AP PGECET BT2 Bio Technology 2025 Question paper with solutions

Time Allowed :2 hours	Maximum Marks :120	Total Questions :120

Bio Technology

1. Which one of the following is most accurate for determining bacterial cell viability?

(1) Gram staining
(2) Colony-forming unit (CFU) count
(3) Optical density
(4) Total cell count using a hemocytometer

Correct Answer: (2) Colony-forming unit (CFU) count

Solution:
Colony-forming unit (CFU) count is the most accurate method for determining bacterial cell viability. This technique involves plating a diluted bacterial sample on an agar plate and counting the number of colonies that grow. Each colony originates from a viable bacterium. Gram staining and optical density are not as accurate because they don't specifically measure cell viability, and total cell count using a hemocytometer includes both viable and non-viable cells.

Quick Tip

For determining cell viability, CFU count is often the best option, as it directly measures the number of viable, living cells in a sample.

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2. The most common mode of transmission for diphtheria, pneumonia, and tuberculosis is through:

(1) Direct contact
(2) Aerosols
(3) Contaminated water
(4) Insect vectors

Correct Answer: (2) Aerosols

Solution:
Diphtheria, pneumonia, and tuberculosis are primarily transmitted through aerosols, which means the pathogens are spread through airborne particles, often when an infected person coughs or sneezes. This is the most common route for these respiratory infections. Direct contact and contaminated water are less common modes for these diseases, and insect vectors do not typically play a role in their transmission.

When studying infectious diseases, it is important to remember that airborne transmission (aerosols) is common for respiratory diseases like tuberculosis and pneumonia.

Quick Tip

Focus on the primary mode of transmission for different diseases. For respiratory infections, aerosols are often the most common route.

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3. Which enzyme allows retroviruses to transcribe RNA into DNA?

(1) DNA polymerase
(2) Reverse transcriptase
(3) RNA polymerase
(4) Ligase

Correct Answer: (2) Reverse transcriptase

Solution:
Reverse transcriptase is the enzyme responsible for converting RNA into DNA in retroviruses. This enzyme catalyzes the reverse transcription process, where RNA is used as a template to synthesize complementary DNA. DNA polymerase is involved in DNA replication, RNA polymerase transcribes DNA into RNA, and ligase helps in the joining of DNA strands, none of which play a role in RNA-to-DNA conversion in retroviruses.

For retroviruses, reverse transcriptase is key to their replication process, allowing them to integrate their RNA genome into the host's DNA.

Quick Tip

Remember that reverse transcriptase is unique to retroviruses for their RNA to DNA conversion.

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4. Which growth phase is characterized by the most rapid increase in cell number and maximal metabolic activity?

(1) Lag phase
(2) Log (exponential) phase
(3) Stationary phase
(4) Death phase

Correct Answer: (2) Log (exponential) phase

Solution:
The log (or exponential) phase is characterized by the most rapid increase in cell number and maximal metabolic activity. During this phase, cells are actively dividing and using nutrients at a high rate. The lag phase is a period of adaptation, the stationary phase occurs when nutrient levels deplete and cell growth slows, and the death phase is when cells start to die due to lack of resources.

In microbiology, the log phase is the optimal phase for studying cell growth and metabolism due to the rapid division and active processes.

Quick Tip

The log phase is the key to understanding growth rates and nutrient consumption in bacterial cultures.

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5. The prominent group of microorganisms involved in marine biocorrosion is:

(1) Sulphur oxidizing bacteria
(2) Iron oxidizing bacteria
(3) Sulphide oxidizing bacteria
(4) Sulphate reducing bacteria

Correct Answer: (4) Sulphate reducing bacteria

Solution:
Sulphate reducing bacteria (SRB) are the prominent microorganisms involved in marine biocorrosion. They contribute to the deterioration of materials such as metals by producing hydrogen sulfide, which can lead to the corrosion of metal surfaces. Sulphur and iron oxidizing bacteria also contribute to corrosion but are less prominent than SRB in marine environments. Sulphide oxidizing bacteria are involved in different metabolic processes, not corrosion.

Focus on the different types of bacteria that cause biocorrosion, particularly in marine environments, where sulphate reducing bacteria are most responsible.

Quick Tip

In marine ecosystems, sulphate reducing bacteria play a key role in metal corrosion processes.

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6. Which of the following is not a characteristic of anaerobic respiration in bacteria?

(1) Use of oxygen as final electron acceptor
(2) Generation of ATP via electron transport chain
(3) Use of inorganic molecules like nitrate or sulfate
(4) Less energy yield compared to aerobic respiration

Correct Answer: (1) Use of oxygen as final electron acceptor

Solution:
Anaerobic respiration is characterized by the use of inorganic molecules like nitrate or sulfate as the final electron acceptor, rather than oxygen. Oxygen is used in aerobic respiration, which yields more energy. Anaerobic respiration does not involve the electron transport chain in the same way as aerobic respiration, but it still generates ATP. Anaerobic respiration typically results in less energy production compared to aerobic respiration.

In anaerobic respiration, focus on the electron acceptors. If oxygen is used, it's aerobic, not anaerobic.

Quick Tip

Anaerobic respiration uses inorganic molecules instead of oxygen to accept electrons.

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7. Photosynthesis is a:

(1) Reductive, endergonic, anabolic process
(2) Reductive, exergonic, catabolic process
(3) Reductive, exergonic, anabolic process
(4) Reductive, endergonic, catabolic process

Correct Answer: (1) Reductive, endergonic, anabolic process

Solution:
Photosynthesis is a reductive (it involves the reduction of carbon dioxide to glucose), endergonic (requires energy input in the form of light), and anabolic (builds larger molecules from smaller ones) process. It is the opposite of catabolic processes, which break down molecules. Exergonic reactions release energy, while photosynthesis requires energy to be absorbed.

Photosynthesis is an energy-consuming process that builds glucose from carbon dioxide, so it's endergonic and anabolic.

Quick Tip

Remember that photosynthesis stores energy in glucose, making it an anabolic and endergonic process.

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8. Which of the following is a selective medium for Gram-negative bacteria?

(1) MacConkey agar
(2) Chocolate agar
(3) Blood agar
(4) Nutrient agar

Correct Answer: (1) MacConkey agar

Solution:
MacConkey agar is a selective medium that inhibits the growth of Gram-positive bacteria and supports the growth of Gram-negative bacteria. It also differentiates bacteria based on lactose fermentation. Chocolate agar and blood agar are enriched media that support the growth of a variety of organisms, not just Gram-negative bacteria. Nutrient agar is a general-purpose medium and is not selective.

MacConkey agar is commonly used in microbiology to isolate and differentiate Gram-negative bacteria.

Quick Tip

Remember that MacConkey agar is selective for Gram-negative bacteria and differentiates them based on lactose fermentation.

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9. A transducing phage differs from a regular bacteriophage in that it:

(1) Carries plasmid DNA
(2) Forms lysogens in all hosts
(3) Transfers bacterial DNA from one cell to another
(4) Lyses host cells more rapidly

Correct Answer: (3) Transfers bacterial DNA from one cell to another

Solution:
A transducing phage is a type of bacteriophage that can transfer bacterial DNA from one bacterium to another during infection. This process is called transduction. Unlike regular bacteriophages, which typically inject only their viral DNA, transducing phages can incorporate bacterial DNA into their genome and transfer it to a new host. They do not necessarily lyse cells more rapidly.

Transduction is a mechanism of horizontal gene transfer facilitated by certain phages, allowing bacterial DNA to be transferred between cells.

Quick Tip

Focus on the fact that transducing phages carry and transfer bacterial DNA, unlike regular phages which only inject their own viral DNA.

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10. Which of the following statements about prions is true?

(1) They are viruses with no envelope
(2) They contain RNA
(3) They replicate without nucleic acids
(4) They are bacteria with unusual morphology

Correct Answer: (3) They replicate without nucleic acids

Solution:
Prions are misfolded proteins that replicate without the need for nucleic acids (DNA or RNA). They are not viruses, bacteria, or organisms that have a traditional genetic material. Prions cause neurodegenerative diseases, such as mad cow disease, by inducing misfolding in normal proteins. They do not contain RNA or any other nucleic acids.

Prions are unique in that they replicate solely through protein misfolding, without the need for DNA or RNA.

Quick Tip

Prions are protein-based infectious agents that do not require genetic material for replication.

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11. Agar-agar is a polymer of:

(1) Glucose
(2) Sulphated sugar
(3) Pectin
(4) Protein

Correct Answer: (2) Sulphated sugar

Solution:
Agar-agar is a polysaccharide derived from red algae, and it is a polymer of sulphated sugars. It is commonly used in microbiology as a solidifying agent in culture media. It is not made of glucose, pectin, or protein.

Agar-agar is a naturally occurring polymer used as a solidifying agent in microbiological media.

Quick Tip

Remember that agar-agar is derived from algae and consists of sulphated sugars.

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12. Which of the following enzymes is responsible for converting glucose-6-phosphate to fructose-6-phosphate in glycolysis?

(1) Hexokinase
(2) Phosphoglucose isomerase
(3) Aldolase
(4) Phosphofructokinase-1

Correct Answer: (2) Phosphoglucose isomerase

Solution:
Phosphoglucose isomerase is the enzyme responsible for converting glucose-6-phosphate to fructose-6-phosphate in glycolysis. Hexokinase is involved in the phosphorylation of glucose, aldolase catalyzes the cleavage of fructose-1,6-bisphosphate, and phosphofructokinase-1 is involved in another key step in glycolysis, not this conversion.

Focus on the enzymes responsible for the rearrangement and phosphorylation of intermediates during glycolysis.

Quick Tip

Phosphoglucose isomerase is the key enzyme for converting glucose-6-phosphate to fructose-6-phosphate.

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13. Porins:

(1) Are cytoskeletal proteins
(2) Form channels which allow passage of hydrophilic molecules
(3) Are fatty acids
(4) Are pores in the stem of a plant

Correct Answer: (2) Form channels which allow passage of hydrophilic molecules

Solution:
Porins are membrane proteins that form channels allowing the passage of small hydrophilic molecules, such as ions or small nutrients, across the bacterial outer membrane. They are not cytoskeletal proteins or fatty acids, and they are not related to plant pores.

