JCECE Biology Sample Paper-11

Duration: 60 Minutes **Maximum Marks: 50**

Instructions

- his paper contains **50** Multiple Choice Questions (Single Correct Answer), modelled on the Biology portion of JCECE entrance.
- Each correct answer carries **+1** mark. Incorrect answer: **−0.25** marks.unattempted questions get 0.
- Only one option is correct. Choose carefully.
- Syllabus level: **Class 11 and Class 12 NCERT Physics (Jharkhand JAC / CBSE aligned)**
- Use of mobile phones, calculators, or electronic gadgets is strictly prohibited.

Q1. During the cardiac cycle, if the stroke volume of an individual is 75 mL and the heart rate is 80 beats per minute, what will be the cardiac output?

(A) 5.0 L

(B) 6.0 L

(C) 5.5 L

(D) 4.8 L

Q2. Which of the following restriction enzymes produces blunt ends upon cleavage of its specific recognition sequence?

(A) EcoRI

(B) HindIII

(C) AluI

(D) BamHI

Q3. In a standard dihybrid cross between two heterozygous individuals (AaBb ×

AaBb), what is the probability of obtaining an offspring that is completely homozygous recessive for both traits?

(A) 1/16

(B) 3/16

(C) 9/16

(D) 1/4

Q4. In an ecosystem, the rate of production of organic matter during photosynthesis that is left after meeting the respiratory losses of plants is termed as:

(A) Gross Primary Productivity

(B) Net Primary Productivity

(C) Secondary Productivity

(D) Net Community Productivity

Q5. Which of the following conditions is caused due to the hyposecretion of thyroid hormones in adults, characterized by a low metabolic rate, weight gain, and tendency to retain water?

(A) Grave's disease

(B) Myxedema

(C) Cretinism

(D) Acromegaly

Q6. Filariasis, a chronic inflammatory disease of the lymphatic vessels, is mechanically transmitted to humans via the bite of which vector?

(A) Female Anopheles mosquito

(B) Female Culex mosquito

(C) Male Aedes mosquito

(D) Female Glossina sandfly

Q7. During which stage of prophase I of meiosis does the process of crossing over between non-sister chromatids of homologous chromosomes take place?

(A) Zygotene

(B) Pachytene

(C) Diplotene

(D) Diakinesis

Q8. Select the correct sequence of layers in the wall of the human alimentary canal from the outermost to the innermost side.

(A) Serosa → Muscularis → Submucosa → Mucosa

(B) Mucosa → Submucosa → Muscularis → Serosa

(C) Serosa → Submucosa → Muscularis → Mucosa

(D) Muscularis → Serosa → Submucosa → Mucosa

Q9. In a double-stranded DNA molecule, if cytosine constitutes 28% of the total nitrogenous bases, what will be the expected percentage of adenine?

(A) 28%

(B) 22%

(C) 44%

(D) 56%

Q10. Which plant hormone is primarily responsible for promoting cell division, delaying leaf senescence, and counteracting apical dominance?

(A) Indole-3-acetic acid

(B) Gibberellic acid

(C) Zeatin

(D) Abscisic acid

Q11. The phenomenon where an unfertilized female gamete directly develops into a complete embryo without undergoing fertilization is known as:

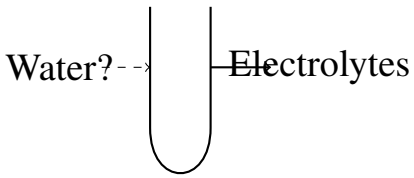
(A) Parthenocarpy

(B) Apomixis

(C) Parthenogenesis

(D) Amphimixis

Q12. Which of the following structures in the mammalian kidney is highly impermeable to water but allows the active or passive transport of electrolytes?



Loop of Henle

(A) Descending limb of Henle's loop

(B) Ascending limb of Henle's loop

(C) Proximal convoluted tubule

(D) Bowman's capsule

Q13. In the lac operon of Escherichia coli, the repressor protein binds to which specific region to prevent RNA polymerase from transcribing the structural genes?

Region?

(A) Promoter region

(B) Regulator gene

(C) Operator region

(D) Structural gene z

Q14. Mushrooms, puffballs, and bracket fungi belong to which class of the kingdom Fungi?

(A) Ascomycetes

(B) Basidiomycetes

(C) Phycomycetes

(D) Deuteromycetes

Q15. During the light reaction of photosynthesis, the primary electron acceptor located on the outer side of the thylakoid membrane transfers its electron to:

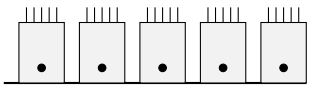
(A) Plastoquinone

(B) Plastocyanin

(C) Cytochrome b_6f

(D) Ferredoxin

Q16. The specific type of epithelial tissue that lines the inner surface of fallopian tubes and bronchioles, facilitating the movement of particles or mucus in a specific direction, is:



(A) Squamous epithelium

(B) Cuboidal epithelium

(C) Ciliated epithelium

(D) Stratified epithelium

Q17. Which of the following is an example of a non-medicated intrauterine device (IUD) used for contraception?

(A) Lippes loop

(B) CuT

(C) LNG-20

(D) Progestasert

Q18. In an inverted pyramid of biomass, which ecosystem typically exhibits a lower biomass at the producer level compared to the primary consumer level?

(A) Grassland ecosystem

(B) Forest ecosystem

(C) Marine ecosystem

(D) Desert ecosystem

Q19. The process of conversion of atmospheric nitrogen gas into ammonia by biological agents like Rhizobium is catalyzed by which enzyme complex?

(A) Nitrogenase

(B) Nitrate reductase

(C) Nitalase

(D) Transaminase

Q20. Which organelle is responsible for the synthesis of steroidal hormones in animal cells and serves as the primary site for lipid synthesis?

(A) Rough Endoplasmic Reticulum

(B) Smooth Endoplasmic Reticulum

(C) Golgi apparatus

(D) Lysosome

Q21. According to the concept of natural selection proposed by Charles Darwin, fitness refers ultimately to:

(A) Physical strength and endurance

(B) Reproductive success and leaving more progeny

(C) Ability to run faster from predators

(D) Efficiency in metabolic utilization of nutrients

Q22. The cells found in the human testes that synthesize and secrete testicular hormones called androgens under the influence of luteinizing hormone are:

(A) Sertoli cells

(B) Leydig cells

(C) Spermatogonia

(D) Primary spermatocytes

Q23. Which industrial sewage treatment process involves the sedimentation of human and organic waste solids, followed by floating debris removal without using microbial action?

(A) Primary treatment

(B) Secondary treatment

(C) Biological treatment

(D) Tertiary treatment

Q24. In human biochemical pathways, an enzyme that catalyzes the linking together of two chemical compounds, utilizing the energy derived from the cleavage of a pyrophosphate bond in ATP, belongs to which class?

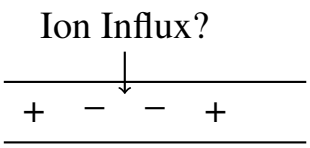
(A) Lyases

(B) Isomerases

(C) Ligases

(D) Hydrolases

Q25. The standard state of depolarization during the conduction of a nerve impulse along an axon is characterized by the rapid:



(A) Influx of Na^+ ions

(B) Efflux of Na^+ ions

(C) Influx of K^+ ions

(D) Efflux of K^+ ions

Q26. If a cross is made between a tall pea plant with round seeds (TTRR) and a dwarf pea plant with wrinkled seeds (ttrr), what will be the phenotypic ratio in the F_2 generation?

(A) 3 : 1

(B) 1 : 2 : 1

(C) 9 : 3 : 3 : 1

(D) 1 : 1 : 1 : 1

Q27. The protective mechanism in double fertilization where one male gamete fuses with the egg cell and the other male gamete fuses with the two polar nuclei is unique to:

(A) Pteridophytes

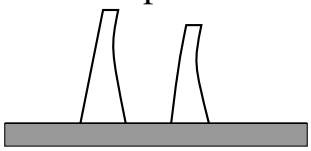
(B) Gymnosperms

(C) Angiosperms

(D) Bryophytes

Q28. The specialized respiratory structures called pneumatophores are characteristic adaptations found in plants growing in:

Pneumatophore



(A) Xeric environments

(B) Mangrove swampy areas

(C) Deep aquatic lakes

(D) Alpine cold regions

Q29. Which technique is used to amplify a specific gene or fragment of DNA in vitro into millions of copies within a short duration?

(A) Gel electrophoresis

(B) Polymerase Chain Reaction

(C) Southern blotting

(D) DNA fingerprinting

Q30. In glycolysis, the conversion of fructose-6-phosphate to fructose-1,6-bisphosphate is catalyzed by which regulatory enzyme?

