# BITSAT Biology Sample Paper-8

**Duration: 60 Minutes** **Maximum Marks: 120**

## Instructions

- This paper contains **40** Multiple Choice Questions (Single Correct).
- Each correct answer carries **+3 marks**. Each incorrect answer carries: **−1** marks. Unattempted questions carry **0** marks.
- Only one option is correct for each question.
- Use of mobile phones, smartwatches, calculators, or any electronic gadgets is strictly prohibited.

**Q1.** Which of the following elements is present in a higher percentage in the human body weight compared to the Earth's crust?

(A) Silicon

(B) Magnesium

(C) Carbon

(D) Calcium

**Q2.** If a double-stranded DNA sample contains 20% Cytosine, what will be the percentage of Adenine in this sample?

(A) 20%

(B) 30%

(C) 40%

(D) 60%

**Q3.** A person goes to a high altitude area like Rohtang Pass and experiences altitude sickness with symptoms like nausea and fatigue.

After a few days, the body gets acclimatized. Which of the following physiological changes does NOT occur during this acclimatization?

(A) Increased RBC production

(B) Increased binding affinity of hemoglobin to oxygen

(C) Increased breathing rate

(D) Decreased binding affinity of hemoglobin to oxygen

**Q4.** Consider the following statements:

Statement 1: The key stage of asymmetric spindle formation occurs during regular mitotic telophase in animal somatic lines.

Statement 2: Polytene chromosomes are prominently visible during the oocyte meiosis of most vertebrates.

(A) Both Statement 1 and Statement 2 are correct.

(B) Both Statement 1 and Statement 2 are incorrect.

(C) Statement 1 is correct but Statement 2 is incorrect.

(D) Statement 1 is incorrect but Statement 2 is correct.

**Q5.** Arrange the following taxonomic categories of the housefly (*Musca domestica*) in descending hierarchical order (from highest/most inclusive to lowest/most specific category):

1. Insecta
2. Muscidae
3. Arthropoda
4. Diptera

(A) $3 \rightarrow 1 \rightarrow 4 \rightarrow 2$

(B) $3 \rightarrow 4 \rightarrow 1 \rightarrow 2$

(C) $1 \rightarrow 3 \rightarrow 2 \rightarrow 4$

(D) $1 \rightarrow 2 \rightarrow 4 \rightarrow 3$

**Q6.** During the processing of pro-insulin into mature insulin in humans, which structural component is proteolytically removed?

(A) A-peptide

(B) B-peptide

(C) C-peptide

(D) Both A and B peptides

**Q7.** In an ecosystem, if the gross primary productivity (GPP) of a terrestrial biome is 150 kcal/$m^2$/yr and the respiratory loss (R) by plants is 30 kcal/$m^2$/yr, what is the Net Primary Productivity (NPP)?

(A) 180 kcal/$m^2$/yr

(B) 120 kcal/$m^2$/yr

(C) 50 kcal/$m^2$/yr

(D) 4.5 kcal/$m^2$/yr

**Q8.** Which of the following secondary metabolites is a toxin derived from plants?

(A) Morphine

(B) Ricin

(C) Vinblastine

(D) Concanavalin A

**Q9.** In human females, the primary oocyte completes its first meiotic division within which of the following structures?

(A) Primary follicle

(B) Secondary follicle

(C) Tertiary follicle

(D) Graafian follicle

**Q10.** Complete the following analogue mapping:
Statins : *Monascus purpureus* :: Cyclosporin A : _____

(A) *Streptococcus pyogenes*

(B) *Trichoderma polysporum*

(C) *Aspergillus niger*

(D) *Propionibacterium sharmanii*

**Q11.** What prevents the backflow of fecal matter from the large intestine into the small intestine in the human digestive system?

(A) Pyloric sphincter

(B) Sphincter of Oddi

(C) Gastro-esophageal sphincter

(D) Ileo-caecal valve

**Q12.** What is the phenotypic ratio obtained in the $F_2$ generation of a cross involving dominant epistasis?

(A) 9 : 3 : 3 : 1

(B) 12 : 3 : 1

(C) 9 : 7

(D) 9 : 3 : 4

**Q13.** In a standard electrocardiogram (ECG), which of the following waves or complexes represents the depolarization of the ventricles?

(A) P-wave

(B) QRS complex

(C) T-wave

(D) PR segment

**Q14.** The given equation describes a key demographic growth pattern:

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

What does the parameter '$K$' represent in this population model?

(A) Intrinsic rate of natural increase

(B) Biotic potential

(C) Carrying capacity

(D) Environmental resistance factor

**Q15.** Which of the following elements is highly immobile within plant tissues and is not readily remobilized from older senescing parts to younger leaves?

(A) Nitrogen

(B) Potassium

(C) Phosphorus

(D) Calcium

**Q16.** During cellular respiration, the enzyme succinate dehydrogenase catalyzes the conversion of succinate to fumarate. Malonate acts as a competitive inhibitor in this reaction because it:

(A) Binds covalently to an allosteric site on the enzyme.

(B) Alters the primary structural conformation of the active site.

(C) Closely resembles the substrate succinate in its molecular structure.

(D) Destroys the coenzyme factor associated with the protein.

**Q17.** Which phase of the cardiac cycle is characterized by the closure of the AV valves due to rising intraventricular pressure, before the opening of the semilunar valves?

(A) Isovolumetric ventricular contraction

(B) Isovolumetric ventricular relaxation

(C) Ventricular ejection phase

(D) Atrial systole

**Q18.** The regulatory protein that masks the active binding sites for myosin on the actin filaments in a resting skeletal muscle state is:

(A) Troponin

(B) Tropomyosin

(C) Meromyosin

(D) Dystrophin

**Q19.** Tobacco plants can be made resistant to the root-knot nematode *Meloidogyne incognita* using RNA interference (RNAi). The specific source of the double-stranded RNA use to trigger this silencing pathway inside the host plant cells is:

(A) Direct microinjection of synthetic viral proteins.

(B) Transposons or retrotransposons that replicate via an RNA intermediate.

(C) Heavy metal induced chemical stress.

(D) Agrobacterium-mediated transfer of single-stranded sense RNA only.

**Q20.** Consider the following statements:

Statement 1: The maternal immune response relies primarily on natural passive immunity via IgA transport across the placental barrier to the human fetus.

Statement 2: Active immunity provides immediate protection against potent pathogens like tetanus toxin due to pre-formed memory cells.

(A) Both Statement 1 and Statement 2 are correct.

(B) Both Statement 1 and Statement 2 are incorrect.

(C) Statement 1 is correct but Statement 2 is incorrect.

(D) Statement 1 is incorrect but Statement 2 is correct.

**Q21.** Arrange the following steps of the Polymerase Chain Reaction (PCR) in the correct operational sequence:

1. Extension of primers using Taq polymerase
2. Denaturation of double-stranded DNA template
3. Annealing of chemically synthesized oligonucleotide primers

(A) 1 → 2 → 3

(B) 2 → 1 → 3

(C) 2 → 3 → 1

(D) 3 → 2 → 1

**Q22.** Which of the following represents an explicit example of a continuous chemical barrier lining the human innate immune defense system?

(A) Tight junctions between endothelial cells of blood vessels

(B) Mucus coating of the epithelium lining the respiratory tract

(C) Lysozyme present in tears and saliva

(D) Phagocytic neutrophils circulating in the peripheral blood

**Q23.** Fill in the blanks with the correct option:
During the non-cyclic photophosphorylation pathway in green plants, the primary electron acceptor from the excited reaction center of Photosystem II is _____, which then passes the electrons to _____.

(A) Pheophytin ; Plastoquinone

(B) Plastocyanin ; Ferredoxin

(C) Cytochrome b6f ; Plastocyanin

(D) Ferredoxin ; NADP+ reductase

**Q24.** An individual with a karyotype of 47 chromosomes due to an additional copy of chromosome number 21 exhibits which clinical syndrome?

