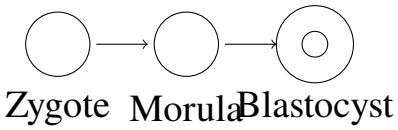
BITSAT Biology Sample Paper-12

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 mark**. Unattempted question carries **0 marks**.
- Only **one** option is correct for each question.
- Use of mobile phones, smartwatches, or any electronic gadgets is strictly prohibited.

Q1. The diagram below represents stages in human embryonic development.



Implantation in the uterine wall normally occurs during the stage labelled:

(A) Zygote

(B) Morula

(C) Blastocyst

(D) Gastrula

Q2. Which extraembryonic membrane in mammals is most directly involved in exchange of nutrients and gases between maternal and fetal blood?

(A) Amnion

(B) Chorion

(C) Yolk sac

(D) Allantois only

Q3. A vasectomized male can still produce semen because the surgical procedure primarily blocks:

(A) Testosterone synthesis in testes

(B) Secretions of seminal vesicles

(C) Transport of sperms through vas deferens

(D) Formation of seminal plasma

Q4. In flowering plants, double fertilization results in formation of:

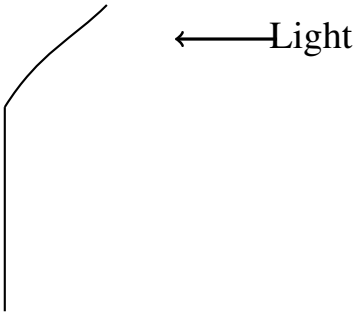
(A) One zygote and one embryo

(B) Two embryos within the ovule

(C) Zygote and triploid primary endosperm nucleus

(D) Endosperm without embryo

Q5. The figure below shows curvature in a plant shoot exposed to unilateral light.



The curvature occurs mainly because auxin concentration becomes:

(A) Equal on both illuminated and shaded sides

(B) Higher on illuminated side causing rapid elongation

(C) Higher on shaded side causing greater cell elongation

(D) Completely absent from the shoot tip

Q6. Which tissue is primarily responsible for secondary growth in dicot stems?

(A) Apical meristem

(B) Cork cambium and vascular cambium

(C) Epidermis only

(D) Pericycle exclusively

Q7. A pollen grain that possesses two male gametes and one vegetative nucleus is generally in which stage?

(A) Microspore mother cell stage

(B) Two-celled stage only

(C) Three-celled mature pollen stage

(D) Tetrad stage

Q8. Which of the following combinations correctly matches the organism with its unique characteristic?

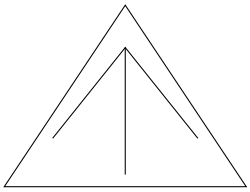
(A) Euglena — Chitinous cell wall

(B) Cyanobacteria — Membrane-bound nucleus

(C) Mycoplasma — Absence of cell wall

(D) Rhizopus — Prokaryotic organization

Q9. The diagram below shows a generalized virus structure.



Capsid

Viruses are regarded as connecting links between living and non-living because they:

(A) Possess both DNA and RNA simultaneously

(B) Can reproduce independently outside host cells

(C) Crystallize outside hosts but reproduce inside living cells

(D) Perform photosynthesis under favourable conditions

Q10. Members of class Mammalia are distinguished from all other vertebrates primarily by the presence of:

(A) Four-chambered heart only

(B) Mammary glands and hair

(C) External fertilization

(D) Notochord throughout life

Q11. A person vaccinated against tetanus receives a booster dose after several years. The rapid and intense immune response produced after booster administration is mainly due to:

(A) Increased antigen mutation rate

(B) Memory B and T lymphocytes formed earlier

(C) Immediate destruction of macrophages

(D) Suppression of plasma cells

Q12. Which of the following diseases is correctly matched with its causative organism?