(A) Hexokinase

(B) Phosphofructokinase

(C) Phosphoglycerate kinase

(D) Pyruvate kinase

Q31. The immunoglobulins that are found in maximum concentration in human colostrum, providing passive immunity to the newborn infant, are of the type:

(A) IgG

(B) IgM

(C) IgA

(D) IgE

Q32. In a sequence of double-stranded DNA, if the coding strand sequence reads 5′-ATGCATGC-3′, what will be the corresponding sequence of the transcribed mRNA?

(A) 5′-AUGCAGUC-3′

(B) 5′-AUGCATGC-3′

(C) 5′-AUGCAUGC-3′

(D) 3′-UACGUACG-5′

Q33. Which of the following interactions represents a classic ecological example of sexual deceit observed between a Mediterranean orchid and a specific species of bee?

(A) Commensalism

(B) Amensalism

(C) Mutualism

(D) Parasitism

Q34. The clear, gel-like matrix that forms the base fluid of the chloroplast, containing the enzymes required for the synthesis of carbohydrates and proteins, is the:

(A) Grana

(B) Stroma

(C) Lumen

(D) Cristae

Q35. During skeletal muscle contraction, the binding of calcium ions (Ca^{2+}) to which specific protein subunit unmasks the active binding sites for myosin on the actin filaments?

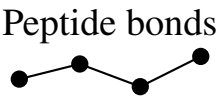
(A) Tropomyosin

(B) Troponin

(C) Meromyosin

(D) Actinin

Q36. The structural unit of a protein consists of amino acids linked together sequentially by peptide bonds. This linear sequence represents which level of protein structural organization?



(A) Primary structure

(B) Secondary structure

(C) Tertiary structure

(D) Quaternary structure

Q37. Which of the following matching pairs correctly identifies a plant and its modified vegetative propagule?

(A) Agave – Runner

(B) Bryophyllum – Leaf buds

(C) Ginger – Sucker

(D) Water hyacinth – Rhizome

Q38. The geological timeline confirms that the first cellular forms of life appeared on Earth approximately how many billion years ago?

(A) 4.5 billion years ago

(B) 3.5 billion years ago

(C) 2.0 billion years ago

(D) 0.5 billion years ago

Q39. According to Allen's Rule, mammals adapted to colder climatic regions typically possess:

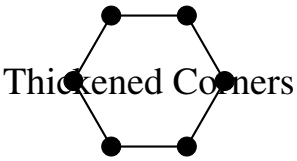
(A) Shorter ears and shorter limbs

(B) Longer ears and shorter limbs

(C) Shorter ears and longer limbs

(D) Longer ears and longer limbs

Q40. The specialized tissue in a dicotyledonous stem that provides mechanical support to the growing juvenile parts and consists of cells thickened at the corners with cellulose and pectin is:



(A) Parenchyma

(B) Sclerenchyma

(C) Collenchyma

(D) Xylem vessels

Q41. In human females, the primary oocyte completes its first meiotic division within which ovarian follicle structure?

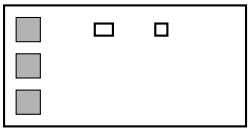
(A) Primary follicle

(B) Secondary follicle

(C) Tertiary follicle

(D) Graafian follicle

Q42. Which tool is utilized to separate DNA fragments according to their size and molecular weight after treatment with restriction endonucleases?



Agarose Gel

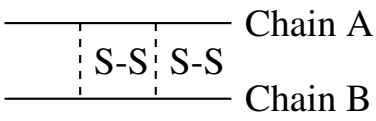
(A) Centrifugation

(B) Agarose gel electrophoresis

(C) Spectrophotometry

(D) Chromatography

Q43. The therapeutic production of insulin via recombinant DNA technology involves the separate synthesis of polypeptide chains A and B, which are subsequently combined by creating:



(A) Hydrogen bonds

(B) Disulfide bonds

(C) Phosphodiester bonds

(D) Ionic bonds

Q44. Which of the following cell junctions prevents structural components or fluids from leaking across a tissue layer?

(A) Tight junctions

(B) Adhering junctions

(C) Gap junctions

(D) Synaptic junctions

Q45. The evolutionary process where organisms from different ancestral lineages evolve similar phenotypic adaptations in response to similar environmental pressures is called:

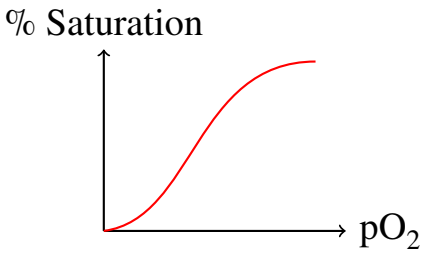
(A) Divergent evolution

(B) Convergent evolution

(C) Adaptive radiation

(D) Saltation

Q46. The standard configuration of the human oxygen-hemoglobin dissociation curve under normal physiological conditions is graphically represented as a:



(A) Hyperbolic curve

(B) Linear line

(C) Sigmoid curve

(D) Parabolic curve

Q47. Which of the following micro-organisms is commercially used for the large-scale industrial production of citric acid?

(A) Lactobacillus acidophilus

(B) Aspergillus niger

(C) Acetobacter aceti

(D) Clostridium butylicum

Q48. The active transport mechanism of the sodium-potassium pump (Na^+/K^+ ATPase) across the plasma membrane moves:

(A) 3 Na^+ ions outward and 2 K^+ ions inward

(B) 2 Na^+ ions outward and 3 K^+ ions inward

(C) 3 Na^+ ions inward and 2 K^+ ions outward

(D) 2 Na^+ ions inward and 3 K^+ ions outward

Q49. The international conservation strategy termed as 'Ex-situ conservation' is best exemplified by which of the following options?

(A) National Parks

(B) Biosphere Reserves

(C) Wildlife Sanctuaries

(D) Botanical Gardens

Q50. In Crassulacean Acid Metabolism (CAM) plants, the fixation of atmospheric carbon dioxide (CO_2) by the action of the PEP carboxylase enzyme takes place during which time period?

(A) At dawn

(B) During midday

(C) During the night

(D) At sunset

Detailed Solutions

Q1.

Solution

Concept: Cardiac output is defined as the volume of blood pumped by each ventricle of the heart per minute. It can be mathematically determined by multiplying the stroke volume (the volume of blood pumped out of a ventricle with each heartbeat) by the heart rate (the number of heartbeats per minute).

Solution: Step 1: Identify the given physiological parameters from the question statement. The stroke volume (SV) is given as 75 mL per beat, and the heart rate (HR) is given as 80 beats per minute.

Step 2: Recall the standard formula used to compute the total cardiac output (CO):

$$CO = SV \times HR$$

Step 3: Substitute the provided values into the algebraic formula to perform the calculation:

$$CO = 75 \text{ mL/beat} \times 80 \text{ beats/min}$$

$$CO = 6000 \text{ mL/min}$$

Step 4: Convert the calculated volume from milliliters per minute into liters per minute to match the standard units used in the options, knowing that 1 L = 1000 mL:

$$CO = \frac{6000}{1000} \text{ L/min} = 6.0 \text{ L/min}$$

Step 5: Compare the final calculated volume with the given multiple-choice choices. The value exactly matches the options provided.

Final Answer: 6.0 L

Answer: (B)

Go Back to Question 1

Q2.

Solution

Concept: Restriction endonucleases are molecular enzymes that cleave double-stranded DNA at specific palindromic recognition sequences. Depending on their cleavage mechanism, they leave either single-stranded overhangs known as sticky ends or clean cuts with no overhanging bases, known as blunt ends.

Solution: Step 1: Analyze the cleavage pattern of the first enzyme EcoRI. EcoRI recognizes the sequence 5′-GAATTC-3′ and cuts between G and A, producing sticky ends with 5′ overhangs.

Step 2: Analyze the cleavage pattern of the second enzyme HindIII. HindIII targets the sequence 5′-AAGCTT-3′ and cleaves between the two adenine bases, generating staggered sticky ends.

Step 3: Analyze the restriction mechanism of AluI. AluI is a restriction endonuclease isolated from *Arthrobacter luteus* that recognizes the four-base pair palindromic sequence 5′-AGCT-3′ and cleaves precisely down the middle axis between G and C. This symmetrical cleavage generates fragments that terminate in blunt ends.

Step 4: Analyze the mechanism of BamHI. BamHI recognizes 5′-GGATCC-3′ and cuts between the adjacent guanine bases, creating sticky cohesive ends.

Step 5: Conclude that AluI is the specific restriction enzyme among the options that produces blunt ends.

Final Answer: AluI

Answer: (C)

Go Back to Question 2

Q3.

Solution

Concept: In Mendelian genetics, a dihybrid cross tracking two independently assorting genes follows the law of independent assortment. The probability of inheriting specific genotypes at two distinct loci can be calculated by determining the product of their individual independent probabilities.