(A) Klinefelter's Syndrome

(B) Turner's Syndrome

(C) Down's Syndrome

(D) Cri-du-chat Syndrome

**Q25.** Which of the following cells secretes an alkaline fluid containing mucus to protect the duodenal mucosa from highly acidic gastric juices?

(A) Oxyntic cells of stomach

(B) Kupffer cells of liver

(C) Brunner's glands of duodenum

(D) Peptic cells of gastric pits

**Q26.** During embryonic development, the blastocyst embeds itself into the functional layer of the endometrium. The outer cellular layer of the blastocyst that makes direct contact with the maternal tissue is called the:

(A) Inner cell mass

(B) Epiblast

(C) Trophoblast

(D) Hypoblast

**Q27.** In the lac operon model of *Escherichia coli*, the repressor protein synthesized by the *i* gene exerts its control by binding to which specific locus?

(A) Promoter site

(B) Operator site

(C) Structural gene *z*

(D) Structural gene *y*

**Q28.** Which of the following features is universally shared by all chordates at some stage of their lifecycle?

(A) Ventral, solid, double nerve cord

(B) Pharyngeal gill slits

(C) Chitinous exoskeleton

(D) Three-chambered myogenic heart

**Q29.** In a monohybrid test cross involving a heterozygous tall pea plant (Tt) and a homozygous dwarf pea plant (tt), what is the expected genotypic and phenotypic ratio among the offspring?

(A) 3 : 1

(B) 1 : 2 : 1

(C) 1 : 1

(D) 9 : 3 : 3 : 1

**Q30.** What type of natural selection operates when environmental changes favor individuals at one extreme of the phenotypic distribution, shifting the mean value of the trait over generations?

(A) Stabilizing selection

(B) Disruptive selection

(C) Directional selection

(D) Balancing selection

**Q31.** Which of the following plant hormones is primarily responsible for promoting apical dominance and inhibiting the growth of lateral buds?

(A) Gibberellic acid

(B) Abscisic acid

(C) Ethylene

(D) Auxin

**Q32.** In human males, the specific target cells for Luteinizing Hormone (LH) that are stimulated to synthesize and secrete testicular androgens are the:

(A) Sertoli cells

(B) Leydig cells

(C) Spermatogonia

(D) Primary spermatocytes

**Q33.** Which of the following structures in a plant cell contains hydrolytic enzymes operating at an acidic pH, analogous to animal lysosomes?

(A) Peroxisome

(B) Glyoxysome

(C) Spherosome / Vacuole

(D) Dictyosome

**Q34.** The evolutionary history of a group of organisms, showing their ancestral relationships and divergence patterns over time, is referred to as their:

(A) Ontogeny

(B) Phenetics

(C) Phylogeny

(D) Systematics

**Q35.** Which of the following acts as an effective emergency contraceptive method if administered within 72 hours of unprotected coitus?

(A) Progestogen-estrogen combinations

(B) Ascorbic acid mega-doses

(C) High-binding Prolactin analogs

(D) Oxytocin antagonists

**Q36.** In a typical anatropous ovule of an angiosperm plant, the small opening or pore where the integuments do not enclose the nucellus is termed the:

(A) Chalaza

(B) Funicle

(C) Hilum

(D) Micropyle

**Q37.** Which of the following fungi belongs to the class Ascomycetes and is widely utilized in biochemical and genetic research workflows?

(A) *Rhizopus stolonifer*

(B) *Neurospora crassa*

(C) *Agaricus bisporus*

(D) *Albugo candida*

**Q38.** The physiological process in plants where water loss occurs in the form of liquid droplets through specialized structures called hydathodes along the margins of leaves is known as:

(A) Transpiration

(B) Guttation

(C) Imbibition

(D) Exudation

**Q39.** What is the correct sequence of layers through which a molecule of oxygen must diffuse across the respiratory membrane from the alveolar air space into the capillary blood?

(A) Alveolar epithelium → Endothelial basement membrane → Capillary endothelium

(B) Capillary endothelium → Alveolar epithelium → Surfactant layer

(C) Interstitial space → Alveolar epithelium → Endothelial basement membrane

(D) Endothelial basement membrane → Capillary endothelium → Alveolar epithelium

**Q40.** Cells during the $G_0$ phase of the cell cycle:

(A) Suspend metabolic activity completely and degenerate.

(B) Exit the cell cycle and enter a state of active differentiation or quiescence.

(C) Duplicate their nuclear DNA content without undergoing cytoplasmic division.

(D) Show rapid progression through checkpoints without cell growth.

## Detailed Solutions

# Q1.

## Solution

**Concept:**

Biomolecules and elements show differing relative abundances between living matter and the non-living world. When comparing the elemental composition of the human body to the Earth's crust, certain light elements are heavily selected for by biology to build organic matrices, cellular frameworks, and functional metabolites.

**Solution:**

(a) Analysis of the chemical composition of living tissue reveals that the percentage of carbon, hydrogen, nitrogen, and oxygen relative to the total body mass is significantly higher than their respective percentages in the Earth's crust.

(b) Carbon serves as the structural backbone for all primary organic molecules, including carbohydrates, lipids, proteins, and nucleic acids. Its unique ability to form four stable covalent bonds allows for structural complexity.

(c) According to quantitative data compiled in standard reference materials, carbon constitutes roughly 18.5 percent of human body weight, whereas its abundance in the Earth's crust is negligible at approximately 0.03 percent.

(d) Conversely, elements like silicon are highly abundant in the inorganic minerals making up the Earth's crust, standing at roughly 27.7 percent, but are found only in trace, negligible amounts within animal bodies.

(e) Calcium and magnesium are vital mineral components for both entities, but their proportional dominance is heavily skewed, with calcium being abundant in crustal rocks and human bone matrices alike, while carbon stands as the most distinctively elevated element in life.

**Final Answer:** The element present in a higher percentage in human body weight is Carbon.

**Answer: (C)**

Go Back to Question 1

## Q2.

### Solution

**Concept:**

The structure of double-stranded DNA molecules is governed by the rules of base pairing discovered by Erwin Chargaff. These stoichiometric relationships state that DNA from any cell of all organisms should have a 1:1 ratio of pyrimidine and purine bases, specifically dictating exact equivalencies between certain base pairings.

**Solution:**

(a) Chargaff's rules explicitly state that in any given double-stranded DNA molecule, the total amount of Adenine is always equal to the total amount of Thymine, and the total amount of Guanine is always equal to the total amount of Cytosine.

(b) This strict equivalence is a direct structural consequence of the complementary hydrogen bonding that occurs inside the double helix, where Adenine pairs exclusively with Thymine via two hydrogen bonds, and Cytosine pairs with Guanine via three.

(c) Given that the sample contains 20 percent Cytosine, it mathematical follows that the percentage of Guanine must also be exactly 20 percent, bringing the combined total for the GC base pairs to 40 percent of the total nucleotide count.

(d) The remaining portion of the genome must consist entirely of Adenine and Thymine base pairs, which is calculated by subtracting the GC total from the complete 100 percent of the sample, yielding 60 percent for AT pairs.

(e) Because the amount of Adenine is strictly equal to the amount of Thymine within a double-stranded molecule, this remaining 60 percent is divided equally between the two bases, resulting in exactly 30 percent Adenine.

**Final Answer:** The percentage of Adenine in this sample is 30%.

**Answer: (B)**

Go Back to Question 2

## Q3.

### Solution

**Concept:**

When humans transition rapidly from low-altitude areas to high-altitude environments, the body encounters a drop in atmospheric pressure. This environmental change reduces the partial pressure of oxygen, making it harder for the blood to maintain homeostatic oxygen saturation levels and triggering acclimatization mechanisms.