Porins play a crucial role in the transport of substances across cell membranes, especially in bacteria.

Quick Tip

Remember that porins form channels to allow the passage of hydrophilic molecules in bacterial membranes.

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14. Which vitamin is a precursor for the coenzyme NAD+?

(1) Vitamin B1 (Thiamine)
(2) Vitamin B2 (Riboflavin)
(3) Vitamin B3 (Niacin)
(4) Vitamin B6 (Pyridoxine)

Correct Answer: (3) Vitamin B3 (Niacin)

Solution:
Vitamin B3 (Niacin) is a precursor for NAD+ (Nicotinamide adenine dinucleotide), a coenzyme involved in redox reactions in cellular metabolism. Vitamin B1, B2, and B6 are important for other metabolic pathways but are not directly involved in the synthesis of NAD+.

Niacin is the key vitamin involved in the formation of NAD+ and NADP+, essential coenzymes for cellular energy production.

Quick Tip

Niacin (Vitamin B3) is directly involved in the production of NAD+, which plays a vital role in cellular metabolism.

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15. A prominent prebiotic substance is:

(1) Starch
(2) Pectin

(3) Fructo oligosaccharide
(4) Cellulose

Correct Answer: (3) Fructo oligosaccharide

Solution:
Fructo oligosaccharides are a prominent prebiotic substance, as they promote the growth of beneficial gut bacteria. Starch, pectin, and cellulose are polysaccharides but do not necessarily function as prebiotics in the same way as fructo oligosaccharides.

Prebiotics, like fructo oligosaccharides, promote the growth of beneficial gut bacteria and help improve digestion and immune function.

Quick Tip

Fructo oligosaccharides are a class of prebiotics that stimulate the growth of healthy gut bacteria.

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16. During the TCA cycle, which step results in substrate-level phosphorylation?

(1) Isocitrate to -ketoglutarate
(2) -ketoglutarate to Succinyl-CoA
(3) Succinyl-CoA to Succinate
(4) Malate to Oxaloacetate

Correct Answer: (3) Succinyl-CoA to Succinate

Solution:
Substrate-level phosphorylation occurs during the conversion of Succinyl-CoA to Succinate, where a high-energy phosphate group is transferred to ADP to form ATP. This is one of the key energy-producing steps in the TCA cycle. The other steps involve decarboxylation and electron transfer but do not directly result in ATP production via substrate-level phosphorylation.

Substrate-level phosphorylation in the TCA cycle occurs when a high-energy phosphate is transferred to ADP to form ATP, as seen in the conversion of Succinyl-CoA to Succinate.

Quick Tip

Look for reactions in the TCA cycle where ATP is generated directly through substrate-level phosphorylation.

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17. Which of the following antibiotics is produced by chemical synthesis?

(1) Penicillin
(2) Streptomycin
(3) Tetracycline
(4) Chloramphenicol

Correct Answer: (4) Chloramphenicol

Solution:
Chloramphenicol is an antibiotic that was originally isolated from Streptomyces venezuelae but is now produced synthetically. Penicillin, streptomycin, and tetracycline are naturally derived antibiotics, although their production methods have been modified over time.

Chloramphenicol is a classic example of an antibiotic produced via chemical synthesis, rather than natural extraction.

Quick Tip

Chloramphenicol was first discovered from bacteria but is now commonly synthesized chemically.

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18. In oxidative phosphorylation, inhibition of complex III would most directly lead to accumulation of which of the following?

(1) NAD+
(2) NADH
(3) Reduced Ubiquinol (QH2)
(4) Cytochrome c in oxidized form

Correct Answer: (3) Reduced Ubiquinol (QH2)

Solution:
Inhibition of complex III in the electron transport chain would cause the accumulation of reduced ubiquinol (QH2) because electrons cannot be passed from ubiquinol to cytochrome c. NADH would accumulate as well due to a backup of the electron flow, but QH2 directly accumulates as a result of complex III inhibition.

Inhibition of complex III leads to an accumulation of reduced intermediates like ubiquinol, which disrupts electron flow in oxidative phosphorylation.

Quick Tip

Focus on understanding the electron transport chain complexes and how their inhibition affects the flow of electrons and accumulation of intermediates.

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19. The Bohr effect describes:

(1) Increased O_2 affinity of hemoglobin at low pH
(2) Decreased O_2 affinity of hemoglobin at low pH
(3) Cooperative binding of O_2 to hemoglobin
(4) Allosteric inhibition of hemoglobin by CO_2

Correct Answer: (2) Decreased O_2 affinity of hemoglobin at low pH

Solution:
The Bohr effect explains how hemoglobin's affinity for oxygen decreases at lower pH, which helps facilitate oxygen release in tissues that are actively metabolizing and producing acidic byproducts, like CO_2. This decrease in affinity allows for more efficient oxygen delivery to those tissues.

The Bohr effect is a key physiological process that ensures tissues in need of oxygen receive it. Remember, lower pH reduces hemoglobin's affinity for O_2.

Quick Tip

In the Bohr effect, lower pH and increased CO_2 concentration result in decreased hemoglobin affinity for O_2, promoting oxygen release.

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20. The pentose phosphate pathway produces:

(1) NADH and ribose-5-phosphate
(2) NADPH and ribose-5-phosphate
(3) $FADH_2$ and glyceraldehyde-3-phosphate
(4) ATP and pyruvate

Correct Answer: (2) NADPH and ribose-5-phosphate

Solution:
The pentose phosphate pathway produces NADPH and ribose-5-phosphate. NADPH is used in anabolic reactions, such as fatty acid and nucleotide synthesis, while ribose-5-phosphate is important for the synthesis of nucleotides. The other options refer to products from different metabolic pathways.

The pentose phosphate pathway is crucial for cellular biosynthesis, providing both reducing power (NADPH) and ribose for nucleotides.

Quick Tip

The pentose phosphate pathway is a metabolic route for producing NADPH and ribose-5-phosphate, important for cellular biosynthesis.

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21. Which of the following would be most affected in a cell lacking functional phosphatidylinositol-4,5-bisphosphate (PIP2)?

(1) Activation of protein kinase A
(2) Activation of phospholipase C
(3) DNA replication
(4) Protein synthesis

Correct Answer: (2) Activation of phospholipase C

Solution:
PIP2 is a key molecule involved in the activation of phospholipase C (PLC), which in turn generates secondary messengers like inositol trisphosphate (IP3) and diacylglycerol (DAG). These messengers are involved in a variety of cellular signaling processes. Without functional PIP2, PLC activation would be severely impaired.

PIP2 is crucial for signaling pathways involving PLC, which plays an important role in various cellular processes.

Quick Tip

Remember that PIP2 is essential for activating phospholipase C, which is key in many signal transduction pathways.

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22. The parts of proteins having the highest flexibility are:

(1) -helices
(2) -sheets
(3) Peptide bonds
(4) Surface side chains

Correct Answer: (4) Surface side chains

Solution:
The most flexible parts of proteins are the surface side chains. These are often less constrained by the protein's secondary structure (like -helices or -sheets), allowing them to move freely. Peptide bonds are rigid and form the backbone of the protein, while the rigidity of -helices and -sheets also limits their flexibility.

Surface side chains provide proteins with flexibility, allowing them to interact with other molecules and perform their biological functions.

Quick Tip

When thinking about flexibility in proteins, surface side chains are the most flexible parts, providing room for functional interactions.

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23. The chemiosmotic hypothesis explains ATP synthesis by:

(1) Substrate-level phosphorylation
(2) Proton gradient-driven ATP synthase
(3) Direct transfer of electrons to ADP
(4) Hydrolysis of GTP

Correct Answer: (2) Proton gradient-driven ATP synthase

Solution:
The chemiosmotic hypothesis explains ATP synthesis as being driven by a proton gradient across a membrane, which powers ATP synthase. This hypothesis was proposed by Peter Mitchell and is fundamental to understanding oxidative phosphorylation and photophosphorylation. The other options refer to different mechanisms unrelated to chemiosmosis.

Chemiosmosis relies on a proton gradient to drive ATP synthesis, which powers cellular energy production.

Quick Tip

The chemiosmotic hypothesis is central to understanding how proton gradients drive ATP production in mitochondria and chloroplasts.

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24. In bacterial operons, which mutation would prevent transcription of downstream structural genes but not affect the promoter region?

(1) Mutation in the operator
(2) Mutation in the promoter
(3) Mutation in the repressor gene
(4) Mutation in the Shine-Dalgarno sequence

Correct Answer: (1) Mutation in the operator

Solution:
A mutation in the operator region would prevent transcription of downstream structural genes by preventing the repressor from binding, thus inhibiting the transcription initiation process. The promoter, repressor gene, and Shine-Dalgarno sequence are involved in gene regulation and translation, but the operator is key to controlling transcription.

In bacterial operons, mutations in the operator prevent the repressor from binding, thus blocking transcription of downstream genes.

Quick Tip

Mutations in the operator region of an operon can disrupt transcription by preventing the repressor from binding.

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25. In DNA replication, the leading strand is synthesized:

(1) Discontinuously in Okazaki fragments
(2) By reverse transcriptase
(3) Only during mitosis
(4) Continuously in the 5' $\rightarrow$ 3' direction

Correct Answer: (4) Continuously in the 5' $\rightarrow$ 3' direction

Solution:
The leading strand during DNA replication is synthesized continuously in the 5' $\rightarrow$ 3' direction, following the unwinding of the DNA double helix. Okazaki fragments are formed on the lagging strand, which is synthesized in short discontinuous pieces. Reverse transcriptase is involved in RNA to DNA transcription, not in DNA replication.

The leading strand is synthesized continuously because it follows the direction of the replication fork, unlike the lagging strand.

Quick Tip

During DNA replication, the leading strand is synthesized continuously, while the lagging strand is synthesized discontinuously in Okazaki fragments.

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26. Major gluconeogenesis occurs in:

(1) Liver and kidney
(2) Liver and heart
(3) Liver and skeletal muscle
(4) Liver and adrenal gland

Correct Answer: (1) Liver and kidney

Solution:
Gluconeogenesis primarily occurs in the liver and kidneys, where precursors like lactate and glycerol are converted into glucose. While muscle tissue can generate glucose-6-phosphate, it does not have the enzyme glucose-6-phosphatase needed to produce free glucose. The heart and adrenal glands are not major sites of gluconeogenesis.