Solution: Step 1: Break down the dihybrid cross (AaBb × AaBb) into two independent monohybrid crosses for each gene locus due to independent assortment: (Aa × Aa) and (Bb × Bb).

Step 2: Determine the probability of obtaining a homozygous recessive genotype (aa) from the first monohybrid cross. According to a standard Mendelian monohybrid cross, the genotypic ratio is 1AA : 2Aa : 1aa, giving a probability of:

$$P(\text{aa}) = \frac{1}{4}$$

Step 3: Determine the probability of obtaining a homozygous recessive genotype (bb) from the second independent monohybrid cross. Following the same distribution pattern, the probability is:

$$P(\text{bb}) = \frac{1}{4}$$

Step 4: Use the product rule of probability for independent events to find the joint probability of an offspring being completely homozygous recessive for both traits simultaneously (aabb):

$$P(\text{aabb}) = P(\text{aa}) \times P(\text{bb}) = \frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$$

Step 5: Conclude that the fraction of offspring exhibiting the double homozygous recessive genotype is $1/16$.

Final Answer: $1/16$

Answer: (A)

Go Back to Question 3

Q4.

Solution

Concept: Ecosystem energetics involves measuring the rate at which radiant solar energy is captured and converted into organic chemical compounds by primary producers. The total energy fixed is modified by physiological metabolic demands before becoming available to higher trophic consumer levels.

Solution: Step 1: Understand Gross Primary Productivity (GPP). GPP represents the total rate at which primary producers, such as green plants, capture solar energy and synthesize organic matter during the process of photosynthesis over a given time interval.

Step 2: Account for the metabolic cost of maintaining the autotrophic organisms. Plants utilize a significant portion of the newly fixed organic matter and chemical energy for their own cellular respiration (R).

Step 3: Express the relationship mathematically. Net Primary Productivity (NPP) is the remaining biomass or organic matter accumulated after deducting these respiratory losses from the gross total:

$$NPP = GPP - R$$

Step 4: Recognize that NPP represents the actual organic matter available for consumption by heterotrophs, including herbivores and decomposers. Therefore, the rate left after meeting respiratory losses is explicitly Net Primary Productivity.

Final Answer: Net Primary Productivity

Answer: (B)

Go Back to Question 4

Q5.

Solution

Concept: The thyroid gland secretes thyroxine (T_4) and triiodothyronine (T_3), which regulate basal metabolic rate, body temperature, and systemic metabolism. Severe clinical deficiency or hyposecretion of these metabolic hormones leads to specific pathological conditions depending on the age of onset.

Solution: Step 1: Define Grave's disease. Grave's disease is an autoimmune endocrine disorder characterized by the hypersecretion of thyroid hormones, resulting in exophthalmos, increased metabolic rate, and weight loss. This contradicts the symptoms in the prompt.

Step 2: Analyze Cretinism. Cretinism is a pathological condition caused by severe hypothyroidism during embryonic development, infancy, or early childhood, leading to stunted physical growth and mental retardation.

Step 3: Analyze Myxedema. Myxedema is the clinical manifestation of advanced hypothyroidism in adults. It is characterized by a significantly lowered basal metabolic rate, sluggishness, weight gain, low body temperature, and a non-pitting edema caused by the accumulation of water-retaining mucopolysaccharides in subcutaneous tissues.

Step 4: Check Acromegaly, which is caused by the excessive hypersecretion of growth hormone in adults after the epiphyseal plates have fused.

Step 5: Conclude that Myxedema is the term matching the symptoms of adult hyposecretion.

Final Answer: Myxedema

Answer: (B)

Go Back to Question 5

Q6.

Solution

Concept: Filariasis, specifically lymphatic filariasis (elephantiasis), is a major vector-borne parasitic disease caused by filarial nematodes such as *Wuchereria bancrofti* and *Wuchereria malayi*. The transmission of the infective larval stage depends on a biological insect vector.

Solution: Step 1: Identify the pathogen. The causative agent of lymphatic filariasis is a roundworm that resides inside the lymphatic vessels of the human lower limbs and scrotum, causing chronic inflammation and swelling.

Step 2: Evaluate the vector options. The female *Anopheles* mosquito is the primary biological vector responsible for transmitting the malaria parasite, *Plasmodium*.

Step 3: Evaluate the female *Culex* mosquito. Species belonging to the genus *Culex* serve as the essential biological vectors for transmitting *Wuchereria bancrofti* larvae between human hosts during blood meals.

Step 4: Examine the other options. The *Aedes* mosquito transmits Dengue and Chikungunya, while the sandfly or tsetse fly (*Glossina*) transmits sleeping sickness. Thus, the female *Culex* mosquito is the correct vector.

Final Answer: Female Culex mosquito

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept: Prophase I of meiosis is a prolonged and complex phase divided into five distinct sequential substages based on chromosomal behavior: leptotene, zygotene, pachytene, diplotene, and diakinesis. Genetic recombination occurs during a specific substage.

Solution: Step 1: Understand the events of the zygotene stage. During zygotene, homologous chromosomes begin to pair up through a process called synapsis, forming a complex structure known as the synaptonemal complex.

Step 2: Examine the pachytene stage. Once synapsis is complete, the bivalent chromosomes appear as tetrads. During this stage, non-sister chromatids of homologous chromosomes undergo reciprocal physical exchange of genetic material at points called recombination nodules. This process is mediated by the enzyme recombinase and is known as crossing over.

Step 3: Examine the diplotene stage. Diplotene is characterized by the dissolution of the synaptonemal complex and the visible separation of homologous chromosomes except at the cross-shaped sites of exchange, known as chiasmata.

Step 4: Verify diakinesis, which marks the terminalization of chiasmata. Therefore, crossing over occurs specifically during pachytene.

Final Answer: Pachytene

Answer: (B)

Go Back to Question 7

Q8.

Solution

Concept: The wall of the human alimentary canal, extending from the esophagus to the rectum, exhibits a uniform histological organization consisting of four distinct, concentric tissue layers. Identifying their spatial arrangement requires understanding the sequence from the outer surface to the internal lumen.

Solution: Step 1: Identify the outermost layer. The outermost covering of the digestive tract wall is the serosa, which consists of a thin mesothelium (secretory epithelium of visceral organs) associated with connective tissue.

Step 2: Identify the second layer moving inward. Beneath the serosa lies the muscularis layer, typically organized into an outer longitudinal muscle layer and an inner circular muscle layer of smooth muscle tissue.

Step 3: Identify the third layer. Internal to the muscularis is the submucosa layer, composed of loose connective tissue containing blood vessels, lymphatic vessels, and nerves.

Step 4: Identify the innermost layer. The layer that directly lines the internal lumen of the alimentary canal is the mucosa, which is responsible for secretion and absorption.

Step 5: Synthesize the full directional sequence from outermost to innermost: Serosa → Muscularis → Submucosa → Mucosa.

Final Answer: Serosa → Muscularis → Submucosa → Mucosa

Answer: (A)

Go Back to Question 8

Q9.

Solution

Concept: Erwin Chargaff's rules govern the base composition of double-stranded DNA molecules. They state that the total amount of purines is always equal to the total amount of pyrimidines, meaning adenine pairs exclusively with thymine, and guanine pairs exclusively with cytosine.

Solution: Step 1: State Chargaff's equations for double-stranded DNA:

$$\%A = \%T \quad \text{and} \quad \%G = \%C$$

Step 2: Use the provided value for cytosine base concentration, which is given as $\%C = 28\%$. According to the base-pairing rule:

$$\%G = \%C = 28\%$$

Step 3: Calculate the combined percentage of guanine and cytosine bases in this specific DNA segment:

$$\%G + \%C = 28\% + 28\% = 56\%$$

Step 4: Subtract this combined value from 100% to determine the remaining percentage allocated to the adenine-thymine base pairs:

$$\%A + \%T = 100\% - 56\% = 44\%$$

Step 5: Divide the remaining percentage equally by two, since $\%A = \%T$, to find the individual percentage of adenine bases:

$$\%A = \frac{44\%}{2} = 22\%$$

Final Answer: 22%

Answer: (B)

Go Back to Question 9

Q10.

Solution

Concept: Plant growth regulators or phytohormones act as biochemical signals that modulate physiological and developmental responses. Each major class of hormones exhibits a distinct set of primary regulatory functions within plant tissues.

Solution: Step 1: Analyze Indole-3-acetic acid (IAA). IAA is a naturally occurring auxin that promotes apical dominance, cell elongation, and root initiation, while suppressing the growth of lateral buds.

Step 2: Analyze Gibberellic acid (GA). GA is involved in stem elongation, internodal expansion, bolting, and breaking seed dormancy.

Step 3: Analyze Zeatin. Zeatin is a naturally occurring cytokinin phytohormone. Cytokinins primarily promote active cell division (cytokinesis). They delay leaf senescence by mobilizing nutrients and directly counteract apical dominance by promoting the growth of lateral buds.