**Solution:**

(a) The initial physiological response to a low-oxygen environment involves altitude sickness, which causes headaches, fatigue, and nausea due to decreased oxygen delivery to peripheral metabolic tissues.

(b) To compensate for this persistent environmental stress, the kidneys synthesize and release the hormone erythropoietin, which targets the bone marrow to stimulate a significant increase in total red blood cell production over subsequent days.

(c) Simultaneously, the respiratory center in the brainstem elevates the rate of ventilation, causing an increased breathing rate to maximize the volume of air passing through the pulmonary alveoli per unit time.

(d) Crucially, the biochemical environment within erythrocytes shifts, accumulating higher levels of 2,3-bisphosphoglycerate, which structurally alters hemoglobin to decrease its binding affinity for oxygen, thereby facilitating oxygen unloading into oxygen-starved peripheral tissues.

(e) Therefore, an increased binding affinity would be counterproductive, as it would trap oxygen on hemoglobin molecules and prevent delivery to cells, making a affinity decrease the actual adaptive mechanism utilized by the human body.

**Final Answer:** The change that does NOT occur is increased binding affinity of hemoglobin to oxygen.

**Answer: (B)**

Go Back to Question 3

## Q4.

### Solution

**Concept:**

The structural organization of eukaryotic chromosomes and the mechanisms of the mitotic spindle apparatus vary drastically across distinct cell types and specialized tissues. Chromosomal variations like polyteny and structural abnormalities during division serve as indicators of specialized cellular function or specific mutations.

**Solution:**

(a) Asymmetric spindle formation is a tightly regulated event crucial for stem cell niche preservation and asymmetric cell divisions. However, this process does not occur during regular, symmetrical mitotic telophase in typical animal somatic lineages.

(b) Telophase is traditionally characterized by the decondensation of sister chromatids, disassembly of the mitotic spindle apparatus, and the reconstitution of the nuclear envelope around two equal, identical diploid daughter nuclei.

(c) Polytene chromosomes are giant, multi-stranded structures formed through repeated rounds of DNA replication without subsequent chromatid separation, a highly specialized process known as endoreduplication.

(d) These massive chromosomal structures are classically found in the salivary glands of dipteran insects like Drosophila melanogaster, where high transcriptional output is needed, rather than during the normal meiotic stages of vertebrate oocytes.

(e) Vertebrate oocytes during the prolonged diplotene stage of meiotic prophase I exhibit lampbrush chromosomes, which are characterized by extensive lateral loops showing active transcription, making both statements completely factually incorrect.

**Final Answer:** Both Statement 1 and Statement 2 are incorrect.

**Answer: (B)**

Go Back to Question 4

## Q5.

### Solution

**Concept:**

Biological taxonomy organizes living organisms into a strict hierarchical classification scheme. This formalized system uses sequential categories that progress from highly broad, inclusive groups down to highly specific, narrow designations based on shared evolutionary history and distinct morphological features.

**Solution:**

(a) The standard taxonomic hierarchy consists of several mandatory categories arranged in order of decreasing inclusivity, moving systematically from Kingdom, Phylum, Class, Order, Family, Genus, down to the final level of Species.

(b) For the housefly, Musca domestica, the broader classification begins within the animal kingdom under the phylum Arthropoda, which encompasses all organisms characterized by jointed appendages, segmented bodies, and a rigid chitinous exoskeleton.

(c) Progressing further down the biological hierarchy into more specific subdivisions, the housefly belongs to the class Insecta, a major arthropod group defined by a three-part body plan consisting of a head, thorax, and abdomen.

(d) Within the class Insecta, the organism falls into the order Diptera, which uniquely identifies true flies possessing only a single pair of functional flight wings alongside a pair of modified balancing organs called halteres.

(e) Moving to the lower levels of taxonomy, the order Diptera contains the specific family Muscidae, which represents the terminal family grouping before reaching the genus Musca, making the correct descending order Phylum to Family.

**Final Answer:** The correct sequence is $3 \rightarrow 1 \rightarrow 4 \rightarrow 2$.

**Answer: (A)**

Go Back to Question 5

## Q6.

### Solution

**Concept:**

Hormone synthesis inside eukaryotic cells frequently involves the production of large, structurally extended precursor molecules known as prohormones. These biochemical precursors undergo post-translational modifications, including specific proteolytic cleavage, to yield the final biologically active molecular conformation.

**Solution:**

(a) Human insulin is initially synthesized by the beta cells of the islets of Langerhans in the pancreas as a single continuous polypeptide chain termed preproinsulin, which includes an initial signal sequence.

(b) Following the removal of the signal peptide within the endoplasmic reticulum, the resulting proinsulin molecule folds into a specific configuration stabilized by three distinct, highly crucial disulfide bonds linking its regional segments.

(c) Proinsulin structurally consists of three sequential peptide segments: an amino-terminal A-chain, a carboxy-terminal B-chain, and an intervening connecting peptide loop designated as the C-peptide segment.

(d) To convert this inactive prohormone into its mature, active endocrine state, specialized endopeptidases cleave the polypeptide backbone at two specific sites, physically excising the intervening C-peptide fragment entirely.

(e) The remaining active mature insulin molecule consists exclusively of the distinct A and B chains, held securely together by two interchain disulfide bonds and one intrachain disulfide bond, making the C-peptide a structural byproduct.

**Final Answer:** The structural component proteolytically removed is the C-peptide.

**Answer: (C)**

Go Back to Question 6

## Q7.

### Solution

**Concept:**

Ecosystem energetics and primary productivity models track the precise rate at which autotrophic organisms convert solar energy into chemical energy. This ecological process is split mathematically into gross values and net values based on the ongoing metabolic demands of the primary producer community.

**Solution:**

(a) Gross Primary Productivity represents the total rate at which primary producers, such as green plants and photosynthetic algae, capture radiant solar energy and convert it into stable organic chemical compounds via photosynthesis.

(b) However, primary producers must continuously expend a significant portion of this fixed chemical energy to sustain their own cellular metabolism, ongoing growth, and general maintenance via the biochemical pathways of cellular respiration.

(c) The total amount of energy consumed by these maintenance processes is designated as the respiratory loss, which must be mathematically subtracted from the total energy captured to find the actual accumulated biomass.

(d) Net Primary Productivity represents the final rate at which organic matter is actually stored and made available to the subsequent trophic levels of heterotrophic consumers, including herbivores and decomposers within the local food web.

(e) The relationship is defined by the basic algebraic ecological formula where Net Primary Productivity equals Gross Primary Productivity minus Respiratory Loss, which in this scenario evaluates directly to 150 minus 30, yielding 120.

**Final Answer:** The Net Primary Productivity is 120 kcal/$m^2$/yr.

**Answer: (B)**

Go Back to Question 7

## Q8.

### Solution

**Concept:**

Plants synthesize an extensive array of organic compounds classified as secondary metabolites. Unlike primary metabolites, these diverse molecules do not directly participate in baseline growth or reproduction, but instead provide defensive functions, acting as toxins, deterrents, or chemical signals.

**Solution:**

(a) Secondary metabolites are grouped into distinct biochemical categories based on their chemical architecture, including alkaloids, terpenoids, lectins, and specific plant-derived toxins that target competitive or predatory organisms.

(b) Morphine is a classic alkaloid derived from the opium poppy plant that acts primarily as a potent central nervous system analgesic and narcotic, rather than operating primarily as a simple cellular toxin.

(c) Ricin is a highly potent, naturally occurring ribosome-inactivating protein toxin extracted from the seeds of the castor oil plant, Ricinus communis, and is classified explicitly as a biological toxin.

(d) Vinblastine is an anticancer chemotherapeutic drug belonging to the vinca alkaloid family that functions by binding to tubulin dimeric units, thereby effectively disrupting regular mitotic spindle assembly.

