

IIT JAM 2026 Biotechnology Question Paper with Solutions(Memory Based)

Time Allowed :3 Hours	Maximum Marks :70	Total questions :5
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. Each activity has to be answered in full sentence/s. One word answers will not be given complete credit. Just the correct activity number written in case of options will not be given credit.
2. Web diagrams, flow charts, tables, etc. are to be presented exactly as they are with answers.
3. In point 2 above, just words without the presentation of the activity format, will not be given credit. Use of colour pencils/pens etc. is not allowed. (Only blue/black pens are allowed.)
4. Multiple answers to the same activity will be treated as wrong and will not be given any credit.
5. Maintain the sequence of the Sections/Question Nos./Activities throughout the activity sheet.

1. Which membrane protein requires ATP to transport?

- (A) Antiporter
- (B) Symporter
- (C) Pumps
- (D) Ion channels

Correct Answer: (C) Pumps

Solution:

Concept: Membrane transport proteins are classified based on whether they require energy (ATP) or not. Transport across membranes can be passive (no ATP) or active (requires ATP).

Step 1: Ion channels Ion channels allow passive diffusion of ions along their concentration gradient. They do **not require ATP**.

Step 2: Symporters and antiporters These are co-transporters involved in **secondary active transport**. They use energy indirectly from ion gradients (like Na^+), not directly from ATP.

Step 3: Pumps Pumps perform **primary active transport**. They directly hydrolyze ATP to move substances against their concentration gradient.

Examples: - Na^+/K^+ pump - Proton pump - Ca^{2+} pump

Step 4: Conclusion Only membrane pumps directly use ATP for transport.

Pumps

Quick Tip

Primary active transport = Uses ATP directly → Pumps. Secondary active transport = Uses ion gradient → Symporters/Antiporters.

2. Which is not a second messenger?

- (A) Ca^{2+}
- (B) DAG
- (C) cAMP
- (D) K^+

Correct Answer: (D) K^+

Solution:

Concept: Second messengers are intracellular signaling molecules released in response to extracellular signals (first messengers like hormones). They amplify and transmit signals inside the cell.

Step 1: Common second messengers Well-known second messengers include: - cAMP (cyclic AMP) - DAG (Diacylglycerol) - IP₃ - Ca²⁺

These molecules activate intracellular pathways.

Step 2: Role of Ca²⁺ Calcium ions act as important second messengers in: - Muscle contraction - Neurotransmission - Enzyme activation

Step 3: Role of DAG and cAMP - DAG activates protein kinase C (PKC). - cAMP activates protein kinase A (PKA).

Both are classic second messengers.

Step 4: Potassium ion (K⁺) Potassium ions mainly: - Maintain membrane potential - Help in nerve impulse transmission

They are **not typical second messengers** in signal transduction pathways.

Conclusion:



Quick Tip

Major second messengers: cAMP, Ca²⁺, IP₃, DAG. If an ion is mainly structural/electrical (like K⁺), it is usually not a second messenger.

3. Which is the most abundant phospholipid in the *E. coli* membrane?

- (A) Phosphatidylcholine
- (B) Serine
- (C) Inositol
- (D) Ethanolamine

Correct Answer: (D) Ethanolamine

Solution:

Concept: The bacterial membrane, especially in *E. coli*, has a distinct phospholipid composition compared to eukaryotic membranes.

Step 1: Major phospholipids in *E. coli* The main phospholipids present are: - Phosphatidylethanolamine (PE) — most abundant - Phosphatidylglycerol (PG) - Cardiolipin (CL)

Step 2: Why phosphatidylethanolamine dominates Phosphatidylethanolamine contributes:
- Membrane curvature - Structural integrity - Proper functioning of membrane proteins
It constitutes about 70–80% of total phospholipids.

Step 3: Eliminating other options - Phosphatidylcholine is mainly found in eukaryotic membranes. - Inositol phospholipids are typical in eukaryotic signaling. - Serine is a precursor but not the dominant lipid.

Conclusion:

Phosphatidylethanolamine (Ethanolamine)

Quick Tip

Bacteria vs Eukaryotes: *E. coli* membrane → Phosphatidylethanolamine dominant. Animal cells → Phosphatidylcholine dominant.

4. Incorrect statement:

- (A) IgM is pentamer
- (B) IgA is dimer
- (C) IgD is most abundant
- (D) IgE is involved in allergic reactions

Correct Answer: (C) IgD is most abundant

Solution:

Concept: Different classes of immunoglobulins (antibodies) have distinct structures, abundance, and functions in the immune system.