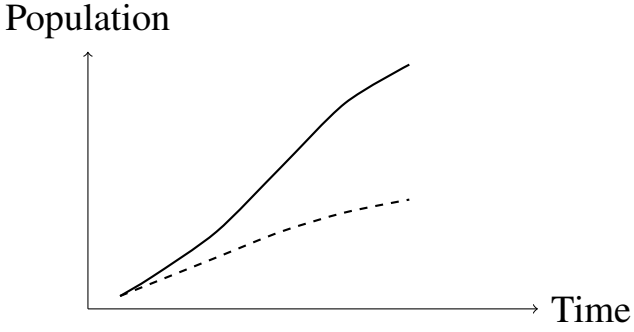
(A) Typhoid — Plasmodium vivax

(B) Ringworm — Salmonella typhi

(C) Malaria — Plasmodium species

(D) Tuberculosis — Vibrio cholerae

Q13. The following graph represents growth of microorganisms in a bioreactor under different conditions.



The reduced growth in the dashed curve is most likely due to:

(A) Optimum nutrient supply

(B) Presence of inhibitory antibiotics

(C) Adequate aeration conditions

(D) Increased substrate concentration

Q14. If all decomposers were suddenly removed from an ecosystem, which consequence would appear first?

(A) Immediate increase in primary productivity

(B) Accumulation of dead organic matter and nutrient cycling failure

(C) Sudden conversion of herbivores into carnivores

(D) Increase in atmospheric oxygen levels

Q15. In an ecological pyramid, biomass pyramids are generally inverted in aquatic ecosystems because:

(A) Producers have extremely long life spans

(B) Consumers reproduce more slowly than producers

(C) Phytoplankton possess low standing crop but high turnover rate

(D) Carnivores directly synthesize organic matter

Q16. In recombinant DNA technology, restriction endonucleases are primarily used because they:

(A) Join DNA fragments permanently

(B) Replicate plasmid DNA rapidly

(C) Cut DNA at specific recognition sequences

(D) Translate mRNA into proteins

Q17. A researcher treated actively dividing onion root tip cells with colchicine and observed that the chromosomes failed to separate toward opposite poles during cell division. Which cellular structure was most directly disrupted by the chemical treatment?

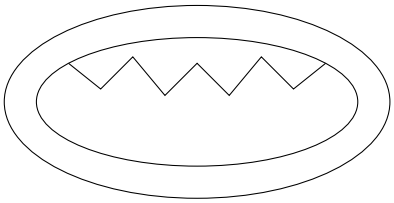
(A) Ribosomes

(B) Spindle fibres

(C) Lysosomes

(D) Golgi vesicles

Q18. The following diagram represents a generalized mitochondrion.



Cristae

The structures labelled as cristae primarily function to:

(A) Store genetic information

(B) Increase surface area for ATP synthesis

(C) Carry out protein digestion

(D) Synthesize ribosomal RNA

Q19. In a photosynthesizing plant cell, oxygen evolved during photosynthesis originates directly from:

(A) Carbon dioxide

(B) Glucose molecules

(C) Water molecules

(D) Chlorophyll pigments

Q20. A patient suffering from myasthenia gravis exhibits muscle weakness due to autoimmune destruction of receptors present at the neuromuscular junction. Which neurotransmitter normally binds to these receptors?

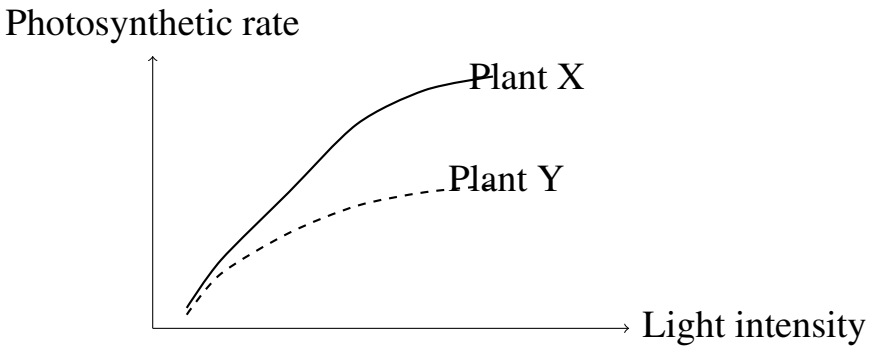
(A) Dopamine

(B) Serotonin

(C) Acetylcholine

(D) Adrenaline

Q21. The graph below represents the effect of light intensity on the rate of photosynthesis in two different plant species.