(e) Concanavalin A belongs to a distinct group of carbohydrate-binding proteins known as lectins, which are isolated from jack beans and interact with specific glycoprotein matrices on cellular surfaces.

**Final Answer:** The secondary metabolite classified as a toxin is Ricin.

**Answer: (B)**

Go Back to Question 8

## Q9.

### Solution

**Concept:**

Human oogenesis is an explicitly discontinuous gametogenic process that begins during embryonic development and remains arrested at specific meiotic checkpoints. The reactivation and completion of these initial genetic stages are strictly coordinated with the structural maturation of the surrounding ovarian follicular anatomy.

**Solution:**

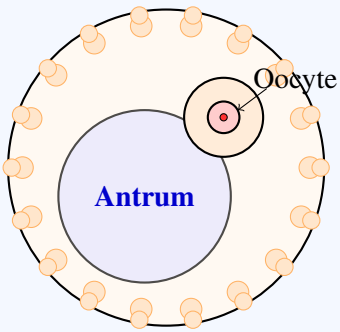
(a) Female germ cells differentiate into primary oocytes during embryonic growth, entering meiotic prophase I where they remain developmentally arrested in the diplotene stage until the individual reaches reproductive puberty.

(b) With the onset of monthly ovarian cycles, structural surges of follicle-stimulating hormone activate a small group of primary and secondary follicles to undergo rapid proliferation and cellular layer differentiation.

(c) As a follicle matures into a tertiary follicle, it develops a large, fluid-filled internal cavity known as the antrum, which segregates the surrounding granulosa cells into distinct structural layers.

(d) It is precisely inside this advanced tertiary follicular environment that the arrested primary oocyte completes its first meiotic division just prior to the structural event of ovulation.

(e) This unequal cellular division yields a large haploid secondary oocyte and a small non-functional first polar body, which then advance into the final mature Graafian follicle stage.




**Tertiary Follicle Anatomy**

**Final Answer:**

Tertiary follicle

**Answer: (C)**

Go Back to Question 9

## Q10.

### Solution

**Concept:**

Industrial microbiology utilizes specific strains of filamentous fungi, yeasts, and bacteria to manufacture commercially valuable bioactive molecules. These microbial products find widespread application in modern human medicine, acting as cholesterol-lowering drugs, immunosuppressants, or clot-dissolving agents.

**Solution:**

(a) Statins are competitive inhibitors of the enzyme HMG-CoA reductase, which is the rate-limiting enzyme in cholesterol biosynthesis. These therapeutic agents are commercially extracted from the yeast strain Monascus purpureus.

(b) Cyclosporin A is a powerful immunosuppressive polypeptide agent that revolutionized organ transplantation procedures by selectively inhibiting T-cell activation, preventing the immune destruction of foreign tissue grafts.

(c) This specific bioactive molecule is naturally synthesized and harvested from the filamentous soil fungus Trichoderma polysporum, which serves as the primary commercial source for the pharmaceutical industry.

(d) Other microbes listed produce different organic commodities; for instance, Aspergillus niger is commonly utilized for the high-yield industrial fermentation and production of citric acid.

(e) Similarly, Propionibacterium sharmanii is a specialized bacterium responsible for the production of Swiss cheese, where its metabolic release of carbon dioxide gas forms characteristic large bubbles.

**Final Answer:** Cyclosporin A is derived from Trichoderma polysporum.

**Answer: (B)**

Go Back to Question 10

## Q11.

### Solution

**Concept:**

The human digestive tract is a continuous muscular tube featuring specialized anatomical junctions and sphincters. These mechanical boundaries regulate the unidirectional movement of chyme and digestive waste products through successive organs, preventing backward contamination.

**Solution:**

(a) The large intestine houses a dense population of symbiotic bacteria that break down undigested organic matter. Because this environment differs fundamentally from the small intestine, backflow must be strictly prevented.

(b) The final segment of the small intestine is the ileum, which connects directly to the cecum, the blind pouch that marks the absolute commencement of the large intestinal tract.

(c) At this specific anatomical transition zone, the muscularis layer forms a specialized structural fold known as the ileo-caecal valve, which functions as a functional one-way mechanical gate.

(d) Under normal physiological conditions, pressure from fluid accumulating in the terminal ileum forces the valve leaflets open, allowing digested chyme to pass smoothly into the cecum.

(e) Conversely, when the cecum distends with fecal matter and gas, the internal pressure pushes the valve leaflets tightly together, completely sealing the orifice and preventing toxic backflow into the small intestine.

**Final Answer:** The structure that prevents backflow is the Ileo-caecal valve.

**Answer: (D)**

Go Back to Question 11

## Q12.

### Solution

**Concept:**

Epistasis represents a form of non-allelic gene interaction where the phenotypic expression of one gene locus masks or completely suppresses the phenotypic expression of an independent gene locus located elsewhere in the genome.

**Solution:**

(a) In a standard Mendelian dihybrid cross involving two completely independent loci with simple dominance, the expected second-generation phenotypic segregation ratio is classicly 9:3:3:1.

(b) When dominant epistasis occurs, a dominant allele at one locus, which we can designate as allele A, suppresses the expression of both alleles at the second locus, designated as B or b.

(c) Therefore, any genomic combination containing at least one copy of the dominant allele A will exhibit the exact same epistatic phenotype, regardless of the allelic state of the second locus.

(d) In a standard Punnett square involving sixteen total genetic combinations, twelve individuals will carry at least one dominant A allele, which completely unifies their structural phenotype.

(e) Of the remaining four individuals lacking the dominant A allele, three will exhibit the dominant B phenotype, and exactly one individual will manifest the fully recessive configuration, creating a 12:3:1 ratio.

**Final Answer:** The phenotypic ratio obtained in dominant epistasis is 12 : 3 : 1.

**Answer: (B)**

Go Back to Question 12

# Q13.

## Solution

**Concept:**

Electrocardiography is a vital diagnostic method that tracks and records the rhythmic electrical vectors generated by the myocardium over time. These registered wave parameters match specific sequential depolarization and repolarization waves traversing the upper and lower cardiac chambers.

**Solution:**

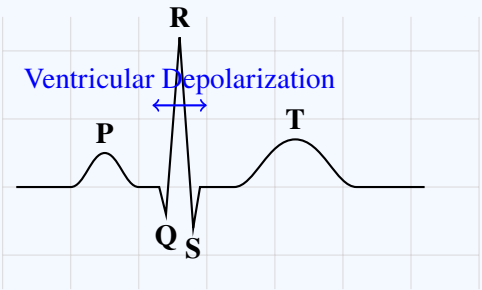
(a) A regular electrocardiogram trace is composed of distinct electrical deflections that systematically recur with each heartbeat, designated sequentially as the P wave, the QRS complex, and the final T wave.

(b) The initial small positive deflection, known as the P wave, corresponds directly to the electrical depolarization wave spreading from the sinoatrial node across the atrial syncytium, inducing mechanical atrial contraction.

(c) After a brief physiological delay at the atrioventricular node, the action potential travels down the specialized conduction bundle, manifesting as a sharp, high-amplitude deflection called the QRS complex.

(d) This specific complex represents complete ventricular depolarization, an event that serves as the immediate electro-mechanical trigger for ventricular systole and the subsequent pumping of blood into systemic arteries.

(e) The final broad deflection is the T wave, which marks ventricular repolarization, signaling the phase where ventricular muscle fibers relax and reset their transmembrane potential prior to the next diastole.




**Final Answer:**

QRS complex

**Answer: (B)**

Go Back to Question 13

## Q14.

### Solution

**Concept:**

Population ecology utilizes mathematical models to simulate and predict how biological populations fluctuate over time under varying environmental constraints and resource limitations within a defined geographic habitat.

**Solution:**

(a) Real-world biological populations do not experience unlimited growth due to finite natural resources like food, nesting territory, water, and sustainable environmental conditions.