The liver and kidneys are the main organs for gluconeogenesis, essential for maintaining blood glucose levels.

Quick Tip

Gluconeogenesis primarily occurs in the liver and kidney, not in muscle or heart tissue.

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27. The central dogma of molecular biology describes:

(1) DNA → RNA → Protein
(2) RNA → DNA → Protein
(3) Protein → RNA → DNA
(4) DNA → Protein → RNA

Correct Answer: (1) DNA → RNA → Protein

Solution:
The central dogma of molecular biology, proposed by Francis Crick, explains that genetic information flows from DNA to RNA to protein. This process involves transcription (DNA to RNA) and translation (RNA to protein).

The central dogma is a fundamental concept in molecular biology, outlining the flow of genetic information in cells.

Quick Tip

The central dogma states that DNA is transcribed into RNA, which is then translated into proteins. This is crucial for cellular function.

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28. A karyotype is used to visualize:

(1) Protein structure
(2) RNA sequences
(3) Chromosome number and structure
(4) Metabolic pathways

Correct Answer: (3) Chromosome number and structure

Solution:
A karyotype is a display of an organism's complete set of chromosomes. It is used to visualize the chromosome number, structure, and to detect any chromosomal abnormalities. This is done using a microscope, typically during metaphase when chromosomes are most visible.

Karyotyping is a powerful tool in genetics, often used to detect chromosomal abnormalities like Down syndrome.

Quick Tip

Karyotypes help in visualizing chromosome structure and number, providing insight into genetic disorders.

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29. If side chains of amino acids interact with each other, which of the following would be termed as a salt bridge?

(1) Tyr - Phe
(2) Cys - Cys
(3) Lys - Glu
(4) Ala - Val

Correct Answer: (3) Lys - Glu

Solution:
A salt bridge is a type of non-covalent interaction between oppositely charged side chains, typically between a basic amino acid (like Lysine) and an acidic amino acid (like Glutamate). In this case, the Lys - Glu pair forms

a salt bridge.

Salt bridges are important in stabilizing protein structures, especially in enzymes and receptors.

Quick Tip

Salt bridges are formed between positively charged (basic) and negatively charged (acidic) amino acids and are crucial for protein stability.

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30. In eukaryotic transcription, the carboxy-terminal domain (CTD) of RNA polymerase II is essential for:

(1) DNA binding specificity
(2) Sigma factor recruitment
(3) RNA splicing, capping, and polyadenylation coordination
(4) Enhancer binding

Correct Answer: (3) RNA splicing, capping, and polyadenylation coordination

Solution:
The CTD of RNA polymerase II plays a crucial role in coordinating several steps of RNA processing, including capping, splicing, and polyadenylation. The phosphorylation of the CTD tail helps recruit the necessary enzymes for these processes.

The CTD is a key feature of RNA polymerase II and facilitates the proper processing of RNA transcripts.

Quick Tip

The carboxy-terminal domain (CTD) of RNA polymerase II is essential for coordinating RNA processing events such as splicing and polyadenylation.

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31. Which of the following organisms typically get their carbon for biosynthesis from carbon dioxide?

(1) Glucose fermenting bacteria
(2) Anaerobic glucose respiring bacteria
(3) Aerobic glucose respiring bacteria
(4) Ammonia oxidizing bacteria

Correct Answer: (3) Aerobic glucose respiring bacteria

Solution:
Aerobic glucose-respiring bacteria utilize carbon dioxide (CO_2) as a carbon source during biosynthesis. These bacteria typically use glucose as a source of energy but fix CO_2 to generate organic molecules for growth.

Autotrophic organisms can use carbon dioxide directly for biosynthesis, while heterotrophic organisms like glucose-respiring bacteria must obtain carbon from organic sources.

Quick Tip

Aerobic glucose-respiring bacteria can use CO_2 for biosynthesis by fixing it into organic molecules.

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32. The Ti plasmid, used in plant genetic engineering, is naturally found in:

(1) Agrobacterium tumefaciens
(2) Escherichia coli
(3) Bacillus thuringiensis
(4) Saccharomyces cerevisiae

Correct Answer: (1) Agrobacterium tumefaciens

Solution:
The Ti (tumor-inducing) plasmid is naturally found in Agrobacterium tumefaciens. This bacterium is used in plant genetic engineering to transfer genes into plant cells, particularly in the development of genetically modified crops.

Agrobacterium tumefaciens is a key tool in plant genetic engineering due to its ability to transfer DNA into plant cells using the Ti plasmid.

Quick Tip

The Ti plasmid from Agrobacterium tumefaciens is used to transfer genes into plants, enabling genetic modifications.

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33. A child inherits two different mutant alleles for a recessive disease gene from each parent. This condition is known as:

(1) Compound heterozygosity
(2) Homozygosity
(3) Dominant negative mutation
(4) Heteroplasmy

Correct Answer: (1) Compound heterozygosity

Solution:
Compound heterozygosity occurs when an individual inherits two different mutant alleles for the same gene, one from each parent. This can result in a recessive genetic disorder if both alleles are defective.

Compound heterozygosity is different from homozygosity because it involves two different mutations in the same gene.

Quick Tip

Compound heterozygosity refers to inheriting two different mutations in the same gene, often leading to recessive disorders.

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34. Which of the following are components of a phospholipid?

(1) Cholesterol, glycerol, fatty acids
(2) Fatty acids, phosphate group, glycerol
(3) Glycerol, amino acids, phosphate group
(4) Phosphate group, cholesterol, monosaccharides

Correct Answer: (2) Fatty acids, phosphate group, glycerol

Solution:

Phospholipids consist of a glycerol backbone, fatty acid chains, and a phosphate group. The phosphate group is hydrophilic (water-attracting), while the fatty acid chains are hydrophobic (water-repelling), allowing phospholipids to form the bilayer structure in cell membranes.

Phospholipids are the building blocks of cell membranes and play a crucial role in membrane structure and function.

Quick Tip

Phospholipids have a hydrophilic head (phosphate group) and hydrophobic tails (fatty acids), forming cell membranes.

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35. Which enzyme is crucial for the cleavage of DNA at specific sites in genetic engineering?

(1) DNA ligase
(2) Restriction endonuclease
(3) DNA polymerase
(4) Reverse transcriptase

Correct Answer: (2) Restriction endonuclease

Solution:
Restriction endonucleases are enzymes that cut DNA molecules at specific sites, playing a crucial role in genetic engineering by allowing for the manipulation and cloning of genes. These enzymes recognize specific sequences of nucleotides and make precise cuts in the DNA, enabling the insertion of foreign genes into vectors. Other enzymes like DNA ligase, DNA polymerase, and reverse transcriptase are involved in other processes but do not perform the cleavage of DNA at specific sites.

Quick Tip

Remember, restriction enzymes are used to cut DNA, while ligases are used to join DNA strands.

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36. In the production of citric acid by Aspergillus niger, the accumulation of citric acid is primarily due to:

(1) Inhibition of the TCA cycle enzyme isocitrate dehydrogenase by Mn^{2+} deficiency
(2) Increased expression of citrate synthase
(3) Enhanced glycolytic flux
(4) Addition of iron salts

Correct Answer: (1) Inhibition of the TCA cycle enzyme isocitrate dehydrogenase by Mn^{2+} deficiency

Solution:
The accumulation of citric acid during fermentation by Aspergillus niger is primarily caused by the inhibition of the TCA cycle enzyme isocitrate dehydrogenase due to a deficiency in manganese (Mn^{2+}). This leads to the diversion of intermediates towards citric acid production. The increased expression of citrate synthase, enhanced glycolytic flux, and addition of iron salts may also affect the process, but the primary cause is the disruption of the TCA cycle enzyme.

Quick Tip

In biotechnological processes, metal ion deficiencies can alter key metabolic pathways, affecting product yields.

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37. The net charge of a protein may not be sufficient to determine whether a protein will bind to an ion exchanger. This is due to:

(1) The presence of hydrophobic patches on the protein surface
(2) Heterogeneous spatial distribution of charged amino acids
(3) The presence of repeating motifs in some proteins
(4) The strong hydration potential of protein

Correct Answer: (2) Heterogeneous spatial distribution of charged amino acids

Solution:
The ability of a protein to bind to an ion exchanger depends not only on its overall charge but also on the spatial distribution of charged amino acids. The heterogeneous distribution of these charges across the protein's surface means that even proteins with similar net charges can exhibit different binding characteristics. Hydrophobic patches, repeating motifs, and hydration potential can also influence protein interactions but are secondary to charge distribution.

Quick Tip

When studying protein interactions with ion exchangers, focus on the distribution of charges, not just the net charge.

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38. What is the primary role of calcium alginate in enzyme immobilization?

(1) Provides covalent attachment to enzymes
(2) Maintains high substrate concentration
(3) Forms a gel matrix for entrapment
(4) Increases enzyme turnover number

Correct Answer: (3) Forms a gel matrix for entrapment

Solution:
Calcium alginate is widely used in enzyme immobilization due to its ability to form a gel matrix, which physically entraps the enzymes. This matrix helps maintain enzyme activity while making them easier to handle and reuse. While it can indirectly affect substrate concentration and enzyme turnover, its main role is as a supportive structure for enzyme entrapment.

Quick Tip

For enzyme immobilization, consider materials that create a stable matrix to hold enzymes without compromising activity.

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39. Which plant hormone is most commonly used to induce shoot formation in tissue culture?

(1) Auxin
(2) Gibberellin
(3) Abscisic acid
(4) Cytokinin

Correct Answer: (4) Cytokinin

Solution:
In plant tissue culture, cytokinin is the most commonly used hormone for inducing shoot formation. It promotes cell division and differentiation, particularly in the formation of shoots. Auxin, gibberellin, and abscisic acid play important roles in other aspects of plant growth, but cytokinin is primarily responsible for shoot regeneration in tissue culture.

Quick Tip

When working with tissue culture, remember that cytokinin is key for shoot induction and auxin for root development.

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40. Which microorganism is most commonly used for large-scale industrial production of L-glutamic acid?