Step 4: Analyze Abscisic acid (ABA), which acts as an inhibitory stress hormone that induces stomatal closure and seed dormancy.

Step 5: Match the physiological functions described in the prompt to conclude that Zeatin is the correct hormone.

Final Answer: Zeatin

Answer: (C)

Go Back to Question 10

Q11.

Solution

Concept: Reproductive mechanisms in biological organisms include various forms of both sexual and asexual reproduction. Distinct botanical and zoological terms are used to classify modes of reproduction that bypass typical fertilization events.

Solution: Step 1: Define Parthenocarpy. Parthenocarpy refers to the formation and development of a fruit without the occurrence of fertilization, resulting in seedless fruits (e.g., banana).

Step 2: Define Apomixis. Apomixis is a form of asexual reproduction in plants that mimics sexual reproduction, where seeds are formed without going through fertilization.

Step 3: Define Parthenogenesis. Parthenogenesis is a biological process in which an unfertilized female gamete (ovum or egg cell) undergoes development to produce a complete individual without being fertilized by a male gamete. This phenomenon occurs in certain invertebrates, rotifers, honeybees, and some lizards.

Step 4: Define Amphimixis, which refers to normal sexual reproduction involving the fusion of male and female gametes. Thus, the correct term is Parthenogenesis.

Final Answer: Parthenogenesis

Answer: (C)

Go Back to Question 11

Q12.

Solution

Concept: The loop of Henle is a specialized section of the nephron that plays a key role in the countercurrent multiplier system, helping to concentrate urine. Its descending and ascending limbs exhibit distinct structural and physiological permeabilities to water and electrolytes.

Solution: Step 1: Analyze the descending limb of Henle's loop. The descending limb has a thin wall that is highly permeable to water molecules but completely impermeable to electrolytes, allowing water to leave the tubule into the hypertonic medullary interstitium.

Step 2: Analyze the ascending limb of Henle's loop. The ascending limb consists of a thin and a thick segment. Structurally, its entire wall is completely impermeable to water. However, it actively or passively transports electrolytes (Na^+, Cl^-) out of the tubular fluid into the surrounding interstitial fluid.

Step 3: Analyze the proximal convoluted tubule (PCT), which is permeable to both water and solutes, reabsorbing the majority of the glomerular filtrate.

Step 4: Review Bowman's capsule, which serves as a non-selective ultrafiltration barrier.

Step 5: Conclude that the ascending limb of Henle's loop is the structure that is impermeable to water but allows electrolyte transport.

Final Answer: Ascending limb of Henle's loop

Answer: (B)

Go Back to Question 12

Q13.

Solution

Concept: The lac operon in *Escherichia coli* is a classic model of prokaryotic gene regulation governed by an inducible negative control mechanism. It consists of regulatory genes, a promoter, an operator, and structural genes that function together to regulate lactose metabolism.

Solution: Step 1: Understand the components of the lac operon. The regulatory gene (i gene) constitutively transcribes and translates an active repressor protein.

Step 2: Examine the role of the promoter region (P). The promoter is the specific nucleotide sequence recognized and bound by RNA polymerase to initiate transcription of the downstream structural genes (z, y, a).

Step 3: Define the function of the operator region (O). The operator is a segment of DNA located adjacent to the promoter sequence. In the absence of an inducer like lactose, the active repressor protein binds directly to the operator region.

Step 4: Analyze the consequence of this binding. The physical presence of the bulky repressor protein on the operator blockades the forward movement of RNA polymerase, preventing the transcription of the structural genes (z, y, a). Thus, the repressor binds specifically to the operator region.

Final Answer: Operator region

Answer: (C)

Go Back to Question 13

Q14.

Solution

Concept: The kingdom Fungi is taxonomically classified into distinct classes (Phycomycetes, Ascomycetes, Basidiomycetes, and Deuteromycetes) based on the morphology of their mycelium, the mode of spore formation, and the structural features of their fruiting bodies.

Solution: Step 1: Evaluate Ascomycetes, known as sac-fungi, which include organisms like *Neurospora*, yeast, and *Penicillium*. Their sexual spores are produced inside an ascus.

Step 2: Evaluate Basidiomycetes. This class is commonly known as club fungi and includes well-known macro-fungi such as mushrooms (*Agaricus*), puffballs, and bracket fungi (shelf fungi). They produce club-shaped structures called basidia, which bear basidiospores exogenously.

Step 3: Evaluate Phycomycetes, which are lower aquatic fungi like *Mucor* and *Rhizopus* (bread mold).

Step 4: Evaluate Deuteromycetes, which represent the fungi imperfecti because they lack a known sexual reproductive stage (e.g., *Alternaria*).

Step 5: Match the common names from the prompt to conclude that mushrooms, puffballs, and bracket fungi belong to Basidiomycetes.

Final Answer: Basidiomycetes

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept: The light-dependent reactions of photosynthesis involve non-cyclic photophosphorylation (Z-scheme), where light absorption drives electrons through a series of membrane-bound electron transport carriers located in the thylakoid membrane.

Solution: Step 1: Trace the initial flow of electrons in Photosystem II (PS II). When the reaction center (P680) absorbs light, it becomes excited and expels electrons to the primary electron acceptor, pheophytin.

Step 2: Locate the primary electron acceptor relative to the thylakoid membrane. This primary acceptor is situated towards the outer stromal side of the membrane.

Step 3: Identify the next carrier in the sequence. The primary acceptor transfers its high-energy electron to an electron carrier called Plastoquinone (PQ), which moves within the lipid bilayer.

Step 4: Trace the subsequent steps. Plastoquinone transfers the electrons to the Cytochrome b_6f complex, which then passes them to Plastocyanin (PC), and eventually to Photosystem I (PS I). Ferredoxin acts downstream near PS I.

Step 5: Confirm that the primary acceptor on the outer side of the membrane transfers its electron directly to Plastoquinone.

Final Answer: Plastoquinone

Answer: (A)

Go Back to Question 15

Q16.

Solution

Concept: Epithelial tissues are categorized based on structural modifications of their cells and the number of cell layers. Specialized surface modifications, such as the presence of hair-like projections, adapt certain epithelia to specific physiological functions in the body.

Solution: Step 1: Identify the structural requirement from the prompt. The tissue must line the inner surfaces of hollow internal structures and be capable of moving particles, fluid, or mucus along the epithelial sheet in a unified direction.

Step 2: Analyze simple squamous epithelium. It consists of a single layer of flattened cells adapted for diffusion and filtration, as seen in the alveoli of the lungs.

Step 3: Analyze simple cuboidal epithelium. It consists of cube-like cells adapted for secretion and absorption, found in kidney tubules.

Step 4: Analyze ciliated epithelium. This specialized tissue consists of cuboidal or columnar epithelial cells that possess hair-like protoplasmic projections called cilia on their free apical surfaces. The rhythmic beating of these cilia moves mucus in the respiratory bronchioles and helps propel the ovum through the lumen of the fallopian tubes.

Final Answer: Ciliated epithelium

Answer: (C)

Go Back to Question 16

Q17.

Solution

Concept: Intrauterine devices (IUDs) are highly effective clinical methods of female contraception inserted into the uterine cavity. They are categorized into three main groups based on their mechanism of action and chemical composition: non-medicated, copper-releasing, and hormone-releasing.

Solution: Step 1: Analyze non-medicated IUDs. These devices do not release any chemical ions or hormones. Instead, they act mechanically as a foreign body within the uterine lumen, inducing a localized sterile inflammatory response that stimulates phagocytosis of spermatozoa. Lippes loop is a classic example of a non-medicated IUD.

Step 2: Analyze copper-releasing IUDs. Devices such as CuT, Cu7, and Multiload 375 release copper ions (Cu^{2+}) that suppress sperm motility and reducing their fertilizing capacity.

Step 3: Analyze hormone-releasing IUDs. Devices like LNG-20 and Progestasert continuously release progestogens, making the cervix hostile to sperm and rendering the endometrium unsuitable for implantation.

Step 4: Conclude that Lippes loop is the correct non-medicated option.

Final Answer: Lippes loop

Answer: (A)

Go Back to Question 17

Q18.

Solution

Concept: Ecological pyramids graphically depict the biomass, energy, or number of organisms across progressive trophic levels in an ecosystem. While pyramids of energy are always upright, pyramids of biomass can be inverted depending on the structural characteristics of the community.

Solution: Step 1: Examine the pyramid of biomass in terrestrial ecosystems. In systems like grasslands or forests, the standing crop biomass of primary producers (grasses, trees) is significantly larger than that of primary consumers (herbivores). This produces a standard upright pyramid structure.

Step 2: Examine the pyramid of biomass in an open aquatic or marine ecosystem. The primary producers are microscopic phytoplankton, which have a very small standing crop biomass at any single moment due to their rapid turnover rates and short lifespans.