(b) The verhulst-pearl logistic growth equation incorporates a feedback mechanism that slows population growth as the total density of individuals approaches the maximum limit that the ecosystem can support.

(c) In this differential calculus model, the variable N represents the current population size, while the parameter r denotes the intrinsic rate of natural increase for that specific species.

(d) The specific algebraic term denoted by the letter K represents the carrying capacity, which is the maximum stable population size an environment can sustain indefinitely without degradation.

(e) When the current population size N is very small, the value of the scaling term approaches one, mimicking exponential growth, but as N approaches K, the term drops to zero, halting growth entirely.

**Final Answer:** The parameter K represents the Carrying capacity.

**Answer: (C)**

Go Back to Question 14

## Q15.

### Solution

**Concept:**

Plant mineral nutrition involves the uptake of essential inorganic ions via the root system and their subsequent distribution through vascular tissues. The mobility of an element within plant architecture dictates where deficiency symptoms first appear.

**Solution:**

(a) Structural and functional mineral elements are categorized based on their ability to be salvaged and translocated via the phloem stream when a plant encounters a localized nutrient deficit.

(b) Highly mobile elements such as nitrogen, potassium, and phosphorus are readily broken down from older, senescing leaves and exported toward younger vegetative structures or growing meristems.

(c) Consequently, when a plant faces a shortage of these mobile nutrients, the characteristic deficiency symptoms, such as chlorosis, manifest prominently in older lower leaves first.

(d) Conversely, certain structural elements are incorporated directly into stable, permanent cellular components, such as the pectin network of the middle lamella that binds adjacent cell walls together.

(e) Calcium is a classic example of an immobile element; once deposited in structural walls, it cannot be remobilized, causing deficiency symptoms to appear exclusively in young, developing apical tissues.

**Final Answer:** The highly immobile element within plant tissues is Calcium.

**Answer: (D)**

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## Q16.

### Solution

**Concept:**

Enzyme kinetics can be profoundly altered by the introduction of specific inhibitory molecules. Competitive inhibition occurs when an exogenous chemical compound physically vies with the natural substrate for access to the catalytic active site.

**Solution:**

(a) Succinate dehydrogenase is a key enzyme in the citric acid cycle that catalyzes the oxidation of succinate into fumarate, utilizing FAD as an electron acceptor.

(b) Malonate is a naturally occurring dicarboxylic acid that acts as a classic competitive inhibitor because its chemical structure and spatial geometry closely resemble those of the natural substrate succinate.

(c) Because of this structural homology, malonate can bind to the free enzyme active site, blocking succinate from entering and effectively shutting down the catalytic cycle.

(d) Crucially, this binding is entirely reversible and non-covalent; malonate does not permanently alter the primary sequence or secondary conformation of the active site.

(e) Because it is a competitive mechanism, the inhibitory effect can be overcome by increasing the concentration of the true substrate succinate, shifting the equilibrium back toward normal enzyme-substrate complex formation.

**Final Answer:** Malonate acts as a competitive inhibitor because it closely resembles succinate.

**Answer: (C)**

Go Back to Question 16

## Q17.

### Solution

**Concept:**

The mechanical activity of the human heart during a single beat is divided into precise sequential phases based on internal pressure differentials, the contraction state of the myocardium, and the open or closed status of the valves.

**Solution:**

(a) At the onset of ventricular systole, the ventricular myocardium begins to contract rapidly, causing an immediate, steep rise in the internal pressure within both lower chambers.

(b) This sudden pressure increase forces blood backward against the atrioventricular valves, snapping the tricuspid and bicuspid valves shut to prevent regurgitation into the atria.

(c) Immediately following valve closure, the ventricular pressure is not yet high enough to overcome the hydrostatic pressure in the aorta and pulmonary artery, keeping the semilunar valves closed.

(d) During this brief window, the ventricles operate as completely sealed chambers; the muscle fibers contract, but because fluid is incompressible, the total volume of blood inside remains constant.

(e) This specific phase is termed isovolumetric ventricular contraction, and it finishes once intraventricular pressure exceeds arterial pressure, forcing the semilunar valves open.

**Final Answer:** The phase described is Isovolumetric ventricular contraction.

**Answer: (A)**

Go Back to Question 17

## Q18.

### Solution

**Concept:**

The molecular mechanics of skeletal muscle contraction operate via a sliding filament mechanism. This process is tightly regulated by intracellular calcium concentrations interacting with specialized structural proteins bound to the thin filaments.

**Solution:**

(a) Muscle thin filaments are composed primarily of globular actin subunits polymerized into a double-helical strand, which contains specific binding sites tailored to interact with myosin heads.

(b) In a resting, non-stimulated muscle cell, the intracellular concentration of calcium ions is kept extremely low due to active sequestration within the sarcoplasmic reticulum.

(c) In this resting state, a long, fibrous regulatory protein complex called tropomyosin lies within the grooves of the actin helix, physically masking the myosin-binding sites.

(d) Another regulatory protein complex, troponin, is attached at regular intervals along the tropomyosin strand, acting as a molecular switch that responds to calcium changes.

(e) When a nerve impulse triggers the release of calcium, the ions bind to troponin, inducing a conformational change that shifts tropomyosin out of the way, exposing the binding sites.

**Final Answer:** The regulatory protein that masks the binding sites is Tropomyosin.

**Answer: (B)**

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## Q19.

### Solution

**Concept:**

RNA interference is a highly conserved post-transcriptional gene silencing mechanism utilized by eukaryotic organisms as an innate defense pathway against viral pathogens, transposons, and parasitic genetic elements.

**Solution:**

(a) The biological trigger for the initiation of the RNA interference cascade inside a cell is the presence of atypical double-stranded RNA molecules within the cytoplasm.

(b) In agricultural biotechnology, tobacco plants are modified using Agrobacterium vectors to express specific genes derived from the root-knot nematode Meloidogyne incognita.

(c) These custom vectors are engineered to transcribe both sense and antisense strands of a vital nematode gene simultaneously within the host plant cell.

(d) Upon transcription, these complementary sense and antisense strands rapidly hybridize with one another, forming stable double-stranded RNA molecules inside the plant tissues.

(e) This double-stranded RNA structure mimics mobile parasitic elements such as transposons or retrotransposons that naturally utilize an RNA intermediate during their genomic replication cycles.

**Final Answer:** The source is transposons or retrotransposons that replicate via an RNA intermediate.

**Answer: (B)**

Go Back to Question 19

## Q20.

### Solution

**Concept:**

Immunology classifies protective mechanisms into active and passive immunity based on whether the host individual's own immune cells are directly stimulated to produce antibodies and memory cells.

**Solution:**

(a) Natural passive immunity occurs when pre-formed antibodies are transferred directly from a maternal donor to a developing fetus or newborn infant, providing immediate, temporary protection.

(b) In humans, the primary antibody class capable of crossing the protective placental barrier from maternal circulation into the fetal bloodstream is IgG, not IgA.

(c) IgA antibodies are instead concentrated within maternal colostrum and breast milk, providing localized passive mucosal immunity within the neonate's digestive tract following birth.

(d) Active immunity develops when exposure to a pathogen or vaccine triggers the host's B cells to synthesize antibodies and generate long-lived memory cells.

(e) However, because active immunity requires cellular proliferation and differentiation, it takes several days or weeks to develop and cannot provide immediate protection during an acute emergency like tetanus exposure.

**Final Answer:** Both Statement 1 and Statement 2 are incorrect.

**Answer: (B)**

Go Back to Question 20

## Q21.

### Solution

**Concept:**

The Polymerase Chain Reaction is an in vitro biotechnology process used to exponentially duplicate specific segments of a target DNA template. The biochemical efficiency of this amplification pathway relies on cycling through three discrete, temperature-dependent enzymatic steps.