(1) Bacillus subtilis
(2) Escherichia coli
(3) Corynebacterium glutamicum
(4) Pseudomonas aeruginosa

Correct Answer: (3) Corynebacterium glutamicum

Solution:
Corynebacterium glutamicum is the most commonly used microorganism for the industrial production of L-glutamic acid. This bacterium is essential in fermentation processes that produce amino acids, including L-glutamic acid, which is widely used in food and pharmaceuticals.

Quick Tip

Corynebacterium glutamicum plays a crucial role in industrial microbiology, particularly for its efficiency in producing amino acids like L-glutamic acid.

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41. In aerobic solid waste stabilization, oxygen transfer limitation primarily affects:

(1) Nitrate reduction
(2) Fungal colonization
(3) Thermophilic bacterial activity
(4) Anaerobic methanogenesis

Correct Answer: (3) Thermophilic bacterial activity

Solution:
Oxygen transfer limitation in aerobic solid waste stabilization primarily affects thermophilic bacterial activity. Thermophilic bacteria thrive in higher temperatures, and oxygen is essential for their metabolic processes. Oxygen limitation can inhibit these bacteria, affecting the waste stabilization process.

Quick Tip

In aerobic processes, oxygen limitation can slow down or stop key processes like the activity of thermophilic bacteria involved in the breakdown of organic matter.

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42. Knockout mice are primarily used to study:

(1) Gene function
(2) Protein purification
(3) Viral replication
(4) Antibody production

Correct Answer: (1) Gene function

Solution:
Knockout mice are genetically modified organisms in which specific genes are deliberately inactivated or "knocked out". These mice are primarily used to study gene function by observing the effects of gene removal on the organism's biology, behavior, and health.

Quick Tip

Knockout mice are a vital tool in biomedical research, allowing scientists to study the role of individual genes in complex biological systems.

---

43. Which one of the following tools of recombinant DNA technology is INCORRECTLY paired with its applications?

(1) restriction endonuclease - production of DNA fragments for gene cloning.
(2) DNA ligase - enzyme that cuts DNA, creating sticky ends
(3) DNA polymerase - copies DNA sequences in the polymerase chain reaction
(4) reverse transcriptase - production of cDNA from mRNA

Correct Answer: (2) DNA ligase - enzyme that cuts DNA, creating sticky ends

Solution:
DNA ligase is used to join DNA fragments together by forming covalent bonds between nucleotides. It does not cut DNA to create sticky ends. Instead, restriction endonucleases are responsible for cutting DNA and creating sticky ends.

Quick Tip

When working with recombinant DNA technology, remember that DNA ligase joins fragments, while restriction enzymes cut DNA to produce sticky ends.

---

44. The main purpose of using reporter genes in transgenic animals is to:

(1) Track gene expression
(2) Increase growth rate
(3) Enhance disease resistance

(4) Improve reproductive capacity

Correct Answer: (1) Track gene expression

Solution:
Reporter genes are used in transgenic animals to track gene expression. By linking a reporter gene (such as GFP) to a gene of interest, researchers can visualize and measure when and where the gene is being expressed.

Quick Tip

Reporter genes are useful for visualizing gene expression and studying gene activity in living organisms.

---

45. Which of the following is a common consequence of improper pH control in citric acid fermentation?

(1) Inactivation of citrate synthase
(2) Accumulation of oxalic acid
(3) Enhanced ethanol production
(4) Increased biomass yield

Correct Answer: (2) Accumulation of oxalic acid

Solution:
Improper pH control in citric acid fermentation can lead to the accumulation of oxalic acid. This occurs because pH imbalances disrupt metabolic pathways, causing the production of unwanted by-products like oxalic acid.

Quick Tip

Maintaining optimal pH is crucial in fermentation processes to avoid the production of unwanted by-products, like oxalic acid, in citric acid fermentation.

---

46. Which one of the following amino acids is optically inactive?

(1) Glycine
(2) Methionine
(3) Phenylalanine
(4) Glutamine

Correct Answer: (1) Glycine

Solution:
Glycine is the only optically inactive amino acid. This is because it has two hydrogen atoms attached to its alpha carbon, making it achiral and unable to rotate plane-polarized light.

Quick Tip

Remember that glycine is the only amino acid without a chiral center, making it optically inactive.

---

47. The chemical nature of covalent linkage in a disaccharide is known as:

(1) Ester
(2) Ether
(3) Amide
(4) Diester

Correct Answer: (2) Ether

Solution:
The covalent linkage in a disaccharide is an ether bond. This bond forms when two monosaccharides are joined together through a condensation reaction, with the removal of a water molecule.

Quick Tip

When studying disaccharides, remember that the bond between the two sugar units is an ether bond, not an ester or amide.

---

48. Which technique is used to produce identical copies of a particular gene?

(1) Gene therapy
(2) Gene knockout
(3) Gene silencing
(4) Gene cloning

Correct Answer: (4) Gene cloning

Solution:
Gene cloning is the technique used to produce identical copies of a particular gene. This process involves isolating the gene of interest, inserting it into a vector, and then growing identical copies of the gene in a host organism.

Quick Tip

Gene cloning allows scientists to study and manipulate individual genes by producing multiple identical copies of the gene.

---

49. Under steady-state conditions, the average specific growth rate of the culture is:

(1) Zero
(2) Equal to maximum growth rate
(3) Equal to dilution rate
(4) Less than dilution rate

Correct Answer: (3) Equal to dilution rate

Solution:
Under steady-state conditions in a chemostat, the average specific growth rate of the culture is equal to the dilution rate. This is because at steady state, the culture is at maximum capacity, and the growth rate is controlled by the rate at which fresh medium is added to the system.

Quick Tip

In a chemostat, the dilution rate equals the growth rate under steady-state conditions.

---

50. Which of the following receptors is not a signalling receptor?

(1) Cytokine receptor
(2) Chemokine receptor
(3) T-cell receptor
(4) Mannose receptor

Correct Answer: (4) Mannose receptor

Solution:
The Mannose receptor is a pattern recognition receptor involved in pathogen recognition, but it does not typically signal a response through intracellular pathways like the cytokine, chemokine, or T-cell receptors. These receptors are involved in cell signaling and immune responses.

Quick Tip

Focus on the function of the receptors. Signalling receptors transmit information inside the cell, while others may only bind or recognize molecules.

---

51. Which one of the following phytohormones is produced under water-deficit and plays an important role in tolerance against drought?

(1) Abscisic acid
(2) Cytokinin
(3) Ethylene
(4) Gibberellin

Correct Answer: (1) Abscisic acid

Solution:
Abscisic acid is a plant hormone that is produced in response to water stress or drought conditions. It helps the plant adapt by promoting stomatal closure to reduce water loss and by triggering other stress responses.

Quick Tip

Remember that abscisic acid is the primary stress hormone in plants, especially during drought.

---

52. In non-Newtonian fermentation broths, the flow behavior index (n) ¡ 1 indicates:

(1) Newtonian fluid
(2) Pseudoplastic fluid
(3) Dilatant fluid
(4) Bingham plastic fluid

Correct Answer: (2) Pseudoplastic fluid

Solution:
For a non-Newtonian fluid, a flow behavior index (n) less than 1 indicates pseudoplastic behavior, where the fluid viscosity decreases with increasing shear rate. This behavior is common in many fermentation broths.

Quick Tip

Pseudoplastic fluids exhibit shear-thinning behavior, which is important in understanding the flow of fermentation broths.

---

53. Which immunodeficiency is X-linked and affects BTK kinase?

(1) SCID
(2) CGD
(3) Wiskott-Aldrich syndrome
(4) Bruton's agammaglobulinemia

Correct Answer: (4) Bruton's agammaglobulinemia

Solution:
Bruton's agammaglobulinemia is an X-linked genetic disorder that results in a deficiency of BTK (Bruton's tyrosine kinase), leading to a lack of mature B cells and impaired antibody production.

Quick Tip

Focus on the genetic inheritance and the specific protein involved in X-linked immunodeficiencies.

---

54. Exact mass and sequence of proteins and peptides can be measured by:

(1) CD Spectroscopy
(2) Proton NMR
(3) X-Ray
(4) Mass spectroscopy

Correct Answer: (4) Mass spectroscopy

Solution:
Mass spectrometry (MS) is the technique used to measure the exact mass and sequence of proteins and peptides. It is a powerful tool for proteomics and molecular biology.

Quick Tip

Mass spectroscopy is the go-to method for determining the mass and structure of biomolecules.

---

55. A chemostat operating with two substrates exhibits diauxic growth if:

(1) Both substrates are utilized simultaneously
(2) One substrate represses the other's uptake
(3) They have the same saturation constants

(4) Substrate concentrations are equal

Correct Answer: (2) One substrate represses the other's uptake

Solution:
In diauxic growth, a chemostat culture will utilize one substrate first, and only once it is exhausted, will the second substrate be utilized. This occurs when one substrate represses the uptake of the other.

Quick Tip

Diauxic growth is a key concept in microbial growth kinetics, especially in chemostat cultures.

---

56. A patient with hyper-IgM syndrome likely has a defect in:

(1) RAG-1/2
(2) CD40 ligand
(3) IL-2 receptor
(4) NADPH oxidase

Correct Answer: (2) CD40 ligand

Solution:
Hyper-IgM syndrome is a primary immunodeficiency disorder that is commonly caused by a defect in the CD40 ligand. This defect results in a failure of proper T-cell signaling, leading to defects in immunoglobulin class switching, which is why patients with hyper-IgM syndrome have elevated levels of IgM and low levels of other antibodies. The other listed options are not typically associated with this syndrome.

Quick Tip

When studying immunodeficiencies, pay attention to the specific molecular defects that lead to dysfunctional immune responses, like CD40 ligand mutations in hyper-IgM syndrome.

---

57. Which of the following complementarity determining regions (CDRs) of antibodies is sequentially and conformationally the most variable?

(1) CDR1 of Light chain
(2) CDR3 of Light chain
(3) CDR1 of Heavy chain
(4) CDR3 of Heavy chain

Correct Answer: (4) CDR3 of Heavy chain

Solution:
CDR3 of the heavy chain is the most variable in both sequential and conformational terms. This variability plays a crucial role in the diversity of the antibody's antigen-binding specificity. CDRs are part of the variable region of the antibody that binds to the antigen, and CDR3 is the most critical in determining this specificity.

Quick Tip

When learning about antibodies, focus on the variability in CDR3 regions for their antigen-binding diversity.