Step 3: Analyze the higher trophic levels in a marine ecosystem. The primary consumers are zooplankton and small fish, which feed on the phytoplankton. They have longer lifespans and accumulate a much larger standing crop biomass, resulting in an inverted pyramid configuration where producer biomass is lower than consumer biomass.

Final Answer: Marine ecosystem

Answer: (C)

Go Back to Question 18

Q19.

Solution

Concept: Biological nitrogen fixation is a biochemical process that converts inert atmospheric dinitrogen gas (N_2) into ammonia (NH_3), a form of nitrogen that plants can readily assimilate. This highly endergonic reaction requires a specialized, oxygen-sensitive enzyme complex found only in certain prokaryotes.

Solution: Step 1: Identify the biochemical reaction:

$$N_2 + 8e^- + 8H^+ + 16ATP \rightarrow 2NH_3 + H_2 + 16ADP + 16P_i$$

Step 2: Identify the enzyme complex responsible for catalyzing this conversion in diazotrophs like *Rhizobium*. The primary enzyme complex is nitrogenase, a multi-subunit protein containing molybdenum and iron (Mo-Fe protein).

Step 3: Evaluate the alternative options. Nitrate reductase catalyzes the conversion of nitrate (NO_3^-) into nitrite (NO_2^-) during nitrogen assimilation in plants. Transaminase functions in amino acid metabolism by transferring amino groups.

Step 4: Conclude that nitrogenase is the specific enzyme complex responsible for converting atmospheric nitrogen to ammonia.

Final Answer: Nitrogenase

Answer: (A)

Go Back to Question 19

Q20.

Solution

Concept: The endoplasmic reticulum (ER) is an extensive endomembrane network within eukaryotic cells that is structurally divided into two distinct regions based on the presence or absence of membrane-bound ribosomes. These structural differences correlate with distinct metabolic functions.

Solution: Step 1: Analyze the function of the Rough Endoplasmic Reticulum (RER). The outer surface of the RER is studded with ribosomes, making it the primary site for protein synthesis, folding, and post-translational modification.

Step 2: Analyze the function of the Smooth Endoplasmic Reticulum (SER). The SER lacks attached ribosomes and contains enzymes involved in lipid biosynthesis, carbohydrate metabolism, and detoxification reactions.

Step 3: Link the SER to hormone production. In animal cells, the SER is the site where cholesterol and lipid-derived steroidal hormones (such as testosterone, estrogen, and cortisol) are synthesized.

Step 4: Compare this with the Golgi apparatus, which handles protein packaging, and lysosomes, which manage intracellular digestion. This confirms that the SER is the site of steroidal hormone synthesis.

Final Answer: Smooth Endoplasmic Reticulum

Answer: (B)

Go Back to Question 20

Q21.

Solution

Concept: The Darwinian theory of organic evolution states that natural selection is the primary mechanism driving evolutionary change. In this context, biological fitness describes an organism's evolutionary success within its environment.

Solution: Step 1: Understand Charles Darwin's definition of fitness. Although physical strength, aggressive dominance, and physiological efficiency can contribute to survival, they do not guarantee evolutionary success unless they result in successful reproduction.

Step 2: Define evolutionary fitness. Evolutionary or Darwinian fitness is measured by an organism's ability to survive, reproduce, and leave viable, fertile offspring in the next generation relative to other individuals in the population.

Step 3: Relate fitness to reproductive success. Individuals with high reproductive success contribute more alleles to the gene pool of the succeeding generation, driving natural selection. Thus, fitness refers to reproductive success and leaving more progeny.

Final Answer: Reproductive success and leaving more progeny

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept: The human male reproductive system is regulated by endocrine feedback loops involving the hypothalamus, anterior pituitary gland, and specialized somatic cells within the testes.

Solution: Step 1: Analyze the histology of the testes. The seminiferous tubules are the sites of spermatogenesis. Inside these tubules are two primary cell types: spermatogonia (germ cells) and Sertoli cells.

Step 2: Define the role of Sertoli cells. Sertoli cells act as nurse cells that provide structural support, protection, and nourishment to developing spermatozoa under the regulation of Follicle-Stimulating Hormone (FSH).

Step 3: Identify the interstitial spaces between the seminiferous tubules. These vascularized spaces contain Leydig cells, also known as interstitial cells.

Step 4: Understand the endocrine regulation of Leydig cells. Luteinizing Hormone (LH) from the anterior pituitary binds to specific receptors on Leydig cells, stimulating them to synthesize and secrete androgens, primarily testosterone. Thus, Leydig cells are responsible for androgen secretion.

Final Answer: Leydig cells

Answer: (B)

Go Back to Question 22

Q23.

Solution

Concept: Municipal and industrial sewage treatment is carried out in sequential stages to reduce environmental pollution before wastewater is discharged into natural bodies of water. These stages are categorized based on whether they rely on physical, biological, or chemical processes.

Solution: Step 1: Analyze the primary treatment phase. Primary treatment is a physical process designed to remove large and small suspended solids from sewage. It relies on physical mechanisms such as sequential filtration to remove floating debris and sedimentation to separate sand, grit, and organic solids. No microorganisms are used during this initial stage.

Step 2: Analyze the secondary treatment phase. Secondary treatment is a biological process where aerobic microorganisms are cultivated in aeration tanks to consume and decompose dissolved organic matter, reducing the Biological Oxygen Demand (BOD) of the effluent.

Step 3: Analyze tertiary treatment, which is a chemical and physical polishing stage designed to remove specific nutrients and pathogens.

Step 4: Match the description in the prompt to conclude that the phase involving physical removal without microbes is primary treatment.

Final Answer: Primary treatment

Answer: (A)

Go Back to Question 23

Q24.

Solution

Concept: The International Union of Biochemistry and Molecular Biology (IUBMB) classifies enzymes into six major functional categories based on the specific type of chemical reaction they catalyze: Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases, and Ligases.

Solution: Step 1: Evaluate the function of Lyases. Lyases catalyze the cleavage of chemical bonds by means other than hydrolysis or oxidation, often creating a double bond or removing a functional group.

Step 2: Evaluate Isomerases, which catalyze structural or geometric rearrangements within a single molecule.

Step 3: Evaluate Hydrolases, which break chemical bonds using water molecules.

Step 4: Evaluate Ligases. Ligases are specialized enzymes that catalyze the synthesis or joining together of two independent chemical substrates. Because forming these covalent bonds is highly endergonic, ligases couple the reaction to the hydrolysis of a pyrophosphate bond in ATP or a similar nucleoside triphosphate (e.g., DNA ligase). This matches the mechanism described in the prompt.

Final Answer: Ligases

Answer: (C)

Go Back to Question 24

Q25.

Solution

Concept: The generation and propagation of an action potential along an unmyelinated neuronal axon is driven by the sequential opening and closing of voltage-gated ion channels, which alters membrane permeability to sodium (Na^+) and potassium (K^+) ions.

Solution: Step 1: Analyze the resting state. In a resting neuron, the axonal membrane is polarized, with a negative electrical potential inside relative to the outside, maintained by the Na^+/K^+ pump.

Step 2: Understand the mechanism of depolarization. When a threshold stimulus triggers the membrane, voltage-gated Na^+ channels open rapidly.

Step 3: Determine the direction of ion movement. Because concentration gradients and electrical gradients favor the movement of sodium into the cell, opening these channels causes a rapid influx of Na^+ ions into the intracellular fluid.

Step 4: Determine the electrical consequence of this movement. The rapid entry of positive sodium ions reverses the local membrane potential, making the interior of the axon positive relative to the exterior, which defines the state of depolarization. Repolarization occurs later via the efflux of K^+ ions.

Final Answer: Influx of Na^+ ions

Answer: (A)

Go Back to Question 25

Q26.

Solution

Concept: A Mendelian dihybrid cross tracks the simultaneous inheritance of two distinct traits governed by independent genes. Analyzing this cross requires tracking alleles through the F_1 hybrid generation to the F_2 generation.

Solution: Step 1: Identify the parental genotypes (P generation): Tall with round seeds (TTRR) and dwarf with wrinkled seeds (ttrr).

Step 2: Determine the genotype of the F_1 generation. The gamete from the dominant parent is TR and from the recessive parent is tr. Combining these produces a uniform F_1 hybrid generation with the genotype TtRr, exhibiting the dominant phenotype (tall and round).

Step 3: Analyze the self-pollination of the F_1 generation (TtRr $\times$ TtRr) to produce the F_2 generation. Each parent produces four distinct types of gametes (TR, Tr, tR, tr) in equal proportions.