**Solution:**

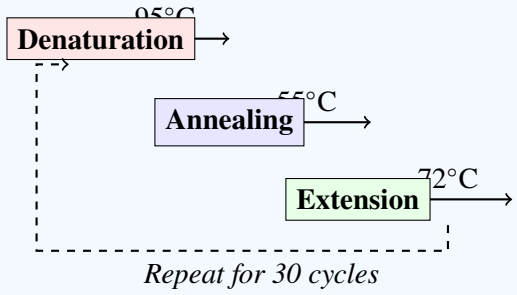
(a) The operation of a single PCR cycle initiates with the denaturation step, where the core reaction coordinates are raised to a high thermal limit, typically ranging between 94 and 96 degrees Celsius.

(b) This intense thermal environment breaks the intermolecular hydrogen bonds binding the complementary nucleotide strands together, splitting the double-stranded DNA template into isolated, open single strands.

(c) The second phase is the annealing step, where the system temperature is lowered to roughly 50 to 65 degrees Celsius to enable synthetic oligonucleotide primers to hybridize to their target sites.

(d) These short primers are added in significant chemical excess to ensure they bond efficiently to the flanking segments of the single-stranded templates before the original strands can re-anneal.

(e) The final step is extension, where the operational temperature is elevated to approximately 72 degrees Celsius, which matches the optimal functional range for the specialized thermostable Taq polymerase enzyme.




**Final Answer:**

$$\boxed{2 \rightarrow 3 \rightarrow 1}$$

**Answer: (C)**

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## Q22.

### Solution

**Concept:**

The human innate immune system comprises broad, non-specific defensive barriers categorized into physical, chemical, cellular, and physiological lines of defense. These components work continuously to prevent microbial colonization.

**Solution:**

(a) Physical or anatomical barriers, such as the stratified squamous epithelium of the skin and the mucous membranes lining internal tracts, mechanically block the entry of foreign pathogens.

(b) Tight junctions between endothelial cells function as structural barriers that regulate permeability, preventing pathogens from slipping between cells into surrounding vascular compartments.

(c) Chemical barriers involve specialized physiological secretions that contain specialized biochemical compounds or hostile pH environments that actively neutralize or destroy invading microorganisms.

(d) Lysozyme is an active antimicrobial enzyme synthesized in exotic secretory fluids like tears, saliva, and nasal mucus that chemically breaks down the peptidoglycan cell walls of Gram-positive bacteria.

(e) Because lysozyme provides continuous, fluid-based chemical destruction of bacterial structures, it serves as a classic example of a chemical defense layer, distinct from cellular phagocytes like neutrophils.

**Final Answer:** The explicit example of a continuous chemical barrier is Lysozyme present in tears and saliva.

**Answer: (C)**

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## Q23.

### Solution

**Concept:**

The light-dependent reactions of oxygenic photosynthesis involve a linear sequence of electron transport known as the Z-scheme. This pathway utilizes two distinct photosystems acting in series to generate biochemical reducing power.

**Solution:**

(a) When photon energy strikes the antenna complex of Photosystem II, the energy is funneled directly to the core reaction center, a specialized pair of chlorophyll a molecules designated as P680.

(b) This excitation drives P680 into a high-energy state, causing it to rapidly eject an energized electron, which is instantly captured by the primary electron acceptor, pheophytin.

(c) Pheophytin is a specialized chlorophyll molecule lacking a central magnesium ion that acts as an immediate electron gateway, preventing the electron from dropping back down to P680.

(d) From pheophytin, the electron is transferred to plastoquinone, a mobile, lipid-soluble electron carrier located within the fluid core of the thylakoid membrane.

(e) Plastoquinone picks up protons from the stroma as it is reduced, subsequently delivering its electrons to the cytochrome b6f complex to drive proton translocation into the thylakoid lumen.

**Final Answer:** The primary electron acceptor is Pheophytin, which passes electrons to Plastoquinone.

**Answer: (A)**

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## Q24.

### Solution

**Concept:**

Human chromosomal disorders frequently arise from errors during gametogenesis, specifically the failure of homologous chromosomes or sister chromatids to separate correctly during meiotic cell divisions.

**Solution:**

(a) The physiological failure of chromosomal separation is known as non-disjunction, and it results in gametes that carry either an abnormal surplus or a deficit of specific chromosomes.

(b) If a gamete containing an extra copy of a chromosome fuses with a normal haploid gamete during fertilization, the resulting zygote will exhibit an abnormal three-copy configuration termed trisomy.

(c) Down syndrome is a classic clinical condition caused explicitly by the trisomy of autosome number 21, resulting in a total somatic karyotype count of 47 chromosomes.

(d) Other well-known genetic syndromes are caused by sex chromosome abnormalities rather than autosomal mutations; for instance, Klinefelter syndrome involves a 47, XXY individual.

(e) Turner syndrome is characterized by a 45, X0 monosomy, while Cri-du-chat syndrome is an explicit structural deletion anomaly affecting the short arm of autosome number 5.

**Final Answer:** An individual with an additional copy of chromosome 21 exhibits Down's Syndrome.

**Answer: (C)**

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## Q25.

### Solution

**Concept:**

The mucosal lining of the human gastrointestinal tract contains specialized multicellular glands adapted to handle sharp chemical transitions between successive digestive compartments.

**Solution:**

(a) The stomach utilizes oxyntic or parietal cells to secrete concentrated hydrochloric acid, creating a highly corrosive luminal fluid with a pH around 1.5 to 2.0 to facilitate protein digestion.

(b) When this highly acidic chyme passes through the pyloric sphincter into the proximal duodenum, the intestinal lining must be protected from chemical burns and ulceration.

(c) To counter this acid, specialized compound tubular submucosal glands called Brunner's glands, located exclusively in the duodenum, secrete an abundance of clear, alkaline, mucus-rich fluid.

(d) This secretion contains a high concentration of bicarbonate ions that actively neutralize the arriving gastric acid, raising the local luminal pH to a slightly alkaline level.

(e) This higher pH environment not only preserves the structural integrity of the delicate intestinal mucosa but also establishes the optimal operational range required for pancreatic digestive enzymes.

**Final Answer:** The cells that secrete this protective alkaline fluid are Brunner's glands of the duodenum.

**Answer: (C)**

Go Back to Question 25

## Q26.

### Solution

**Concept:**

Early embryonic development converts a single-celled diploid zygote through rapid mitotic cleavage divisions into a specialized multicellular sphere termed the blastocyst, which possesses distinct cellular lineages tailored for uterine implantation.

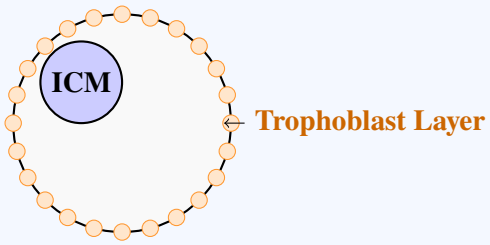
**Solution:**

(a) The blastocyst configuration is established roughly five to six days after fertilization, showing an asymmetrical structural design critical for negotiating attachment with maternal uterine tissues.

(b) The interior of the blastocyst features an eccentric mass of tightly grouped cells called the inner cell mass, which retains pluripotency and eventually forms all primary embryonic germ layers.

(c) Encapsulating this inner cellular cluster and lining the fluid-filled blastocoel cavity is an outer single-layered epithelial ring designated explicitly as the trophoblast.

(d) It is the outer trophoblast layer that establishes direct physical contact with the functional endometrium of the maternal uterus, anchoring the embryo securely.




**Blastocyst Cross-Section**

**Final Answer:**

Trophoblast

**Answer: (C)**

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## Q27.

### Solution

**Concept:**

Prokaryotic gene regulation uses operon systems to coordinate the expression of functionally related structural genes in response to changing metabolic environments and substrate availability.