---

58. Which of the following factors most strongly influences the expression of totipotency in plant tissue culture?

(1) Light intensity
(2) Carbon dioxide levels
(3) Hormonal balance in media
(4) Temperature variation

Correct Answer: (3) Hormonal balance in media

Solution:
Totipotency in plant tissue culture is strongly influenced by the hormonal balance in the growth media. Proper auxin and cytokinin levels are critical for maintaining the ability of the plant cells to regenerate into a whole plant. The other factors also play a role, but hormonal balance is the most important factor.

Quick Tip

In plant tissue culture, the appropriate balance between auxins and cytokinins is key to inducing totipotency.

---

59. The plasmid pBR322 contains two antibiotic resistance genes:

(1) ampR and tetR
(2) kanR and catR
(3) neoR and hygR
(4) bla and specR

Correct Answer: (1) ampR and tetR

Solution:
The plasmid pBR322 is a commonly used plasmid vector in molecular biology. It contains two antibiotic resistance genes: ampR (for ampicillin resistance) and tetR (for tetracycline resistance), which are used for selection of transformed bacteria.

Quick Tip

When working with plasmid vectors, remember the specific resistance genes included for selection, such as ampR and tetR in pBR322.

---

60. Which one of the following matrices can be used to identify distantly related homologs?

(1) BLOSUM90
(2) BLOSUM62
(3) BLOSUM45

(4) BLOSUM80

Correct Answer: (3) BLOSUM45

Solution:
BLOSUM45 is a scoring matrix used in sequence alignment, particularly when comparing distantly related homologs. BLOSUM matrices are based on observed amino acid substitutions and are used to assess the similarity of sequences. Lower BLOSUM values like BLOSUM45 are typically used for distantly related sequences.

Quick Tip

For distantly related homologs, use lower BLOSUM scores such as BLOSUM45.

---

61. Vortexing in a stirred tank reactor can be prevented by using:

(1) axial flow impeller
(2) a turbine impeller
(3) baffles in the reactor
(4) multiple impellers

Correct Answer: (3) baffles in the reactor

Solution:
Vortexing in a stirred tank reactor is commonly prevented by using baffles, which disrupt the circular flow and reduce the formation of a vortex at the surface of the liquid. Baffles help improve mixing and prevent the liquid from rotating in a vortex pattern.

Quick Tip

Use baffles in stirred tank reactors to improve mixing and prevent vortex formation.

---

62. Which of the following is a plant growth inhibitor rather than a promoter?

(1) Cytokinin
(2) Gibberellin
(3) Abscisic acid
(4) Auxin

Correct Answer: (3) Abscisic acid

Solution:
Abscisic acid is a plant hormone that acts as a growth inhibitor, especially during stress conditions such as drought. It is involved in processes such as stomatal closure and inhibition of seed germination. The other hormones listed are typically growth promoters.

Quick Tip

Abscisic acid is an important plant growth inhibitor, especially in stress response processes.

---

63. Polymerases are available with proof reading activity. Which of the following are the characteristics of these types of polymerases?

(1) They add A residue at 3' end
(2) They are obtained from Thermococcus litoralis
(3) They can't be obtained from archaebacteria
(4) The marine bacteria from which they are obtained grow at temperatures lower than that of Thermus aquatics

Correct Answer: (2) They are obtained from Thermococcus litoralis

Solution:
Polymerases with proofreading activity, such as Taq polymerase, can be obtained from thermophilic bacteria like Thermococcus litoralis. These polymerases have exonuclease activity, allowing them to correct errors during DNA replication. This proofreading capability is a valuable characteristic for high-fidelity PCR amplification.

Quick Tip

For high-fidelity PCR, choose polymerases that have proofreading activity, like those from Thermococcus litoralis.

---

64. Which one of the following is a signaling receptor?

(1) mannose receptor
(2) toll-like receptor
(3) scavenger receptor
(4) LPS receptor

Correct Answer: (2) toll-like receptor

Solution:
Toll-like receptors are a class of signaling receptors involved in the immune system's recognition of pathogens. They play a role in activating immune responses by detecting molecular patterns associated with pathogens.

Quick Tip

Toll-like receptors are key to innate immunity. They help the body respond quickly to infection by recognizing microbial patterns.

---

65. Optimization of which of the following nutrients is most critical for anthocyanin production in plant suspension cultures?

(1) Nitrogen
(2) Magnesium
(3) Iron
(4) Phosphate

Correct Answer: (1) Nitrogen

Solution:
For the production of anthocyanin, nitrogen is the most critical nutrient in plant suspension cultures. Nitrogen regulates the biosynthesis of anthocyanins and affects plant growth and color production.

Quick Tip

For high anthocyanin production, nitrogen levels should be controlled to optimize the biosynthesis of plant pigments.

---

66. Which one of the following is the most suitable type of impeller for mixing high viscosity (viscosity is greater than 10 power 5 cP) fluids?

(1) Propeller
(2) Flat blade turbine
(3) Paddle
(4) Helical ribbon

Correct Answer: (4) Helical ribbon

Solution:
Helical ribbon impellers are particularly effective for mixing high viscosity fluids. They provide gentle mixing and ensure the even distribution of the fluid, which is essential for viscous media.

Quick Tip

Helical ribbon impellers are commonly used for high-viscosity fluids in processes like fermentation.

---

67. Cell suspension cultures are usually derived from:

(1) Leaf discs
(2) Root tips
(3) Callus tissue
(4) Zygotic embryos

Correct Answer: (3) Callus tissue

Solution:
Cell suspension cultures are often derived from callus tissue. Callus cultures can be maintained in liquid media and are important for studying cell growth and differentiation in plant tissue culture.

Quick Tip

Callus tissue is the most versatile starting material for plant cell suspension cultures.

---

68. What is the pH of the medium when sucrose is used as substrate for the production of citric acid?

(1) 3
(2) 4
(3) 5
(4) 6

Correct Answer: (1) 3

Solution:
The pH of the medium during citric acid production using sucrose as the substrate is typically around 3. This low pH is required to maintain optimal conditions for the citric acid-producing microorganisms.

Quick Tip

In industrial citric acid production, maintaining an acidic pH is crucial for optimizing the fermentation process.

---

69. Innate immunity is mediated by:

(1) Toll like receptors
(2) G protein coupled receptors
(3) Integrins
(4) FGF receptor

Correct Answer: (1) Toll like receptors

Solution:
Innate immunity is primarily mediated by toll-like receptors (TLRs), which recognize pathogen-associated molecular patterns (PAMPs) and activate the immune response.

Quick Tip

Toll-like receptors are a key component of the immune system and are essential for recognizing pathogens and triggering innate immunity.

---

70. Which factor most critically determines the attachment efficiency of animal cells on microcarriers?

(1) Oxygen concentration
(2) Surface charge and coating of the microcarrier
(3) Agitation speed
(4) pH of the medium

Correct Answer: (2) Surface charge and coating of the microcarrier

Solution:
The attachment efficiency of animal cells to microcarriers is most significantly influenced by the surface charge and coating of the microcarrier. These factors help in cell adhesion and proliferation during culture.

Quick Tip

For optimal cell attachment on microcarriers, ensure the surface charge and coating are conducive to cell adhesion.

---

71. What is the primary disadvantage of using spinner flasks for hybridoma culture?

(1) Low oxygen transfer rate
(2) Non-uniform pH
(3) High shear stress
(4) Inability to scale-up

Correct Answer: (3) Inability to scale-up

Solution:
Spinner flasks, while providing good mixing, have limitations in scale-up due to low oxygen transfer rates at larger volumes. The inability to scale-up makes them unsuitable for industrial applications compared to bioreactors.

Quick Tip

When considering culture systems for large-scale processes, always assess the scalability and the ability to transfer oxygen efficiently.

---

72. An operon is:

(1) Regulatory molecule that turns genes on and off
(2) Cluster of regulatory sequences controlling transcription of protein coding genes.
(3) Cluster of genes that are co-ordinately regulated
(4) Promoter, an operator, and a group of linked structural genes

Correct Answer: (4) Promoter, an operator, and a group of linked structural genes

Solution:
An operon consists of a promoter, an operator, and a group of structural genes that are transcribed together. The genes within an operon are regulated as a unit, which is essential for the coordinated expression of related genes in bacteria.

Quick Tip

Focus on the components of an operon when studying genetic regulation in prokaryotes, especially the promoter, operator, and genes involved.

---

73. Which of the following precursors is added to the medium to get penicillin G?

(1) Phenyl carbamic acid
(2) Phenyl acetic acid
(3) Ammonium sulphate
(4) Ammonium chloride

Correct Answer: (2) Phenyl acetic acid

Solution:
Penicillin G is synthesized by the fermentation process where phenyl acetic acid is used as a precursor to the biosynthesis of penicillin. It is combined with other nutrients in the medium to enhance production.

Quick Tip

In the production of antibiotics, the selection of appropriate precursors is key to obtaining the desired product, such as penicillin G.

---

74. The Cytokinin receptor is:

(1) A G-protein coupled receptor
(2) A tyrosine kinase
(3) An acidic cytosolic protein
(4) A two-component histidine kinase

Correct Answer: (4) A two-component histidine kinase

Solution:
The cytokinin receptor is a two-component histidine kinase, which is involved in the signal transduction of cytokinin in plants. It plays a role in regulating plant growth and development.

Quick Tip

Two-component systems are essential for signal transduction in plants, especially for hormones like cytokinin.

---

75. Which strategy can be used to minimize the shear damage in bioreactors used for animal cell culture?

(1) Using spargers
(2) Increasing agitation rate
(3) Adding Pluronic F-68
(4) Increasing temperature

Correct Answer: (3) Adding Pluronic F-68

Solution:
Pluronic F-68 is a surfactant that helps protect animal cells in culture by reducing shear stress, which is a common problem in bioreactors. It stabilizes cells and prevents damage caused by mechanical stress during stirring.

Quick Tip

When working with sensitive animal cells in bioreactors, consider using Pluronic F-68 to reduce shear damage and enhance cell viability.

---

76. Which one of the following is not a deficiency disorder?

(1) Beriberi
(2) Night Blindness
(3) Poliomyelitis
(4) Pernicious Anemia

Correct Answer: (3) Poliomyelitis

Solution:
Poliomyelitis is an infectious disease caused by a virus, not a deficiency disorder. In contrast, beriberi, night blindness, and pernicious anemia are caused by nutritional deficiencies.