Step 4: Use a Punnett square to determine the resulting distribution of phenotypes. The independent assortment of these alleles yields a classic Mendelian dihybrid phenotypic ratio:

9 Tall-Round : 3 Tall-Wrinkled : 3 Dwarf-Round : 1 Dwarf-Wrinkled

Step 5: Conclude that the standard phenotypic ratio in the F_2 generation is 9 : 3 : 3 : 1.

Final Answer: 9 : 3 : 3 : 1

Answer: (C)

Go Back to Question 26

Q27.

Solution

Concept: Double fertilization is a complex reproductive mechanism found in plants, where two distinct fertilization events occur within the female gametophyte (embryo sac) from a single pollen tube delivery.

Solution: Step 1: Understand the mechanism of double fertilization. A pollen grain produces two haploid male gametes. When the pollen tube enters the embryo sac, it releases both gametes.

Step 2: Trace the first fertilization event. One male gamete fuses with the haploid egg cell (syngamy) to form a diploid zygote ($2n$), which develops into the embryo.

Step 3: Trace the second fertilization event. The second male gamete fuses with the two polar nuclei (or the fused diploid central cell) to undergo triple fusion, forming a triploid primary endosperm nucleus (PEN, $3n$), which develops into nutritive endosperm tissue.

Step 4: Identify the plant group where this occurs. This dual fertilization process is a definitive taxonomic characteristic exclusive to angiosperms (flowering plants). Bryophytes, pteridophytes, and gymnosperms do not undergo double fertilization.

Final Answer: Angiosperms

Answer: (C)

Go Back to Question 27

Q28.

Solution

Concept: Plants growing in challenging ecological habitats often evolve specialized morphological modifications to survive. Halophytes, which grow in saline coastal wetlands and mangrove swamps, face severe root hypoxia due to waterlogged, oxygen-depleted soils.

Solution: Step 1: Identify the physiological challenge. In mangrove ecosystems, the muddy substrate is completely saturated with water, preventing underground roots from absorbing oxygen for cellular respiration.

Step 2: Describe the specialized structural modification. To cope with this, plants like *Rhizophora* develop modified roots called pneumatophores.

Step 3: Explain the growth pattern and anatomy of these roots. Pneumatophores grow vertically upward, emerging against gravity out of the water and mud into the air. Their exposed surfaces contain small pores called lenticels (or pneumathodes) that allow the root system to exchange gases directly with the atmosphere.

Step 4: Conclude that pneumatophores are characteristic adaptations found in plants growing in mangrove swampy areas.

Final Answer: Mangrove swampy areas

Answer: (B)

Go Back to Question 28

Q29.

Solution

Concept: Biotechnology utilizes various molecular biology techniques to manipulate, separate, and amplify genetic material. Choosing the correct tool depends on the experimental goals, such as separating fragments or making multiple copies of a target gene.

Solution: Step 1: Evaluate agarose gel electrophoresis. This technique is used to separate DNA fragments based on their size and electrical charge, but it does not synthesize new copies of DNA.

Step 2: Evaluate Polymerase Chain Reaction (PCR). PCR is an *in vitro* enzymatic technique developed by Kary Mullis that allows a specific target sequence of DNA to be exponentially amplified into millions of copies. It utilizes a thermostable DNA polymerase (such as *Taq* polymerase), oligonucleotides primers, and thermal cycling. This matches the description in the prompt.

Step 3: Evaluate Southern blotting, which is used to transfer separated DNA fragments to a membrane for hybridization analysis. DNA fingerprinting is a profiling technique used for identification. Thus, PCR is the correct answer.

Final Answer: Polymerase Chain Reaction

Answer: (B)

Go Back to Question 29

Q30.

Solution

Concept: Glycolysis is a conserved ten-step metabolic pathway that breaks down glucose into pyruvate while generating ATP and NADH. The pathway is regulated at specific irreversible steps by key allosteric enzymes.

Solution: Step 1: Review the initial steps of glycolysis. Hexokinase catalyzes the first committed step, converting glucose to glucose-6-phosphate. Glucose-6-phosphate is then isomerized into fructose-6-phosphate by phosphoglucose isomerase.

Step 2: Analyze the third step of the pathway. Fructose-6-phosphate is phosphorylated into fructose-1,6-bisphosphate. This reaction consumes one molecule of ATP.

Step 3: Identify the enzyme that catalyzes this step. This reaction is catalyzed by phosphofructokinase-1 (PFK-1). PFK is a major rate-limiting regulatory enzyme in glycolysis and is allosterically regulated by the cell's energy charge (ATP/AMP ratio).

Step 4: Verify the remaining options. Pyruvate kinase and phosphoglycerate kinase act in the later payoff phase of glycolysis. Therefore, phosphofructokinase is the correct enzyme.

Final Answer: Phosphofructokinase

Answer: (B)

Go Back to Question 30

Q31.

Solution

Concept: Immunity can be classified as active or passive depending on whether the host's immune system produces its own antibodies. Passive immunity involves the direct transfer of pre-formed antibodies from an immune donor to a non-immune recipient.

Solution: Step 1: Understand colostrum. Colostrum is the yellowish fluid secreted by the maternal mammary glands during the initial few days of lactation following childbirth.

Step 2: Identify the immunological components of colostrum. It contains high concentrations of maternal antibodies that protect the newborn's vulnerable digestive tract.

Step 3: Classify the specific class of antibody present. The dominant immunoglobulin class found in colostrum is secretory Immunoglobulin A (IgA).

Step 4: Contrast with other classes. IgG is the only antibody capable of crossing the placental barrier during gestation. IgE is involved in allergic responses, and IgM is the first antibody produced during a primary immune response. Therefore, IgA is responsible for providing passive immunity through colostrum.

Final Answer: IgA

Answer: (C)

Go Back to Question 31

Q32.

Solution

Concept: Transcription is the biochemical process where RNA polymerase synthesizes an RNA molecule from a double-stranded DNA template. A transcription unit consists of a template strand and a coding (non-template) strand.

Solution: Step 1: Understand the relationship between the DNA strands and the transcribed mRNA. The DNA template strand ($3' \rightarrow 5'$) is read by RNA polymerase to synthesize mRNA in the $5' \rightarrow 3'$ direction via complementary base pairing.

Step 2: Understand the relation to the coding strand. The DNA coding strand ($5' \rightarrow 3'$) has the identical sequence and orientation as the newly synthesized mRNA molecule, with the sole exception that DNA contains thymine (T) whereas RNA contains uracil (U).

Step 3: Use the provided DNA coding strand sequence: 5′-ATGCATGC-3′.

Step 4: Transcribe the sequence into mRNA by directly copying the coding strand sequence while replacing every thymine base (T) with a uracil base (U):

$$\text{mRNA sequence} = 5'\text{-AUGCAUGC-}3'$$

Final Answer: 5′-AUGCAUGC-3′

Answer: (C)

Go Back to Question 32

Q33.

Solution

Concept: Interspecific ecological interactions occur when populations of different species within a community interact. These interactions can be mutually beneficial (+/+), harmful to one or both parties, or neutral. Some specialized relationships involve evolutionary adaptations for pollination.

Solution: Step 1: Analyze the interaction described. The Mediterranean orchid *Ophrys* employs a specialized mechanism to ensure pollination by a specific species of solitary bee.

Step 2: Describe the floral adaptation. One petal of the orchid flower structurally mimics the exact color, shape, size, and markings of a female bee.

Step 3: Explain the behavior of the male bee. The male bee is attracted to the flower, mistake it for a female partner, and attempts to mate with it, a behavioral phenomenon known as pseudocopulation. During this process, pollen grains are transferred to the bee's body.

Step 4: Categorize the interaction. Because both organisms benefit overall (the plant achieves pollination, and the interaction is part of a co-evolved obligate relationship), it is classified as a specialized form of mutualism, despite involving sensory mimicry or deceit.

Final Answer: Mutualism

Answer: (C)

Go Back to Question 33

Q34.

Solution

Concept: The chloroplast is a double-membrane-bound organelle responsible for photosynthesis in green plants and algae. It contains distinct structural compartments adapted to carry out either the light-dependent or light-independent reactions of photosynthesis.

Solution: Step 1: Identify the membrane bound structures. The thylakoids are flattened membrane sacs arranged in stacks called grana, which contain chlorophyll pigments and carry out the light-driven reactions of photosynthesis.

Step 2: Define the internal space of the thylakoid sac, which is called the lumen.

Step 3: Identify the fluid matrix surrounding the grana. The internal volume bounded by the inner chloroplast membrane is filled with a colorless, aqueous, gel-like matrix known as the stroma.

Step 4: Understand the biochemical composition of the stroma. The stroma contains the circular DNA molecule, ribosomes, and all the soluble enzymes required to catalyze the light-independent reactions (Calvin cycle), which fix carbon dioxide into carbohydrates. Thus, this matrix is the stroma.

Final Answer: Stroma

Answer: (B)

Go Back to Question 34

Q35.