**Solution:**

(a) The lac operon of Escherichia coli is an inducible genetic system that regulates the synthesis of enzymes required for the transport and breakdown of lactose.

(b) The regulatory framework consists of structural genes, a promoter site where RNA polymerase binds, an operator locus, and a regulatory gene designated as the i gene.

(c) The i gene functions constitutively, meaning it continuously transcribes and translates a specialized regulatory protein known as the lac repressor.

(d) In the absence of an inducer like lactose, this repressor protein possesses a high binding affinity for the specific nucleotide sequence of the operator site.

(e) When the repressor binds tightly to the operator locus, it physically blocks RNA polymerase from moving forward from the promoter, preventing transcription of the structural genes.

**Final Answer:** The repressor protein exerts its control by binding to the Operator site.

**Answer: (B)**

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## Q28.

### Solution

**Concept:**

The phylum Chordata is a diverse group of animals unified by a specific set of primary structural features that must be manifest during embryogenesis or throughout their adult lifecycles.

**Solution:**

(a) Chordate classification is built upon four fundamental anatomical traits: a rigid longitudinal notochord, a dorsal hollow nerve cord, pharyngeal gill slits, and a post-anal tail.

(b) In contrast to non-chordate invertebrates, which possess a ventral, solid, double nerve cord, all chordates characteristically exhibit a single, hollow nerve cord situated dorsally.

(c) Pharyngeal gill slits appear during embryonic development in all chordates, serving respiratory or filtering functions in lower aquatic forms and modifying into structural head elements in tetrapods.

(d) Invertebrates often possess a rigid, non-living chitinous exoskeleton, whereas chordates rely on a living, vascularized endoskeleton made of cartilage or bone.

(e) Cardiovascular designs vary significantly within the phylum, ranging from the simple contractile vessels of protochordates to the complex, multi-chambered hearts seen in modern birds and mammals.

**Final Answer:** The feature universally shared by all chordates is Pharyngeal gill slits.

**Answer: (B)**

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## Q29.

### Solution

**Concept:**

Mendelian genetics utilizes test crosses to deduce the unknown genotype of an individual displaying a dominant phenotype by crossing them with a known homozygous fully recessive partner.

**Solution:**

(a) In pea plants, the allele for tall height, designated as T, exhibits complete dominance over the alternative allele for dwarf height, designated as t.

(b) A heterozygous tall pea plant possesses the genomic combination Tt, meaning it will produce two distinct classes of gametes in equal proportions due to meiotic segregation.

(c) Half of the gametes produced by this heterozygous parent will carry the dominant T allele, while the remaining half will carry the recessive t allele.

(d) The homozygous dwarf testing partner possesses the genotype tt and can consequently produce only a single uniform class of gametes, all carrying the recessive t allele.

(e) Combining these gametes yields two equal classes of offspring: half will be Tt displaying a tall phenotype, and half will be tt displaying a dwarf phenotype, establishing a 1:1 ratio.

**Final Answer:** The expected genotypic and phenotypic ratio is $1:1$.

**Answer: (C)**

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## Q30.

### Solution

**Concept:**

Evolutionary mechanisms shift allele frequencies within a population over time in response to natural selection operating on phenotypic variations under changing environmental pressures.

**Solution:**

(a) Natural selection modifies phenotypic distributions across generations through three primary modes of action: stabilizing selection, directional selection, and disruptive selection.

(b) Stabilizing selection occurs in a constant environment, weeding out extreme variations and favoring intermediate phenotypes, which reduces overall variance without shifting the mean value.

(c) Directional selection operates when an environmental shift favors individuals at one extreme of the phenotypic range over intermediate and opposite extreme phenotypes.

(d) This selective pressure drives a systematic shift in allele frequencies, moving the mean value of the quantitative trait toward that favored extreme over subsequent generations.

(e) Classic examples include the industrial melanism observed in peppered moths and the widespread development of antibiotic resistance in bacterial populations exposed to antimicrobial drugs.

**Final Answer:** The mode of natural selection described is Directional selection.

**Answer: (C)**

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## Q31.

### Solution

**Concept:**

Plant growth and development are orchestrated by chemical messengers known as phytohormones. These organic molecules are synthesized in minute quantities within specific tissues and translocated to target cells to regulate physiological behaviors.

**Solution:**

(a) Apical dominance is a common physiological phenomenon in vascular plants where the central main stem grows rapidly and suppresses the outgrowth of lateral, axillary buds.

(b) This developmental control is mediated primarily by auxin, a class of phytohormones synthesized in abundance within the actively dividing cells of the shoot apical meristem.

(c) Once synthesized, auxin moves downward through the stem via a specialized active transport system known as polar auxin transport, creating a concentration gradient.

(d) This downward flux of auxin acts directly or indirectly via secondary signaling networks to inhibit the expansion and development of the lower axillary buds.

(e) If the apical bud is physically removed, a common agricultural practice known as decapitation, the source of auxin is eliminated, allowing lateral buds to grow and make the plant bushier.

**Final Answer:** The plant hormone responsible for promoting apical dominance is Auxin.

**Answer: (D)**

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## Q32.

### Solution

**Concept:**

The regulation of the human male reproductive system depends on a complex endocrine loop known as the hypothalamus-pituitary-gonadal axis, which balances hormone synthesis and gametogenesis.

**Solution:**

(a) The anterior pituitary gland responds to gonadotropin-releasing hormone from the hypothalamus by secreting two primary gonadotropins: follicle-stimulating hormone and luteinizing hormone.

(b) These peptide hormones travel through the systemic circulation to target specific, distinct cellular populations located within the structural compartments of the testes.

(c) Luteinizing hormone binds to high-affinity receptors on the surface of Leydig cells, which reside in the interstitial spaces surrounding the seminiferous tubules.

(d) This binding activates an intracellular signaling cascade that drives the enzymatic conversion of cholesterol into potent androgenic hormones, primarily testosterone.

(e) Follicle-stimulating hormone targets the Sertoli cells within the tubules, stimulating them to secrete androgen-binding protein and other critical factors needed to support active spermatogenesis.

**Final Answer:** The target cells for Luteinizing Hormone are the Leydig cells.

**Answer: (B)**

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## Q33.

### Solution

**Concept:**

Eukaryotic cells segregate distinct biochemical pathways into specialized, membrane-bound organelles to optimize metabolic efficiency and prevent accidental cellular autolysis.

**Solution:**

(a) Animal cells utilize lysosomes, which contain an assortment of acid hydrolases, to degrade worn-out organelles, macromolecular aggregates, and internalized foreign pathogens.

(b) Plant cells lack classic morphologically distinct lysosomes, but they possess a large central vacuole that acts as the primary functional analogue for macromolecular degradation.

(c) The vacuolar membrane, termed the tonoplast, houses active proton-pumping v-type ATPases that continually pump hydrogen ions from the cytoplasm into the vacuolar lumen.

(d) This active transport maintains an acidic internal environment within the vacuole, which matches the optimal operational pH required by its resident hydrolytic enzymes.

(e) These enzymes break down proteins, nucleic acids, and polysaccharides, allowing the plant cell to recycle essential nutrient components during periods of metabolic stress or starvation.

**Final Answer:** The structure containing hydrolytic enzymes operating at an acidic pH is the Spherosome / Vacuole.

**Answer: (C)**

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## Q34.

### Solution

**Concept:**

Systematic biology focuses on documenting, characterizing, and cataloging the massive structural diversity of living organisms by synthesizing morphological data, developmental pathways, and historical evolutionary changes.

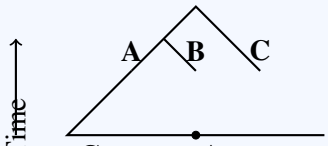
**Solution:**

(a) While historical taxonomic frameworks relied on superficial traits, modern biological classification prioritizes evolutionary descent to establish true genetic relationships.

