acidic in nature

- **Answer:** c) Do not form insoluble precipitates with

Ca2+/Mg2+cap C a raised to the 2 plus power / cap M g raised to the 2 plus power

$Ca2+/Mg2+$ ions

Q49. In the cleansing action of detergents, the hydrophobic part is:
a) A long-chain hydrocarbon
b) Anionic part
c) Water-soluble
d) Sodium ion

- **Answer:** a) A long-chain hydrocarbon

Q50. Which membrane module configuration offers the highest packing density?
A) Plate and Frame
B) Tubular
C) Hollow Fiber
D) Spiral Wound

- **Answer: C) Hollow Fiber**

Q51. The mechanism of separation in ultrafiltration is primarily:
A) Diffusion
B) Size exclusion
C) Absorption
D) Electrostatic attraction

- **Answer: B) Size exclusion**

Q52. Which of the following is used to remove proteins, bacteria, and viruses?
A) Microfiltration

B) Nanofiltration
C) Ultrafiltration
D) Reverse Osmosis

- **Answer: C) Ultrafiltration**

Q53. In a cross-flow ultrafiltration module, the feed flows:
A) Perpendicular to the membrane
B) Tangentially (parallel) to the membrane surface
C) Through the center tube
D) Only from the bottom up

- **Answer: B) Tangentially (parallel) to the membrane surface**

Q54. What does MWCO stand for in membrane technology?
A) Membrane Water Chemical Operation
B) Molecular Weight Cut-Off
C) Maximum Waste Concentration Output
D) Molecular Weight Chemical Operation

- **Answer: B) Molecular Weight Cut-Off**

Q55. Which membrane module is best suited for liquids with high suspended solids?
A) Hollow Fiber
B) Spiral Wound
C) Tubular
D) Capillary

- **Answer: C) Tubular**

Q56. Concentration polarization in UF leads to:
A) Increased flux
B) Improved water quality
C) Reduced membrane fouling
D) Reduced permeate flux

- **Answer: D) Reduced permeate flux**

Q57. Solvent extraction is primarily defined as a:
a) Gas-liquid operation
b) Liquid-liquid operation
c) Liquid-solid operation

d) Solid-gas operation

Answer: b) Liquid-liquid operation

Q58. Which of the following is essential for the solvent used in liquid-liquid extraction?

a) Highly soluble in the feed phase

b) Immiscible with the aqueous phase

c) High viscosity

d) Low affinity for the desired solute

Answer: b) Immiscible with the aqueous phase

Q59. The phase that is rich in the solvent and contains the extracted solute is called the:

a) Feed

b) Raffinate

c) Extract

d) Diluent

Answer: c) Extract

Q60. If the selectivity of a solvent in extraction is unity, it means:

a) Separation is most effective

b) No separation will occur

c) The solvent is highly efficient

d) The extraction is instantaneous

Answer: b) No separation will occur

Q61. Which solvent is widely used in LLE due to its low toxicity and good solubility for organic compounds?

a) Benzene

b) Ethyl acetate

c) Water

d) Sulfuric acid

Answer: b) Ethyl acetate

Q62. What is the purpose of adding inorganic salts or buffers during LLE?

a) To reduce the volume of the solvent

b) To break the emulsion

c) To improve extraction kinetics/efficiency

d) To increase the toxicity

Answer: c) To improve extraction kinetics/efficiency

Q63. In a triangular coordinate diagram, what does a "tie line" represent?

a) The flow rate of the solvent

b) The temperature of the system

c) The equilibrium compositions of two phases

d) The total time of extraction

Answer: c) The equilibrium compositions of two phases

Q64. Liquid-liquid extraction is highly preferred when:
a) One of the components is heat sensitive
b) The components have very high boiling points
c) The components have identical solubilities
d) The mixture is a gas
Answer: a) One of the components is heat sensitive
Q65. Which of the following bioseparation techniques is used to separate solid particles from a broth, acting as a high-throughput, low-resolution step?
a) Liquid Chromatography
b) Electrophoresis
c) Precipitation
d) Affinity Chromatography
Answer: c) Precipitation
Q66. In dialysis, what is the primary driving force for separation?
a) Pressure difference
b) Concentration gradient
c) Electric potential
d) Temperature difference
Answer: b) Concentration gradient
Q67. Which technique is most suitable for the purification of proteins based on their solubility?
a) Distillation
b) Precipitation
c) Evaporation
d) Gas absorption
Answer: b) Precipitation
Q68. Electro-dialysis uses which of the following to separate ions?
a) Size exclusion
b) Hydrophobic interaction
c) Electric potential
d) Affinity binding
Answer: c) Electric potential
Q69. Adsorption is primarily considered a _____ phenomenon.
a) Volume-based
b) Surface-based
c) Density-based
d) Time-based
Answer: b) Surface-based
Q70. Which of the following is an example of a high-resolution, low-throughput technique?
a) Filtration

b) Electrophoresis
c) Cell disruption
d) Centrifugation
Answer: b) Electrophoresis
Q70. The Cohn fractionation method is a, well-known application of _____ in blood plasma purification.
a) Distillation
b) Precipitation
c) Electrodialysis
d) Adsorption
Answer: b) Precipitation
Q71. Which technique relies on the difference in boiling points?
a) Adsorption
b) Absorption
c) Distillation
d) Dialysis
Answer: c) Distillation
Q72. What is the purpose of adding SODIUM DODECYL SULFATE (SDS) in SDS-PAGE electrophoresis?
a) To increase the temperature
b) To break the cell wall
c) To confer a negative charge to proteins
d) To increase the viscosity
Answer: c) To confer a negative charge to proteins
Q73. Which of the following is generally the first step in the downstream processing (RIPP scheme) of intracellular products?
a) Purification
b) Polishing
c) Cell disruption
d) Crystallization
Answer: c) Cell disruption
Q74. Which of the following facilitates crystallisation?

(a) Adiabatic evaporation and cooling

(b) Solution is concentrated by evaporation

(c) Hot concentrated solution is cooled for crystals to form

(d) All of the above

Answer: (d) Adiabatic evaporation, cooling and cooling of hot concentrated solution to form crystals facilitates crystallisation.

Q75. What is the name of the substance containing water of crystallisation?

(a) Anion

(b) Hydrate

(c) Buffer

(d) None of the above

Answer: (b) Hydrate contains water of crystallisation.

Q76. Which of the following is not an essential criterion for crystal formation?

(a) Moisture content

(b) Caking characteristics of the crystal

(c) Shape

(d) None of the above

Answer: (d) Moisture content, caking characteristics of the crystal and shape are the essential criterion for crystal formation.

Q77. Which of the following salts does not contain water of crystallisation?

(a) Blue vitriol

(b) Washing soda

(c) Baking soda

(d) All of the above

Answer: (c) Washing soda does not contain water of crystallisation.

Q78. Which of the following parameter affects the rate of crystallisation?

(a) Purity of solution

(b) Agitator speed

(c) Population density

(d) All of the above

Answer: (d) Purity of solution, agitator speed and population density affect the rate of crystallisation.

Q79. Which of the following tells the significance of crystallisation in food processing?

(a) Physical stability of the food

(b) Consistency of food emulsions

(c) A good feel of food inside the mouth

(d) All of the above

Answer: (d) Physical stability of the food, consistency of food emulsions and a good feel of food inside the mouth tells about the significance of crystallisation in food processing.