Solution

Concept: Skeletal muscle contraction follows the sliding filament mechanism, regulated by changes in intracellular calcium ion concentration within the myofibril. Actin thin filaments contain regulatory proteins that control binding interactions with myosin thick filaments.

Solution: Step 1: Analyze the resting state of a muscle fiber. In the absence of calcium ions, the active myosin-binding sites on the actin thin filaments are physically covered by a continuous filamentous protein called tropomyosin, preventing cross-bridge formation.

Step 2: Understand the effect of a nerve impulse. A nerve impulse triggers the release of calcium ions (Ca^{2+}) from the sarcoplasmic reticulum into the sarcoplasm.

Step 3: Identify the specific binding target of these ions. The released Ca^{2+} ions bind to a specialized regulatory protein complex called troponin, which is distributed at regular intervals along the tropomyosin filament.

Step 4: Describe the conformational change. Binding of calcium causes a structural change in the troponin complex, shifting the attached tropomyosin filament away from the active sites on actin. This exposes the binding sites, allowing myosin heads to bind and initiate contraction. Thus, calcium binds directly to troponin.

Final Answer: Troponin

Answer: (B)

Go Back to Question 35

Q36.

Solution

Concept: Proteins are macromolecules composed of linear chains of amino acids linked together by covalent peptide bonds. Their complex three-dimensional architecture is organized into four structural levels: primary, secondary, tertiary, and quaternary.

Solution: Step 1: Define the primary structure of a protein. The primary structure is the fundamental linear sequence of amino acids in a polypeptide chain, determined by the genetic code of the transcribing mRNA molecule. The primary structure is stabilized entirely by covalent peptide bonds between adjacent amino and carboxyl groups.

Step 2: Define secondary structure. The secondary structure refers to localized spatial conformations of the polypeptide backbone, such as alpha-helices or beta-pleated sheets, stabilized by hydrogen bonding.

Step 3: Define tertiary structure, which represents the overall three-dimensional folding of a single polypeptide chain, stabilized by hydrophobic interactions, disulfide bridges, and ionic bonds.

Step 4: Conclude that the simple linear sequence linked by peptide bonds represents the primary structure of the protein.

Final Answer: Primary structure

Answer: (A)

Go Back to Question 36

Q37.

Solution

Concept: Vegetative propagation is a form of asexual reproduction in plants where new individuals develop from specialized vegetative structures or propagules, rather than from seeds or spores. Each plant species utilizes specific modified vegetative structures.

Solution: Step 1: Evaluate option A. In *Agave*, the modified vegetative propagule is a bulbous, fleshy structure known as a bulbil, not a runner. Runners are typical of grasses and strawberries.

Step 2: Evaluate option B. In the plant *Bryophyllum*, adventitious vegetative buds develop along the notches of its fleshy leaf margins. These leaf buds can detach, fall onto the soil, and grow into independent new plants. This pair is correctly matched.

Step 3: Evaluate option C. In ginger, the vegetative propagation structure is an underground modified stem known as a rhizome, not a sucker.

Step 4: Evaluate option D. In water hyacinth (*Eichhornia*), the vegetative propagule is a short, horizontal sub-aerial branch called an offset, not a rhizome.

Step 5: Conclude that *Bryophyllum* matched with leaf buds is the correct option.

Final Answer: Bryophyllum – Leaf buds

Answer: (B)

Go Back to Question 37

Q38.

Solution

Concept: The geological timescale and biochemical evolutionary data trace the origin of the universe, the formation of the Earth, and the subsequent appearance of life from primitive molecular complexes to organized cellular life forms.

Solution: Step 1: Identify the age of the Earth. The planet Earth formed approximately 4.5 billion years ago within our solar system.

Step 2: Trace the initial signs of life. Evidence of organic chemical evolution and macromolecular assemblies emerged later, with the earliest non-cellular forms of life (such as RNA, proteins, and polysaccharides) originating around 3 billion years ago.

Step 3: Determine the origin of the first organized cells. The first true cellular forms of life, which were anaerobic, single-celled prokaryotic organisms, appeared on Earth approximately 2.0 billion years ago (or 2000 million years ago).

Step 4: Review the timeline options. The value of 2.0 billion years ago matches the standard timeline for the appearance of cellular life.

Final Answer: 2.0 billion years ago

Answer: (C)

Go Back to Question 38

Q39.

Solution

Concept: Endothermic animals living in different geographic climates exhibit evolutionary anatomical adaptations to regulate their body temperature and minimize metabolic energy loss in response to environmental conditions.

Solution: Step 1: Understand the physiological challenge of cold climates. Mammals inhabiting cold arctic or alpine environments must conserve metabolic core body heat and prevent excessive heat loss across exposed body surfaces.

Step 2: State Allen's Rule. Formulated by Joel Asaph Allen, this ecological rule states that endothermic animals adapted to colder environments evolve shorter extremities or appendages compared to closely related species from warmer regions.

Step 3: Apply the rule to specific appendages. This means these mammals possess significantly shorter ears, snouts, tails, and limbs.

Step 4: Explain the adaptive advantage. Shorter appendages reduce the overall surface-area-to-volume ratio of the organism's body, minimizing heat dissipation into the freezing environment. Thus, mammals in cold regions have shorter ears and shorter limbs.

Final Answer: Shorter ears and shorter limbs

Answer: (A)

Go Back to Question 39

Q40.

Solution

Concept: Simple plant tissues are categorized into three main types based on their structural characteristics and cell wall composition: parenchyma, collenchyma, and sclerenchyma. Each tissue type is adapted to perform specific physiological and mechanical functions.

Solution: Step 1: Analyze parenchyma tissue. It consists of living, thin-walled cells with walls composed uniformly of cellulose, adapted primarily for storage and photosynthesis.

Step 2: Analyze sclerenchyma tissue. It consists of dead, thick-walled cells with secondary walls heavily lignified, providing rigid mechanical support to mature, non-growing plant parts.

Step 3: Analyze collenchyma tissue. It is a specialized, living simple tissue found beneath the epidermis (in the hypodermis) of young dicotyledonous stems and petioles. Its cells are characterized by localized, uneven wall thickenings at their corners, caused by the heavy deposition of cellulose, hemicellulose, and hydrophilic pectin.

Step 4: Evaluate its function. Collenchyma provides flexibility and mechanical support to growing juvenile plant organs without restricting growth. This matches the description in the prompt.

Final Answer: Collenchyma

Answer: (C)

Go Back to Question 40

Q41.

Solution

Concept: Oogenesis is the complex developmental process by which female gametes are formed. Unlike spermatogenesis, it begins during embryonic development, suspends at prophase I, and resumes sequentially during the monthly ovarian cycle following puberty.

Solution: Step 1: Trace the early stages of follicular development. Primary oocytes are surrounded by a single layer of granulosa cells, forming a primary follicle. This structure grows to become a secondary follicle as more granulosa layers and a theca layer are added.

Step 2: Analyze the transition to a tertiary follicle. The secondary follicle matures into a tertiary follicle, characterized by the appearance of a fluid-filled cavity called an antrum and the organization of the theca into inner and outer layers.

Step 3: Identify the nuclear event that occurs at this stage. Within the tertiary follicle, the primary oocyte, which had been arrested in prophase I since fetal life, resumes and completes its first meiotic division.

Step 4: Describe the outcome of this division. This asymmetrical division produces a large haploid secondary oocyte and a small first polar body. The follicle then matures into a mature Graafian follicle. Thus, the first meiotic division is completed within the tertiary follicle.

Final Answer: Tertiary follicle

Answer: (C)

Go Back to Question 41

Q42.

Solution

Concept: Agarose gel electrophoresis is a key molecular biology technique used to separate and analyze nucleic acid fragments based on their physical properties under the influence of an electromotive force.

Solution: Step 1: Understand the biochemical nature of DNA fragments. The sugar-phosphate backbone of DNA contains repeating phosphate groups, giving DNA molecules a uniform negative electrical charge at neutral pH.

Step 2: Explain the setup of the technique. DNA samples are loaded into wells in a porous matrix made of agarose gel. An electric field is applied across the gel.

Step 3: Describe the migration pattern. Due to their negative charge, the DNA fragments migrate away from the negative cathode towards the positive anode.

Step 4: Explain the separation mechanism. The cross-linked polymer network of the agarose gel acts as a molecular sieve. Smaller DNA fragments move more easily through the pores and migrate faster, while larger fragments move more slowly. This separates the DNA fragments according to size and molecular weight.

Final Answer: Agarose gel electrophoresis

Answer: (B)

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Q43.

Solution

Concept: Human insulin is a peptide hormone consisting of two distinct amino acid chains: chain A (with 21 amino acids) and chain B (with 30 amino acids). In vivo, it is synthesized as an inactive single-chain precursor called proinsulin, which contains an additional C-peptide sequence that is later cleaved.