(b) The term phylogeny refers to the chronological evolutionary history and ancestral line of descent linking a specific group of genetically related biological organisms.

(c) Reconstructing an operational phylogeny involves tracking homologous characteristics, reviewing fossil records, and evaluating molecular sequences to map when specific lineages branched away from common ancestors.

(d) This systemic evolutionary history is typically mapped out using a specialized branching diagram known as a phylogenetic tree or cladogram, which tracks speciation events across deep geological time.




**Phylogenetic Branching Model**

**Final Answer:**

Phylogeny

**Answer: (C)**

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## Q35.

### Solution

**Concept:**

Reproductive health technologies include a variety of contraceptive strategies engineered to prevent unintended pregnancies by disrupting ovulation, fertilization, or subsequent embryonic implantation.

**Solution:**

(a) Emergency contraception is designed to prevent pregnancy following unprotected coitus or a primary contraceptive failure, and it must be administered within a tight physiological window.

(b) To be highly effective, these emergency methods must be implemented within 72 hours of intercourse, before a fertilized blastocyst can successfully initiate uterine implantation.

(c) The most common chemical formulations rely on high doses of synthetic progestogens, either administered alone or combined in a balanced ratio with synthetic estrogens.

(d) These elevated hormone levels act primarily by delaying or fully inhibiting ovulation, preventing the release of a mature secondary oocyte from the ovaries.

(e) Additionally, they alter the viscosity of cervical mucus to block sperm transport and modify the endometrial lining, making it completely unreceptive to blastocyst attachment.

**Final Answer:** The effective emergency contraceptive method is Progestogen-estrogen combinations.

**Answer: (A)**

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## Q36.

### Solution

**Concept:**

The angiosperm ovule, or megasporangium, is a highly organized structure attached to the internal placental wall of the ovary by a vascularized stalk called the funicle.

**Solution:**

(a) A typical anatropous ovule undergoes a 180-degree structural inversion during its development, positioning its developmental openings in close proximity to the basal stalk.

(b) The central core of the ovule consists of a nutritive tissue mass termed the nucellus, which is enclosed and protected by one or two protective layers called integuments.

(c) These protective integuments wrap completely around the nucellus but leave a tiny, specialized opening at one extreme end, which is designated as the micropyle.

(d) The micropyle acts as a vital entry gateway, allowing the arriving pollen tube to penetrate the ovule and deliver its sperm nuclei directly into the embryo sac.

(e) The region situated directly opposite the micropylar opening, where the integuments originally differentiate from the nucellar base, is termed the chalaza.

**Final Answer:** The small opening where the integuments do not enclose the nucellus is the Micropyle.

**Answer: (D)**

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## Q37.

### Solution

**Concept:**

The kingdom Fungi is divided into distinct taxonomic classes based on the structural morphology of their vegetative mycelium, their mechanisms of asexual spore formation, and the nature of their sexual fruiting bodies.

**Solution:**

(a) The class Ascomycetes, commonly referred to as sac fungi, is characterized by the production of sexual spores called ascospores inside specialized microscopic sacs termed asci.

(b) Neurospora crassa is a classic filamentous ascomycete fungus that serves as an invaluable model organism in modern biochemical, cellular, and eukaryotic genetic research.

(c) Its rapid life cycle, haploid genome configuration, and easily screenable mutational phenotypes made it the ideal biological system for confirming the one-gene, one-enzyme hypothesis.

(d) Other fungal representatives listed belong to completely different classes; for example, Rhizopus stolonifer is a common zygomycete mold that causes soft rot on bread.

(e) Agaricus bisporus belongs to the class Basidiomycetes and is widely cultivated as an edible mushroom, while Albugo candida is an obligate oomycete plant pathogen.

**Final Answer:** The fungus belonging to Ascomycetes used in genetic research is Neurospora crassa.

**Answer: (B)**

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## Q38.

### Solution

**Concept:**

Plant vascular physiology coordinates water transport through the xylem network using a combination of root pressure forces, capillary action, and transpirational pull dynamics.

**Solution:**

(a) Under conditions of high soil moisture availability and low atmospheric evaporation, such as humid nights, plant roots continue to actively absorb inorganic ions from the soil matrix.

(b) This continuous accumulation of ions lowers the internal water potential of the root xylem, driving water into the vascular cylinder and generating a positive hydrostatic pressure.

(c) This positive force, termed root pressure, pushes water up the xylem conduits toward the aerial leaves faster than the rate of slow nocturnal transpiration.

(d) The excess water is forced out of the vascular system through specialized structural pores called hydathodes, which are located along the margins and tips of the leaves.

(e) This exudation of liquid water droplets from hydathodes is known as guttation, which is distinct from transpiration because water is lost as a liquid rather than a vapor.

**Final Answer:** The process where water loss occurs as liquid droplets through hydathodes is Guttation.

**Answer: (B)**

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## Q39.

### Solution

**Concept:**

The structural efficiency of the human respiratory system relies on an incredibly thin respiratory membrane that optimizes the passive diffusion of respiratory gases between air and blood.

**Solution:**

(a) Gas exchange in the human lungs takes place across the respiratory membrane, which separates the air inside the alveolar spaces from the blood circulating through the pulmonary capillaries.

(b) For an oxygen molecule to diffuse from the alveolar space into the blood, it must sequentially cross three distinct, highly integrated structural tissue layers.

(c) The initial layer encountered by the gas molecule is the simple squamous epithelium that forms the actual cellular boundary of the alveolar wall.

(d) Next, the molecule must pass through the thin, fibrous extracellular layer formed by the fusion of the alveolar epithelial and capillary endothelial basement membranes.

(e) Finally, the oxygen molecule crosses the thin simple squamous endothelial cell layer that forms the actual physical wall of the surrounding pulmonary capillary.

**Final Answer:** The correct sequence of layers is Alveolar epithelium → Endothelial basement membrane → Capillary endothelium.

**Answer: (A)**

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## Q40.

### Solution

**Concept:**

The eukaryotic cell cycle is a highly structured, sequential process divided into interphase periods of growth and DNA replication, followed by active mitotic division phases.

**Solution:**

(a) Cells that stop dividing can exit the active proliferative cycle during the early G1 phase and enter a specialized non-dividing state designated as the G0 phase.

(b) This G0 phase is commonly referred to as the quiescent stage, representing a state where the cell has suspended its cell cycle machinery.

(c) Crucially, cells in the G0 phase remain highly metabolically active, continuously performing their specific physiological tasks and undergoing differentiation within their respective tissues.

(d) Certain highly specialized human somatic cells, such as mature neurons and skeletal muscle fibers, enter a permanent G0 state and lose their capacity to divide.

(e) Other cell types, including hepatocytes and fibroblasts, can remain quiescent in G0 for long periods but retain the ability to re-enter G1 if triggered by specific growth factors.

**Final Answer:** Cells during the G0 phase exit the cell cycle and enter a state of active differentiation or quiescence.

**Answer: (B)**

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# Answer Key

| Q | Ans | Q | Ans | Q | Ans | Q | Ans | Q | Ans |
|---|---|---|---|---|---|---|---|---|---|
| 1 | C | 2 | B | 3 | B | 4 | B | 5 | A |
| 6 | C | 7 | B | 8 | B | 9 | C | 10 | B |
| 11 | D | 12 | B | 13 | B | 14 | C | 15 | D |
| 16 | C | 17 | A | 18 | B | 19 | B | 20 | B |
| 21 | C | 22 | C | 23 | A | 24 | C | 25 | C |
| 26 | C | 27 | B | 28 | B | 29 | C | 30 | C |
| 31 | D | 32 | B | 33 | C | 34 | C | 35 | A |
| 36 | D | 37 | B | 38 | B | 39 | A | 40 | B |