Step 1: IgM structure IgM exists as a **pentamer** in its secreted form. Hence statement (A) is correct.

Step 2: IgA structure Secretory IgA is typically found as a **dimer** (especially in mucosal secretions). So statement (B) is correct.

Step 3: Most abundant immunoglobulin The most abundant antibody in serum is **IgG**, not IgD. IgD is present in very low concentrations and mainly acts as a B-cell receptor.

Hence statement (C) is incorrect.

Step 4: IgE function IgE is responsible for: - Allergic reactions - Type I hypersensitivity - Defense against parasites

So statement (D) is correct.

Conclusion: Incorrect statement:

IgD is most abundant

Quick Tip

Antibody facts: IgG = most abundant IgM = pentamer IgA = dimer (secretions) IgE = allergy mediator

5. Which of the following is NOT an essential amino acid?

- (A) Valine
- (B) Threonine
- (C) Tyrosine
- (D) Tryptophan

Correct Answer: (C) Tyrosine

Solution:

Concept: Amino acids are classified as essential and non-essential based on whether the human body can synthesize them.

- **Essential amino acids:** Must be obtained from diet. - **Non-essential amino acids:** Can be synthesized in the body.

Step 1: Essential amino acids Some important essential amino acids include: - Valine - Threonine - Tryptophan - Lysine - Methionine - Leucine - Isoleucine - Phenylalanine - Histidine

Step 2: Tyrosine classification Tyrosine is considered a **non-essential (conditionally essential)** amino acid because it is synthesized from phenylalanine in the body.

Hence, it does not need to be obtained directly from diet under normal conditions.

Step 3: Check options - Valine → Essential - Threonine → Essential - Tryptophan → Essential - Tyrosine → Non-essential

Conclusion:

Tyrosine

Quick Tip

Mnemonic for essential amino acids: **PVT TIM HALL** Tyrosine is NOT included → it is derived from phenylalanine.

6. Coenzyme A is a cofactor derived from:

- (A) Riboflavin
- (B) Folic acid
- (C) Pyridoxine
- (D) Pantothenic acid

Correct Answer: (D) Pantothenic acid

Solution:

Concept: Coenzymes are organic cofactors derived from vitamins and are essential for enzyme function in metabolism.

Step 1: Structure of Coenzyme A (CoA) Coenzyme A is a complex molecule composed of: - Adenosine diphosphate - Cysteamine group - Pantothenic acid (Vitamin B₅)

Pantothenic acid forms the core structure.

Step 2: Function of CoA CoA plays a crucial role in: - Fatty acid metabolism - Krebs cycle (acetyl-CoA formation) - Acyl group transfer reactions

Step 3: Eliminating other options - Riboflavin → precursor of FAD and FMN - Folic acid → one-carbon metabolism - Pyridoxine (Vitamin B₆) → amino acid metabolism

None of these form Coenzyme A.

Conclusion:

Pantothenic acid

Quick Tip

Vitamin origins of coenzymes: CoA → Pantothenic acid (B₅) FAD/FMN → Riboflavin (B₂) PLP → Pyridoxine (B₆)

7. Which of the following is characteristic of the CD spectrum of an α -helix?

- (A) Negative peak at 220 nm
- (B) Negative peak at 195 nm
- (C) Negative peak at 210 nm
- (D) Positive peak at 195 nm

Correct Answer: (A) Negative peak at 220 nm

Solution:

Concept: Circular Dichroism (CD) spectroscopy is used to determine protein secondary structure. Different structures (-helix, -sheet, random coil) have characteristic CD signals.

Step 1: CD spectrum of α -helix An α -helix typically shows: - Two negative minima at ~ 208 nm and ~ 222 nm - One positive peak near ~ 190 nm

Step 2: Interpretation of options - Negative at 220 nm → matches α -helix signature (near 222 nm). - Negative at 195 nm → incorrect (positive peak occurs near 190–195 nm). - Negative at 210 nm → not the main characteristic peak. - Positive at 195 nm → true generally, but the most diagnostic feature is the strong negative band near 222 nm.

Step 3: Diagnostic feature The most characteristic hallmark of an α -helix is:

Strong negative ellipticity near 222 nm

Conclusion:

Negative peak at 220 nm

Quick Tip

CD signatures: α -helix → Negative at 208 & 222 nm, positive near 190 nm. β -sheet → Negative 218 nm, positive 195 nm.