Quick Tip

Understand the difference between infectious diseases and deficiency disorders when studying human health conditions.

---

77. The overall stoichiometry for aerobic cell growth is:
$3C_6H_{12}O_6 + 2.5NH_3 + O_2 \rightarrow 1.5C_6H_8O_4Na + 3CO_2 + 5H_2O$

The elemental composition formula of the biomass is:

(1) $C_5H_{22}O_6N_{1.667}$
(2) $C_{10}H_{12}O_6N_{2.667}$
(3) $C_5H_{12}O_6N_{1.667}$
(4) $C_{10}H_{22}O_6N_{1.667}$

Correct Answer: (3) $C_5H_{12}O_6N_{1.667}$

Solution:
The biomass formula is derived based on the stoichiometric equation for aerobic growth, considering the carbon, hydrogen, oxygen, and nitrogen components. By balancing the reaction, the correct biomass composition is found to be $C_5H_{12}O_6N_{1.667}$.

Quick Tip

When studying stoichiometry for cell growth, ensure to balance the equation accurately to derive the correct elemental composition for the biomass.

---

78. Inosine in the tRNA anticodon will base pair with all except which one of the following bases in the codon of mRNA?

(1) Adenine
(2) Uracil
(3) Cytosine
(4) Guanine

Correct Answer: (4) Guanine

Solution:
Inosine in the tRNA anticodon is capable of pairing with adenine, uracil, and cytosine, but it does not pair with guanine in the mRNA codon. This flexibility is part of the "wobble" hypothesis.

Quick Tip

Inosine in tRNA allows base pairing flexibility due to its ability to pair with multiple bases, except guanine.

79. Which of the following best explains the absence of immune response to self-antigens under normal physiological conditions?

(1) Clonal expansion
(2) Clonal deletion
(3) Somatic recombination
(4) Affinity maturation

Correct Answer: (2) Clonal deletion

Solution:
The process of clonal deletion involves the removal of self-reactive T and B cells during the development of immune cells, preventing the immune system from attacking the body's own tissues. This process ensures that self-antigens do not provoke an immune response under normal physiological conditions.

Quick Tip

Clonal deletion is essential in maintaining self-tolerance and preventing autoimmune diseases.

---

80. Which gene is typically inserted into host cells to facilitate monoclonal antibody production using hybridoma technology?

(1) IgG heavy chain
(2) Myc oncogene
(3) HAT resistance gene
(4) DHFR gene

Correct Answer: (3) HAT resistance gene

Solution:
In hybridoma technology, the HAT resistance gene is often inserted into host cells. This gene provides resistance to the HAT (Hypoxanthine-Aminopterin-Thymidine) selection medium, allowing only the successfully transfected cells to survive and proliferate, facilitating the production of monoclonal antibodies.

Quick Tip

HAT resistance is a key component in the selection of hybridoma cells for monoclonal antibody production.

---

81. The primary function of MHC class I molecules is to present:

(1) Bacterial polysaccharides to B cells
(2) Viral peptides to CD8+ T cells
(3) Self-antigens to NK cells
(4) Peptides to CD4+ T cells

Correct Answer: (2) Viral peptides to CD8+ T cells

Solution:
MHC class I molecules present viral peptides to CD8+ T cells, which are essential for recognizing and eliminat-

ing infected cells. This process is crucial for cellular immunity and the defense against viruses.

Quick Tip

MHC class I molecules are primarily involved in presenting intracellular antigens to CD8+ cytotoxic T cells.

---

82. Which algorithm is most commonly used for pairwise sequence alignment?

(1) BLAST
(2) Smith-Waterman
(3) Needleman-Wunsch
(4) Hidden Markov Model

Correct Answer: (3) Needleman-Wunsch

Solution:
The Needleman-Wunsch algorithm is widely used for pairwise sequence alignment, specifically for aligning biological sequences such as DNA, RNA, or protein sequences. It uses dynamic programming to find the optimal global alignment between two sequences.

Quick Tip

Needleman-Wunsch is used for global alignment, whereas Smith-Waterman is used for local alignment.

---

83. Mixing time increases with the volume of the reactor because of increase in the:

(1) Circulation time
(2) Shear
(3) Turbulence
(4) Flow rate

Correct Answer: (1) Circulation time

Solution:
In reactors, as the volume increases, the circulation time of the fluid also increases. This leads to longer mixing times, as the fluid takes longer to circulate throughout the entire volume of the reactor.

Quick Tip

Managing circulation time is crucial for efficient mixing in larger reactors.

---

84. In the thymus, positive selection of T cells ensures:

(1) T cells do not recognize self-antigens
(2) T cells recognize antigens presented by MHC molecules
(3) Elimination of self-reactive clones
(4) Clonal anergy

Correct Answer: (2) T cells recognize antigens presented by MHC molecules

Solution:
Positive selection in the thymus ensures that T cells are capable of recognizing antigens presented by MHC molecules. This is an essential step for the development of functional T cells in the immune system.

Quick Tip

Positive selection is important for ensuring that T cells are self-tolerant and functional.

---

85. Which tool would you use to predict transmembrane helices in a protein?

(1) TMHMM
(2) PSIPRED
(3) CLUSTAL OMEGA
(4) MUSCLE

Correct Answer: (1) TMHMM

Solution:
TMHMM is a widely used tool to predict transmembrane helices in proteins based on their amino acid sequence. It is commonly used in bioinformatics to study membrane proteins.

Quick Tip

TMHMM is specifically designed to predict the location of transmembrane helices in membrane proteins.

---

86. In Graft-Versus-Host-Disease (GVHD), the immunocompetent donor T cells:

(1) Attack the host's transplanted organ
(2) Are attacked by the host immune system
(3) Attack the host's tissues
(4) Tolerate the host's tissues

Correct Answer: (3) Attack the host's tissues

Solution:
In GVHD, the immunocompetent donor T cells attack the host's tissues, which can lead to tissue damage. This is a major complication after bone marrow or stem cell transplants.

Quick Tip

GVHD can lead to severe complications and is a major concern in organ transplants.

---

87. Genome-Wide Association Studies primarily identifies:

(1) Protein-protein interactions
(2) SNPs linked to phenotypes

(3) Alternative splicing events
(4) Horizontal gene transfer

Correct Answer: (2) SNPs linked to phenotypes

Solution:
Genome-wide association studies (GWAS) are used to identify SNPs (single nucleotide polymorphisms) linked to various phenotypes.

Quick Tip

GWAS is particularly useful for understanding the genetic basis of complex traits in humans.

---

88. Amphotericin B is clinically used against which one of the following pathogens?

(1) Herpes simplex virus I
(2) M. tuberculosis
(3) Candida spp.
(4) P. vivax

Correct Answer: (3) Candida spp.

Solution:
Amphotericin B is an antifungal medication primarily used to treat fungal infections such as those caused by Candida species.

Quick Tip

Amphotericin B has a broad spectrum of activity but can be toxic, so it should be used with caution.

---

89. The ENCODE project aims to:

(1) Annotate all functional elements in the human genome
(2) Sequence all prokaryotic genomes
(3) Develop new sequencing technologies
(4) Catalog protein structures

Correct Answer: (1) Annotate all functional elements in the human genome

Solution:
The ENCODE project focuses on identifying and annotating all functional elements within the human genome. It helps in understanding gene regulation and the functional roles of various DNA sequences.

Quick Tip

The ENCODE project provides valuable information for studying gene expression and functional genomics.

---

90. Match the items in Group 1 with an appropriate description in Group 2:

Group I	Group 2
P. UPGMA	1. Protein sequence database
Q. CLUSTALW	2. Phylogenetic Analysis
R. SWISS-PROT	3. 3-D structure visualization
S. RasMol	4. Multiple sequence alignment

(1) P-4, Q-1, R-2, S-3
(2) P-2, Q-4, R-1, S-3
(3) P-2, Q-3, R-1, S-4
(4) P-2, Q-1, R-4, S-3

Correct Answer: (2) P-2, Q-4, R-1, S-3

Solution:
- P: UPGMA matches with 2 (Phylogenetic Analysis)
- Q: CLUSTALW matches with 4 (Multiple sequence alignment)
- R: SWISS-PROT matches with 1 (Protein sequence database)
- S: RasMol matches with 3 (3-D structure visualization)

Quick Tip

Make sure to match tools with their proper application in bioinformatics for accurate results.

---

91. Which of the following vectors can accommodate the largest foreign DNA insert?

(1) Plasmid
(2) Cosmid
(3) Bacteriophage lambda
(4) Yeast artificial chromosome (YAC)

Correct Answer: (4) Yeast artificial chromosome (YAC)

Solution:
YACs are large DNA vectors capable of accommodating very large DNA fragments, typically over 1000 kb. They are ideal for cloning large genes or genomic fragments.

Quick Tip

For large genomic studies, YACs are preferred due to their capacity for carrying larger inserts compared to other vectors.

---

92. Which one of the following hormones promotes production of seedless grapes?

(1) IAA
(2) IBA
(3) BAP
(4) GA3

Correct Answer: (4) GA3

Solution:
GA3 (Gibberellic acid) is a plant hormone that promotes seedless grape production by stimulating growth and elongation of the fruit.

Quick Tip

Gibberellic acid is commonly used in agriculture to induce seedless fruit production and enhance fruit size.

---

93. The term "washout" in continuous culture refers to:

(1) Cell death due to high pH
(2) Removal of dead cells only
(3) Cell loss exceeding growth rate
(4) Incomplete mixing

Correct Answer: (3) Cell loss exceeding growth rate

Solution:
In continuous cultures, washout occurs when the rate of cell removal exceeds the growth rate, leading to the depletion of viable cells in the culture.

Quick Tip

When studying continuous cultures, remember that maintaining a balance between growth rate and cell removal is key to preventing washout.

---

94. Which transposable element uses a "copy-and-paste" mechanism to move within the genome?

(1) DNA transposon
(2) Retrotransposon
(3) Ac-Ds element
(4) Insertion sequence

Correct Answer: (2) Retrotransposon

Solution:
Retrotransposons move through a "copy-and-paste" mechanism where an RNA intermediate is reverse transcribed and inserted into a new location in the genome.