Plant X is most likely adapted to:

(A) Deep shade conditions

(B) High light intensity habitats

(C) Aquatic environments only

(D) Complete absence of chlorophyll

Q22. During glycolysis, substrate-level phosphorylation directly results in the formation of:

(A) NADPH only

(B) ATP molecules

(C) Oxygen molecules

(D) $FADH_2$ exclusively

Q23. A homozygous tall pea plant with yellow seeds was crossed with a dwarf green-seeded plant. Assuming independent assortment, what fraction of the F_2 progeny would be expected to show both recessive traits?

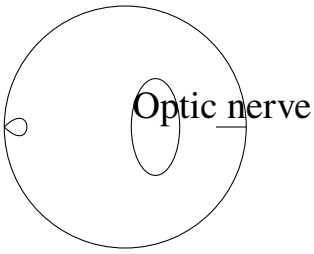
(A) 1/16

(B) 3/16

(C) 9/16

(D) 1/4

Q24. The following diagram represents a section through the human eye.



The blind spot in the human eye occurs at the point where:

(A) Rod cells are concentrated

(B) Cone cells are absent

(C) Optic nerve exits the retina

(D) Lens becomes opaque

Q25. In angiosperms, the aleurone layer of the seed is particularly rich in proteins and is prominently found in:

(A) Monocot seeds

(B) Dicot embryos

(C) Bryophyte spores

(D) Gymnosperm cones

Q26. A scientist observed that a bacterial population became resistant to an antibiotic after repeated exposure over several generations. This observation most directly supports the concept of:

(A) Artificial selection

(B) Adaptive radiation

(C) Natural selection

(D) Genetic drift only

Q27. The movement of mineral ions from root epidermal cells into the xylem against a concentration gradient requires:

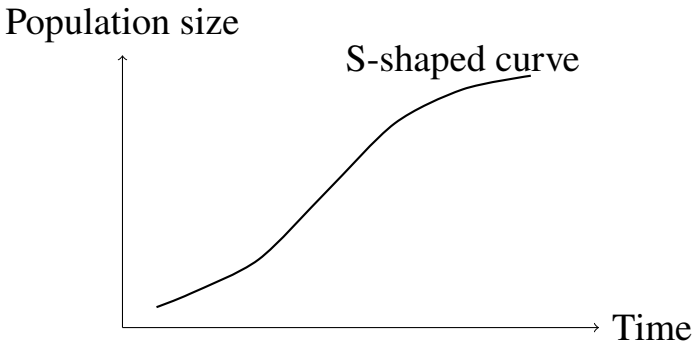
(A) Diffusion only

(B) Active transport using ATP

(C) Osmosis through plasmodesmata

(D) Passive transport through stomata

Q28. The following graph represents the growth of a population under limited resources.



The type of population growth represented is:

(A) Exponential growth

(B) Logistic growth

(C) Negative growth

(D) Random oscillation

Q29. Which of the following enzymes is responsible for unwinding the DNA double helix during replication?

(A) Ligase

(B) Primase

(C) Helicase

(D) Polymerase I

Q30. In humans, failure of the pancreas to secrete sufficient insulin results primarily in:

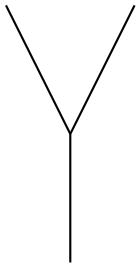
(A) Diabetes mellitus

(B) Diabetes insipidus

(C) Addison's disease

(D) Acromegaly

Q31. The diagram below represents the structure of an antibody molecule.



Fc region

The antigen-binding sites of the antibody are located:

(A) At the tips of the Y-shaped arms

(B) Only in the Fc region

(C) Within the plasma membrane

(D) Inside lysosomes

Q32. Which of the following plant hormones is most directly associated with cell elongation and apical dominance?