8. Methods used in local alignment of nucleotide/protein sequences include:

- (A) Needleman–Wunsch
- (B) BLAST
- (C) Smith–Waterman
- (D) Neighbor-Joining (NJ)

Correct Answer: (C) Smith–Waterman

Solution:

Concept: Sequence alignment methods are classified into: - Global alignment → aligns entire sequences - Local alignment → finds best matching subsequences

Step 1: Needleman–Wunsch This is a **global alignment** algorithm. It aligns sequences end-to-end. Hence not used for local alignment.

Step 2: BLAST BLAST is a heuristic tool for rapid similarity searches. It performs local alignment but is not the classical dynamic programming method expected here.

Step 3: Smith–Waterman Smith–Waterman is the **standard dynamic programming algorithm** for local alignment. It identifies high-scoring local regions between sequences.

Step 4: Neighbor-Joining (NJ) NJ is a phylogenetic tree construction method, not an alignment algorithm.

Conclusion:

Smith–Waterman

Quick Tip

Alignment algorithms: Needleman–Wunsch → Global alignment Smith–Waterman → Local alignment NJ → Phylogenetic trees

9. Match the vitamins with their deficiency diseases.

Vitamins: VIT A, VIT D, VIT B₆, VIT C, VIT K

Deficiencies: Prolonged wound repair, Night blindness, Bone softening, Anaemia

Correct Answer:

Vit A → Night blindness

Vit D → Bone softening

Vit B₆ → Anaemia

Vit C → Prolonged wound healing

Vit K → Bleeding tendency (not listed)

Solution:

Concept: Each vitamin has specific physiological roles, and deficiency leads to characteristic diseases.

Step 1: Vitamin A Role: Vision (retinal pigment rhodopsin). Deficiency leads to:

Night blindness

Step 2: Vitamin D Role: Calcium absorption and bone mineralization. Deficiency causes:

Bone softening (Rickets/Osteomalacia)

Step 3: Vitamin B₆ (Pyridoxine) Role: Amino acid metabolism and heme synthesis.

Deficiency results in:

Anaemia

Step 4: Vitamin C Role: Collagen synthesis and wound healing. Deficiency causes:

Delayed wound healing (Scurvy)

Step 5: Vitamin K Role: Blood clotting factor synthesis. Deficiency leads to:

Bleeding tendency

(Not explicitly listed but important correction.)

Quick Tip

Quick vitamin recall: A → Eyes (Night blindness) D → Bones C → Collagen (Wound healing) K → Clotting B₆ → Anaemia

10. Which of the following processes causes the founder effect?

- (A) Mutualism
- (B) Genetic drift
- (C) Natural selection
- (D) Genetic recombination

Correct Answer: (B) Genetic drift

Solution:

Concept: The founder effect is an evolutionary phenomenon that occurs when a small group of individuals establishes a new population, carrying only a limited portion of the original genetic variation.

Step 1: Understanding founder effect When a few individuals colonize a new area: - Genetic diversity is reduced - Certain alleles become overrepresented - Rare traits may become common

This happens due to random sampling.

Step 2: Role of genetic drift The founder effect is a type of:

Genetic drift

Genetic drift refers to random changes in allele frequencies, especially in small populations.

Step 3: Eliminating other options - Mutualism → Ecological interaction, not evolutionary mechanism. - Natural selection → Non-random adaptation. - Genetic recombination → Shuffles genes but does not cause founder effect.

Conclusion:

Genetic drift

Quick Tip

Founder effect = Small population + Random allele sampling. It is a classic example of **genetic drift**.

11. Which of the following is/are found in the human brain?

- (A) Microglial cells
- (B) Astrocytes
- (C) Podocytes
- (D) Oligodendrocytes

Correct Answer: (A), (B), and (D)

Solution:

Concept: The human brain contains neurons and various types of glial cells (neuroglia), which support and protect neurons.

Step 1: Microglial cells Microglia are immune cells of the central nervous system. They act as macrophages and are present in the brain. Hence, correct.

Step 2: Astrocytes Astrocytes are star-shaped glial cells that: - Maintain blood-brain barrier - Provide metabolic support - Regulate neurotransmitters
They are abundant in the brain. Correct.

Step 3: Podocytes Podocytes are specialized cells of the kidney (glomerulus). They are involved in filtration and not found in the brain. Incorrect.

Step 4: Oligodendrocytes Oligodendrocytes produce myelin sheaths around CNS axons. They are present in the brain and spinal cord. Correct.

Conclusion: Cells found in human brain:

Microglia, Astrocytes, Oligodendrocytes

Quick Tip

CNS glial cells: Astrocytes, Oligodendrocytes, Microglia, Ependymal cells. Podocytes belong to kidney, not brain.