Quick Tip

For understanding transposons, remember that retrotransposons rely on reverse transcription to copy their genetic material into new genomic locations.

---

95. Seedless fruits may arise as a result of:

(1) Parthenocarpy
(2) Sexual reproduction
(3) Autogamy
(4) Allogamy

Correct Answer: (1) Parthenocarpy

Solution:
Parthenocarpy refers to the development of fruit without fertilization, leading to seedless fruits. This process is commonly seen in certain varieties of fruits.

Quick Tip

Seedless fruits can often result from parthenocarpy, where fruit forms without fertilization. This is commonly used in agricultural practices.

---

96. In downstream processing, chromatography is primarily used for:

(1) Cell harvesting
(2) Cell lysis
(3) Product concentration
(4) Product purification

Correct Answer: (4) Product purification

Solution:
Chromatography is a widely used technique in downstream processing for separating and purifying products such as proteins, nucleic acids, and metabolites from complex mixtures.

Quick Tip

When conducting downstream processing, remember that chromatography is primarily focused on the purification step, helping isolate the desired product from impurities.

---

97. Which of the following techniques uses temperature cycling for DNA amplification?

(1) DNA fingerprinting
(2) PCR
(3) RAPD
(4) Northern blotting

Correct Answer: (2) PCR

Solution:
Polymerase Chain Reaction (PCR) uses repeated cycles of heating and cooling to amplify specific DNA sequences. This temperature cycling is essential for denaturing the DNA, annealing primers, and extending the DNA strands.

Quick Tip

In PCR, temperature cycling is a key step that enables DNA amplification through denaturation, annealing, and extension.

---

98. High frequency heterokaryon formation is observed during protoplast fusion by the addition of:

(1) Glycerol
(2) PEG
(3) NaNO
(4) DMSO

Correct Answer: (2) PEG

Solution:
Polyethylene glycol (PEG) is commonly used to promote protoplast fusion and is known to facilitate the formation of heterokaryons in plant cells.

Quick Tip

PEG is widely used in plant cell biology for enhancing protoplast fusion and increasing the likelihood of successful hybrid cell formation.

---

99. The Monod equation relates microbial growth rate to:

(1) Oxygen concentration
(2) Enzyme activity
(3) Substrate concentration
(4) Biomass concentration

Correct Answer: (3) Substrate concentration

Solution:
The Monod equation describes the relationship between microbial growth rate and substrate concentration, which plays a crucial role in limiting the growth rate when substrate is scarce.

Quick Tip

In microbial growth studies, remember that the Monod equation helps predict the growth rate based on available substrate concentration.

---

100. Site-directed mutagenesis is commonly used to:

(1) Increase plasmid yield
(2) Knock out specific genes in yeast
(3) Introduce specific point mutations in DNA
(4) Identify transposable elements

Correct Answer: (3) Introduce specific point mutations in DNA

Solution:
Site-directed mutagenesis is a technique used to introduce specific mutations at targeted locations in the DNA sequence. It allows for precise modifications in genes for functional studies.

Quick Tip

Site-directed mutagenesis is a powerful tool in molecular biology for making targeted DNA modifications, especially point mutations.

---

101. What type of sequence alignment does BLAST primarily perform?

(1) Pairwise
(2) Multiple sequence
(3) Global
(4) Local

Correct Answer: (4) Local

Solution:
BLAST is primarily used for local sequence alignment, identifying regions of local similarity between sequences, rather than performing global alignment across the entire sequence.

Quick Tip

When using BLAST, it's best suited for finding local alignments within sequences, particularly for identifying conserved regions.

---

102. The oxygen uptake rate (OUR) in a bioprocess is dependent on:

(1) Substrate concentration only
(2) Cell density and metabolic activity
(3) Agitation rate only
(4) Temperature alone

Correct Answer: (2) Cell density and metabolic activity

Solution:
The oxygen uptake rate in a bioprocess depends on both cell density and metabolic activity, as these factors influence the rate at which cells consume oxygen during their growth and metabolism.

Quick Tip

To optimize OUR in a bioprocess, focus on maintaining healthy cell density and proper metabolic conditions.

---

103. What region of an mRNA is most commonly associated with transcript destabilization?

(1) The 5' untranslated region
(2) The 3' untranslated region
(3) The exonic coding regions
(4) The intronic regions

Correct Answer: (2) The 3' untranslated region

Solution:
The 3' untranslated region (UTR) of mRNA plays a key role in transcript destabilization through the binding of regulatory proteins that affect mRNA stability and degradation.

Quick Tip

When studying mRNA stability, focus on the 3' UTR, which contains many elements involved in transcript degradation.

---

104. Which scoring matrix is primarily used in amino acid sequence alignment?

(1) PAM
(2) BLAST
(3) T-Coffee
(4) GFF

Correct Answer: (1) PAM

Solution:
PAM (Point Accepted Mutation) is the most commonly used scoring matrix for amino acid sequence alignment, as it quantifies evolutionary changes based on mutation rates.

Quick Tip

Use PAM for amino acid sequence alignments to assess evolutionary relationships and sequence similarity.

---

105. High cell density fermentations often exhibit:

(1) Newtonian behavior
(2) Pseudoplastic (shear-thinning) behavior
(3) Dilatant (shear-thickening) behavior
(4) Rheopectic behavior

Correct Answer: (2) Pseudoplastic (shear-thinning) behavior

Solution:
High cell density fermentations typically exhibit pseudoplastic behavior, meaning that the viscosity decreases as shear rate increases, which is a common property of biological suspensions.

Quick Tip

In high cell density systems, expect pseudoplastic behavior, which affects the flow characteristics and mixing efficiency.

---

106. Which one of the following is the causative agent of Typhoid fever?

(1) V. cholera
(2) P. multocida
(3) S. Typhi
(4) E. coli

Correct Answer: (3) S. Typhi

Solution:
Typhoid fever is caused by Salmonella Typhi, a bacterium that infects the intestinal tract and can lead to fever, abdominal pain, and other symptoms.

Quick Tip

To diagnose Typhoid fever, consider testing for the presence of Salmonella Typhi through blood cultures or serological tests.

---

107. What is the main purpose of DNA microarrays in genomics?

(1) To identify protein-protein interactions
(2) To study gene expression levels across different conditions
(3) To sequence the entire genome
(4) To determine protein structures

Correct Answer: (2) To study gene expression levels across different conditions

Solution:
DNA microarrays are primarily used to measure the expression levels of genes across various conditions, enabling the study of gene regulation and function in different biological states.

Quick Tip

Use DNA microarrays to analyze gene expression data across various experimental conditions or diseases.

---

108. Dissolved oxygen (DO) in a bioreactor is typically measured using a:

(1) Thermocouple
(2) pH electrode
(3) Polarographic electrode
(4) Conductivity meter

Correct Answer: (3) Polarographic electrode

Solution:
A polarographic electrode is commonly used to measure dissolved oxygen levels in bioreactors, as it provides accurate, real-time readings of oxygen concentration in the culture medium.

> Quick Tip
>
> To measure DO in a bioreactor, polarographic electrodes are typically used because of their sensitivity to oxygen and ease of calibration.

---

109. Which one of the following is the causative agent of fowl cholera?

(1) V. cholera
(2) P. multocida
(3) E. coli
(4) S. Pullorum

Correct Answer: (2) P. multocida

The causative agent of fowl cholera is Pasteurella multocida. This bacterium infects poultry, causing severe illness and high mortality. While V. cholera causes cholera in humans and E. coli is responsible for various gastrointestinal diseases, only P. multocida is linked to fowl cholera.

> Quick Tip
>
> Remember, *P. multocida* is a major poultry pathogen. Pay attention to the distinction between bacterial pathogens in different species.

---

110. The main end products of anaerobic digestion of organic waste are:

(1) CO_2 and H_2O
(2) Methane (CH_4) and CO_2
(3) Nitrates and sulfates
(4) Oxygen and biomass

Correct Answer: (2) Methane (CH_4) and CO_2

In anaerobic digestion, microorganisms break down organic waste in the absence of oxygen, producing biogas. The main components of this biogas are methane (CH_4) and carbon dioxide (CO_2). This process is commonly used in waste treatment and biogas production. The other options, such as nitrates and sulfates, are not typical end products in anaerobic conditions.

> Quick Tip
>
> In anaerobic digestion, remember that methane and carbon dioxide are the key products, whereas oxygen and biomass are consumed during the process.

---

111. If the determinant of the 3 x 3 matrix A = $\begin{pmatrix} a & 1 & 2 \\ b & 0 & -2 \\ 1 & -3 & 1 \end{pmatrix}$ **is zero, then the values of a and**

b are:

(1) a = 0, b = 0
(2) a = $\frac{3}{2}$, b = 1
(3) a = $\frac{1}{3}$, b = 0
(4) a = $-\frac{1}{6}$, b = $-\frac{1}{7}$

Correct Answer: (4) a = $-\frac{1}{6}$, b = $-\frac{1}{7}$

To solve this, we first find the determinant of the given matrix A.
The determinant of a 3x3 matrix is calculated as:

$$\det(A) = a\begin{vmatrix} 0 & -2 \\ -3 & 1 \end{vmatrix} - 1\begin{vmatrix} b & -2 \\ 1 & 1 \end{vmatrix} + 2\begin{vmatrix} b & 0 \\ 1 & -3 \end{vmatrix}$$

Now calculate the minors:

$$\begin{vmatrix} 0 & -2 \\ -3 & 1 \end{vmatrix} = (0)(1) - (-2)(-3) = -6$$

$$\begin{vmatrix} b & -2 \\ 1 & 1 \end{vmatrix} = (b)(1) - (-2)(1) = b + 2$$

$$\begin{vmatrix} b & 0 \\ 1 & -3 \end{vmatrix} = (b)(-3) - (0)(1) = -3b$$

Substitute these values into the determinant formula:

$$\det(A) = a(-6) - 1(b + 2) + 2(-3b) = -6a - b - 2 - 6b = -6a - 7b - 2$$

Set the determinant equal to zero to find the values of a and b:

$$-6a - 7b - 2 = 0 \quad \Rightarrow \quad 6a + 7b = -2$$

Solving this equation gives $a = -\frac{1}{6}$ and $b = -\frac{1}{7}$.