Solution: Step 1: Review the challenge of recombinant insulin production. When Eli Lilly engineered bacteria to produce human insulin, *E. coli* lacked the enzymatic machinery to properly cleave the C-peptide from proinsulin.

Step 2: Describe the engineered approach. Two separate plasmid expression vectors were designed to synthesize polypeptide chain A and polypeptide chain B independently in separate bacterial cultures.

Step 3: Explain the extraction and assembly steps. The recombinant polypeptide chains A and B were extracted and purified from the bacterial lysates.

Step 4: Identify the chemical bonds required to assemble active insulin. To form functional insulin, the two chains must be linked together chemically *in vitro* by forming covalent disulfide bonds (S-S bonds) between specific cysteine residues, mimicking the native configuration.

Final Answer: Disulfide bonds

Answer: (B)

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Q44.

Solution

Concept: Cell junctions are specialized structural regions that link adjacent cells together within epithelial and connective tissues. They are categorized into three main functional types: tight junctions, adhering junctions, and gap junctions.

Solution: Step 1: Evaluate gap junctions. Gap junctions contain channels called connexons that facilitate direct cytoplasmic communication between adjacent cells, allowing the rapid passage of ions, small molecules, and metabolites.

Step 2: Evaluate adhering junctions. Adhering junctions (such as desmosomes) provide mechanical anchorage, cementing neighboring cells together to form a cohesive tissue sheet.

Step 3: Evaluate tight junctions. Tight junctions consist of localized webs of transmembrane proteins that fuse the outer plasma membranes of adjacent cells together.

Step 4: Describe the primary function of tight junctions. By sealing the intercellular space, tight junctions create an impermeable barrier that prevents extracellular fluid, ions, or solutes from leaking across the epithelial tissue layer. This matches the definition in the prompt.

Final Answer: Tight junctions

Answer: (A)

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Q45.

Solution

Concept: Evolutionary pathways describe patterns of structural and phenotypic change in organisms over generations, driven by ecological pressures and natural selection. These pathways are classified based on ancestral relationships and environmental demands.

Solution: Step 1: Define divergent evolution. Divergent evolution occurs when organisms sharing a common ancestral lineage accumulate differences over time due to adaptation to different niches, leading to homologous structures.

Step 2: Define adaptive radiation. Adaptive radiation is a form of rapid divergent evolution where a single ancestral species diverges into a variety of distinct forms to fill available ecological niches (e.g., Darwin's finches).

Step 3: Define convergent evolution. Convergent evolution occurs when distinct, unrelated organisms from different ancestral lineages independently evolve similar phenotypic traits, body forms, or physiological adaptations.

Step 4: Identify the driving force behind this pattern. This pattern is driven by similar environmental challenges or selective pressures in their respective habitats, leading to analogous structures (e.g., wings of insects and birds). This matches the evolutionary process in the prompt.

Final Answer: Convergent evolution

Answer: (B)

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Q46.

Solution

Concept: The oxygen-hemoglobin dissociation curve illustrates the relationship between the partial pressure of oxygen (pO_2) and the percentage saturation of hemoglobin with oxygen. The curve's characteristic shape reflects the cooperative binding properties of the hemoglobin tetramer.

Solution: Step 1: Understand cooperative binding. Hemoglobin is a tetrameric protein containing four iron-binding heme groups. The binding of the first oxygen molecule to a heme group induces a conformational change that increases the affinity of the remaining subunits for oxygen.

Step 2: Analyze the shape at low oxygen levels. At low partial pressures of oxygen, binding is slow because affinity is relatively low, resulting in a gentle initial slope on the graph.

Step 3: Analyze the shape at intermediate oxygen levels. As partial pressure rises, cooperative binding accelerates oxygen uptake, producing a steep upward slope.

Step 4: Analyze the shape at high oxygen levels. At high partial pressures, the binding sites become saturated, and the curve plateaus. This multi-phase binding behavior produces a characteristic sigmoid (S-shaped) curve.

Final Answer: Sigmoid curve

Answer: (C)

Go Back to Question 46

Q47.

Solution

Concept: Industrial microbiology utilizes specific strains of microorganisms (fungi, bacteria, or yeast) as biological factories to produce valuable organic acids, enzymes, and compounds at scale via fermentation.

Solution: Step 1: Evaluate *Lactobacillus acidophilus*. This bacterium converts lactose into lactic acid and is used in the dairy industry to produce curd and yogurt.

Step 2: Evaluate *Aspergillus niger*. *Aspergillus niger* is a filamentous ascomycete fungus. Under specific aerobic fermentation conditions, it is used industrially for the large-scale commercial production of citric acid from carbohydrate substrates. This matches the query.

Step 3: Evaluate *Acetobacter aceti*, which is a bacterium utilized to oxidize ethanol into acetic acid (vinegar).

Step 4: Evaluate *Clostridium butylicum*, an anaerobic bacterium used to produce butyric acid.

Step 5: Conclude that *Aspergillus niger* is the microbial source used to produce citric acid.

Final Answer: Aspergillus niger

Answer: (B)

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Q48.

Solution

Concept: The sodium-potassium pump (Na^+/K^+ ATPase) is a well-studied active transport mechanism found in the plasma membrane of animal cells. It utilizes energy derived from ATP hydrolysis to move ions against their respective electrochemical concentration gradients.

Solution: Step 1: Identify the type of transport. The Na^+/K^+ ATPase is an electrogenic primary active transporter that maintains low intracellular sodium and high intracellular potassium concentrations relative to the extracellular fluid.

Step 2: Understand the stoichiometry of the transport cycle. For every single molecule of ATP hydrolyzed into ADP and inorganic phosphate (P_i), the pump undergo a series of conformational changes.

Step 3: Specify the number and direction of ions moved. The pump binds and expels three sodium ions (3 Na^+) out of the cell into the extracellular matrix, while simultaneously binding and importing two potassium ions (2 K^+) into the cytoplasm.

Step 4: Select the option that matches this 3 Na^+ out/2 K^+ in directional transport ratio.

Final Answer: 3 Na^+ ions outward and 2 K^+ ions inward

Answer: (A)

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Q49.

Solution

Concept: Biodiversity conservation strategies are broadly categorized into two major approaches based on whether the threatened species are protected within their natural habitat or outside of it: In-situ (on-site) and Ex-situ (off-site).

Solution: Step 1: Define In-situ conservation. This approach protects endangered plant and animal species within their natural ecosystems. Examples include National Parks, Biosphere Reserves, Wildlife Sanctuaries, and Sacred Groves.

Step 2: Define Ex-situ conservation. This approach involves removing threatened or endangered organisms from their vulnerable natural habitats and transferring them to specialized, human-managed facilities for protection, care, and breeding.

Step 3: Identify examples of Ex-situ facilities, which include zoological parks, wildlife safari parks, seed banks, cryopreservation facilities, and Botanical Gardens.

Step 4: Analyze the choices. National Parks, Biosphere Reserves, and Wildlife Sanctuaries are forms of In-situ conservation. Botanical Gardens represent an Ex-situ strategy.

Final Answer: Botanical Gardens

Answer: (D)

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Q50.

Solution

Concept: Crassulacean Acid Metabolism (CAM) is a specialized metabolic adaptation found in succulent plants (such as pineapple and cacti) growing in arid desert environments, designed to minimize water loss via transpiration.

Solution: Step 1: Understand the stomatal behavior of CAM plants. CAM plants exhibit scotoactive stomata, meaning their stomata remain tightly closed during the hot, dry daytime hours to conserve water, and open only during the cooler night.

Step 2: Analyze the biochemical events that occur during the night. When stomata open at night, atmospheric carbon dioxide (CO_2) enters the mesophyll cells.

Step 3: Identify the primary carboxylation enzyme. The primary fixation of this CO_2 is catalyzed by Phosphoenolpyruvate carboxylase (PEP carboxylase) in the cytoplasm, converting PEP into oxaloacetate (OAA), which is then reduced to malic acid and stored in vacuoles.

Step 4: Contrast with daytime events, where malic acid is decarboxylated to release CO_2 internally for the Calvin cycle (RuBisCO). Thus, PEP carboxylase fixes CO_2 specifically during the night.

Final Answer: During the night

Answer: (C)

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Answer Key

Q	Ans	Q	Ans	Q	Ans	Q	Ans	Q	Ans
1	B	2	C	3	A	4	B	5	B
6	B	7	B	8	A	9	B	10	C
11	C	12	B	13	C	14	B	15	A
16	C	17	A	18	C	19	A	20	B
21	B	22	B	23	A	24	C	25	A
26	C	27	C	28	B	29	B	30	B
31	C	32	C	33	C	34	B	35	B
36	A	37	B	38	C	39	A	40	C
41	C	42	B	43	B	44	A	45	B
46	C	47	B	48	A	49	D	50	C