(A) Ethylene

(B) Auxin

(C) Cytokinin

(D) Abscisic acid

Q33. A child inherits blood group O despite one parent having blood group A and the other having blood group B. The most probable genotypes of the parents are:

(A) IAIA and IBIB

(B) IAi and IBi

(C) IAIB and ii

(D) ii and ii

Q34. The ozone layer in the stratosphere protects life on Earth mainly by absorbing:

(A) Infrared radiation

(B) Visible radiation

(C) Ultraviolet radiation

(D) Radio waves

Q35. The process by which RNA is synthesized using DNA as a template is known as:

(A) Translation

(B) Replication

(C) Transcription

(D) Transformation

Q36. The following diagram represents a food chain.

Grass $\rightarrow$ Rabbit $\rightarrow$ Snake $\rightarrow$ Hawk

Which trophic level is occupied by the snake in the above food chain?

(A) Primary producer

(B) Primary consumer

(C) Secondary consumer

(D) Tertiary producer

Q37. In biotechnology, plasmids are widely used because they can function as:

(A) Restriction enzymes

(B) Vectors carrying foreign DNA

(C) Ribosomal subunits

(D) Hormonal regulators

Q38. A plant kept in complete darkness for several days showed yellowing of leaves because chlorophyll synthesis requires:

(A) Oxygen only

(B) Light indirectly or directly

(C) Carbon dioxide exclusively

(D) Nitrogen fixation only

Q39. The contraction of skeletal muscles occurs due to sliding of:

(A) DNA strands

(B) Actin and myosin filaments

(C) Microtubules and centrioles

(D) Cellulose fibres

Q40. Which of the following adaptations is most characteristic of xerophytic plants?

(A) Large thin leaves

(B) Extensive aerenchyma tissues

(C) Thick cuticle and sunken stomata

(D) Absence of vascular tissues

Detailed Solutions

Q1.

Solution

Concept: Implantation is the process by which a developing embryo attaches to and embeds itself into the endometrium of the maternal uterus. In humans, this occurs at a specific multicellular stage of early development.

Solution: Step 1: Understand the stages of early human embryonic development:

- **Zygote:** The single diploid cell formed immediately after fertilization. It does not implant.
- **Morula:** A solid, spherical mass of 16–32 cells formed by cleavage divisions. It is still traveling down the fallopian tube.
- **Blastocyst:** A hollow sphere of cells comprising an outer layer (trophoblast) and an inner cell mass.
- **Gastrula:** A later stage where the three primary germ layers (ectoderm, mesoderm, endoderm) are established.

Step 2: Identify the stage at which implantation occurs. The outer trophoblast layer of the **blastocyst** is specialized to attach to and invade the uterine endometrium, typically occurring 6–9 days after fertilization.

Step 3: Therefore, the correct stage is the blastocyst.

Final Answer: Blastocyst

Answer: (C)

Go Back to Question 1

Q2.

Solution

Concept: Extraembryonic membranes surround, protect, and nourish the developing mammalian embryo. The interface between maternal and fetal tissues requires a specialized membrane to form the fetal portion of the placenta.

Solution: Step 1: Evaluate the functions of the four main extraembryonic membranes in mammals:

- **Amnion:** Forms a fluid-filled cavity around the embryo to protect it from mechanical shock and desiccation.
- **Chorion:** The outermost membrane that develops finger-like projections (chorionic villi). These villi interdigitate with the maternal endometrium to form the placenta, serving as the primary barrier for the exchange of nutrients, oxygen, carbon dioxide, and metabolic wastes.
- **Yolk sac:** A vestigial structure in placental mammals involved in early blood cell formation.
- **Allantois:** Contributes to blood vessels of the umbilical cord and assists in early waste storage.

Step 2: Identify the membrane most directly involved in exchange. The **chorion** plays the primary role in establishing the circulatory interface with maternal tissues.

Final Answer: Chorion

Answer: (B)

Go Back to Question 2

Q3.

Solution

Concept: A vasectomy is a minor surgical procedure for male sterilization. Understanding the distinction between sperm transport and the production of seminal fluids explains why semen production remains intact.

Solution: Step 1: Define the composition of semen:

$$\text{Semen} = \text{Spermatozoa} + \text{Seminal Plasma}$$

Seminal plasma constitutes about 90–95% of semen volume and is contributed by accessory glands, including the seminal vesicles, prostate, and bulbourethral glands.