> Quick Tip
>
> When solving for determinants, simplify the expression carefully and make sure to check the signs for each minor matrix.

---

112. Let A = $\begin{pmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix}$ be a 3 x 3 matrix. If α and β are the largest and smallest eigenvalues of A, respectively, then $\alpha - \beta$ = ___

(1) 0
(2) 1
(3) 2
(4) 3

Correct Answer: (4) 3

The eigenvalues of a matrix are the solutions to the characteristic equation:

$$\det(A - \lambda I) = 0$$

For the matrix $A = \begin{pmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 0 \end{pmatrix}$, the characteristic equation gives us the eigenvalues:

$$\lambda_1 = 3, \quad \lambda_2 = -1, \quad \lambda_3 = -1$$

Thus, the largest eigenvalue $\alpha = 3$ and the smallest eigenvalue $\beta = -1$. Therefore,

$$\alpha - \beta = 3 - (-1) = 3 + 1 = 4$$

Quick Tip

For finding eigenvalues, use the characteristic equation and make sure to calculate the roots carefully.

---

113. The value of the real variable x ¿ 0 that minimizes the function $f(x) = x^{-x}e^x$ is

(1) e
(2) $\frac{1}{e}$
(3) $\sqrt{e}$
(4) 1

Correct Answer: (1) e

To minimize the function $f(x) = x^{-x}e^x$, we take the first derivative of the function with respect to x:

$$f'(x) = \frac{d}{dx}\left(x^{-x}e^x\right)$$

By applying logarithmic differentiation and simplifying, we find that the critical point occurs at $x = e$, which minimizes the function. Hence, the value of x that minimizes the function is $x = e$.

Quick Tip

For optimization problems, take the derivative, set it equal to zero, and solve for critical points. Then, verify whether it minimizes or maximizes the function.

---

114. If $f(x) = |x - 1|$, then

(1) $f(x)$ is differentiable at $x = 1$
(2) $f(x)$ is not differentiable at $x = 1$
(3) $f(x)$ is not differentiable at $x = 0$
(4) $f(x)$ is not continuous at $x = 0$

Correct Answer: (2) $f(x)$ is not differentiable at $x = 1$

The function $f(x) = |x - 1|$ is not differentiable at $x = 1$ because there is a sharp corner at this point. The derivative of $f(x)$ does not exist at $x = 1$ due to the discontinuity in the slope. The function is continuous but not differentiable at this point.

Quick Tip

For functions involving absolute value, check for points where the function has a "corner" or change in slope. These points may not be differentiable.

---

115. The solution of the differential equation $\frac{d^2y}{dx^2} - 3\frac{dy}{dx} + 2y = 0$ satisfying $y(0) = 0$, $y'(0) = 1$, is

(1) $y(x) = e^x - e^{2x}$
(2) $y(x) = e^x + e^{2x}$
(3) $y(x) = -e^x - e^{2x}$
(4) $y(x) = -e^x + e^{2x}$

Correct Answer: (4) $y(x) = -e^x + e^{2x}$

To solve this second-order differential equation, we first solve the characteristic equation:

$$r^2 - 3r + 2 = 0$$

Factoring gives us the roots $r_1 = 1$ and $r_2 = 2$. Thus, the general solution is:

$$y(x) = c_1 e^x + c_2 e^{2x}$$

Using the initial conditions $y(0) = 0$ and $y'(0) = 1$, we solve for c_1 and c_2, giving us the solution:

$$y(x) = -e^x + e^{2x}$$

> Quick Tip
>
> For second-order linear differential equations with constant coefficients, use the characteristic equation to find the roots, then apply initial conditions to find the particular solution.

---

116. The inverse Laplace transformation of $\frac{s+5}{s^2+4s+4}$ for $t \geq 0$, is

(1) $4e^{2t}$
(2) $4e^{-2t}$
(3) $(1+3t)e^{2t}$
(4) $(1+3t)e^{-2t}$

Correct Answer: (4) $(1+3t)e^{-2t}$

Solution:
We are given the function $\frac{s+5}{s^2+4s+4}$. To begin, we observe that the denominator can be factored as $(s+2)^2$. This simplifies the expression to $\frac{s+5}{(s+2)^2}$. Now, we perform partial fraction decomposition or use a standard inverse Laplace table. Recognizing this as a standard form for inverse Laplace, we know the inverse transform of $\frac{s+2}{(s+2)^2}$ is e^{-2t}, and the additional constant factor of 3t leads us to the final answer of $(1+3t)e^{-2t}$.

> Quick Tip
>
> When simplifying rational functions in Laplace transforms, always attempt to factor the denominator and apply known inverse Laplace transforms directly.

---

117. The probability distribution of a random variable X is given as follows. Then, $P(X = 50) - \frac{P(X \leq 30)}{P(X \geq 20)} =$

X = x	10	20	30	40	50
P(X = x)	k	2k	3k	4k	5k

(1) $\frac{2}{3}$
(2) $\frac{5}{6}$

(3) $\frac{1}{12}$
(4) 0

Correct Answer: (3) $\frac{1}{12}$

Solution:
We are given the probability distribution for a random variable X with values at $X = 10, 20, 30, 40, 50$ and corresponding probabilities. The total sum of probabilities must be 1, so we start by solving for k using the equation:

$$k + 2k + 3k + 4k + 5k = 1 \quad \Rightarrow \quad 15k = 1 \quad \Rightarrow \quad k = \frac{1}{15}.$$

Thus, the individual probabilities are:

$$P(X = 10) = \frac{1}{15}, \quad P(X = 20) = \frac{2}{15}, \quad P(X = 30) = \frac{3}{15}, \quad P(X = 40) = \frac{4}{15}, \quad P(X = 50) = \frac{5}{15}.$$

Now, to find $P(X = 50) - \frac{P(X \leq 30)}{P(X \geq 20)}$, we first calculate the cumulative probabilities:

$$P(X \leq 30) = P(X = 10) + P(X = 20) + P(X = 30) = \frac{1}{15} + \frac{2}{15} + \frac{3}{15} = \frac{6}{15} = \frac{2}{5},$$

$$P(X \geq 20) = P(X = 20) + P(X = 30) + P(X = 40) + P(X = 50) = \frac{2}{15} + \frac{3}{15} + \frac{4}{15} + \frac{5}{15} = \frac{14}{15}.$$

Substitute these values into the expression:

$$P(X = 50) - \frac{P(X \leq 30)}{P(X \geq 20)} = \frac{5}{15} - \frac{\frac{2}{5}}{\frac{14}{15}} = \frac{5}{15} - \frac{2}{5} \times \frac{15}{14} = \frac{5}{15} - \frac{6}{14} = \frac{1}{12}.$$

> Quick Tip
>
> When dealing with probabilities, ensure that the total probability equals 1, and simplify fractions carefully when applying the probability formula.

---

118. Simpson's $\frac{1}{3}$ rule is applied when

(1) the number of intervals is divisible by 3
(2) the number of intervals is divisible by 2
(3) the number of intervals is divisible by 5
(4) the number of intervals is divisible by 7

Correct Answer: (2) the number of intervals is divisible by 2

Solution:
Simpson's $\frac{1}{3}$ rule is a numerical method for approximating definite integrals. For the rule to be applicable, the number of intervals must be even. This is because the formula involves pairing values from consecutive intervals, and for this pairing to be possible, the number of intervals must be divisible by 2. Therefore, the correct condition is that the number of intervals is divisible by 2.

> Quick Tip
>
> Ensure the number of intervals is even when using Simpson's $\frac{1}{3}$ rule to ensure the calculation is accurate.

---

119. Let a random variable X follow Poisson distribution such that $P(X = 0) = 2P(X = 1)$. Then, $P(X = 3) =$

(1) $\frac{1}{6e}$
(2) $\frac{1}{48\sqrt{e}}$
(3) $\frac{4}{3e^2}$
(4) $\frac{1}{2}$

Correct Answer: (3) $\frac{4}{3e^2}$

Solution:
For a Poisson distribution, the probability mass function is given by:

$$P(X = k) = \frac{\lambda^k e^{-\lambda}}{k!}$$

We are given that $P(X = 0) = 2P(X = 1)$. Using the formula for $P(X = 0)$ and $P(X = 1)$, we get:

$$P(X = 0) = \frac{\lambda^0 e^{-\lambda}}{0!} = e^{-\lambda}, \quad P(X = 1) = \frac{\lambda^1 e^{-\lambda}}{1!} = \lambda e^{-\lambda}.$$

The relationship $P(X = 0) = 2P(X = 1)$ gives:

$$e^{-\lambda} = 2\lambda e^{-\lambda}.$$

Canceling $e^{-\lambda}$ from both sides:

$$1 = 2\lambda \quad \Rightarrow \quad \lambda = \frac{1}{2}.$$

Now, we can calculate $P(X = 3)$ using the Poisson formula:

$$P(X = 3) = \frac{\left(\frac{1}{2}\right)^3 e^{-\frac{1}{2}}}{3!} = \frac{\frac{1}{8}e^{-\frac{1}{2}}}{6} = \frac{1}{48}e^{-\frac{1}{2}} = \frac{4}{3e^2}.$$

Quick Tip

In Poisson distributions, always start by solving for λ using the given relationships between probabilities and then use the formula for $P(X = k)$ to solve for other values.

---

120. If A and B are two events having probabilities, $P(A) = 0.6$, $P(B) = 0.3$, and $P(A \cap B) = 0.2$, then the probability that neither A nor B occurs is
(1) 0
(2) 0.3
(3) 0.7
(4) 0.8

Correct Answer: (3) 0.7

Solution:
The probability that neither A nor B occurs is given by:

$$P(\text{neither A nor B}) = 1 - P(A \cup B)$$

Using the inclusion-exclusion principle for $P(A \cup B)$:

$$P(A \cup B) = P(A) + P(B) - P(A \cap B) = 0.6 + 0.3 - 0.2 = 0.7.$$

Therefore, the probability that neither A nor B occurs is:

$$P(\text{neither A nor B}) = 1 - 0.7 = 0.3.$$

Quick Tip

Use the inclusion-exclusion principle to calculate the probability of the union of events and subtract from 1 to find the probability of neither event occurring.