Step 2: Determine the site of surgical intervention in a vasectomy: A vasectomy involves cutting and sealing the bilateral **vasa deferentia**. This prevents mature spermatozoa stored in the epididymis from traveling to the ejaculatory ducts.

Step 3: Analyze the options:

- Testosterone synthesis (Option A) is unaffected because hormones are secreted directly into the bloodstream from Leydig cells.
- Accessory gland secretions (Option B) and seminal plasma formation (Option D) continue normally because their anatomical pathways are unaffected.
- The procedure primarily blocks the **transport of sperms through the vas deferens** (Option C), leading to semen that is fluid-rich but completely devoid of sperm (azoospermia).

Final Answer: Transport of sperms through vas deferens

Answer: (C)

Go Back to Question 3

Q4.

Solution

Concept: Double fertilization is a characteristic feature of angiosperms (flowering plants) involving two distinct fusion events inside the embryo sac.

Solution: Step 1: Analyze the process of double fertilization:

- **Syngamy:** One haploid male gamete (n) fuses with the haploid egg cell (n) to produce a diploid zygote ($2n$), which eventually develops into the embryo.

$$\text{Male Gamete } (n) + \text{Egg } (n) \longrightarrow \text{Zygote } (2n)$$

- **Triple Fusion:** The second haploid male gamete (n) fuses with the two polar nuclei ($2n$) of the central cell to produce a triploid primary endosperm nucleus ($3n$), which later forms the nutritive endosperm.

$$\text{Male Gamete } (n) + \text{Two Polar Nuclei } (2n) \longrightarrow \text{Primary Endosperm Nucleus } (3n)$$

Step 2: Identify the products of these two simultaneous fusion events: The products are a diploid zygote and a triploid primary endosperm nucleus.

Final Answer: Zygote and triploid primary endosperm nucleus

Answer: (C)

Go Back to Question 4

Q5.

Solution

Concept: Phototropism is the growth response of plant organs toward or away from a directional light stimulus. This movement is mediated by the asymmetrical distribution of the phytohormone auxin.

Solution: Step 1: Understand how auxin responds to unilateral light: When a shoot tip is exposed to light from one direction (unilateral light), auxin (indole-3-acetic acid) is transported laterally from the illuminated side to the shaded side.

Step 2: Relate auxin concentration to stem growth: In stems, higher concentrations of auxin stimulate greater cell elongation.

Step 3: Analyze the outcome: The cell elongation on the shaded side is greater than on the illuminated side. This asymmetrical growth rate causes the shoot to curve and bend toward the light source.

Step 4: Evaluate the options: Option C correctly describes that auxin concentration becomes higher on the shaded side, causing greater cell elongation.

Final Answer: Higher on shaded side causing greater cell elongation

Answer: (C)

Go Back to Question 5

Q6.

Solution

Concept: Primary growth increases the length of the plant body, whereas secondary growth increases the thickness or girth of stems and roots. Secondary growth is mediated by lateral meristems.

Solution: Step 1: Identify the roles of the tissue layers mentioned:

- **Apical meristems:** Responsible for primary growth (elongation at tips).
- **Lateral meristems:** Responsible for secondary growth. In dicot stems, these include:
  (a) **Vascular cambium:** Produces secondary xylem (wood) inward and secondary phloem outward.
  (b) **Cork cambium (phellogen):** Produces cork (phellem) outward and phelloderm inward, forming the protective periderm.
- **Epidermis:** The primary outer dermal tissue, which is eventually replaced during secondary growth.
- **Pericycle:** Plays a role in lateral root initiation and secondary growth in roots, but not primarily in stems.

Step 2: Thus, the cork cambium and vascular cambium are the primary tissues responsible for secondary growth in dicot stems.

Final Answer: Cork cambium and vascular cambium

Answer: (B)

Go Back to Question 6

Q7.

Solution

Concept: Pollen development (microgametogenesis) yields different cellular configurations prior to pollination. Pollen grains can be shed from the anthers at either a two-celled or a three-celled stage depending on the plant species.

Solution: Step 1: Detail the cells present in the given pollen grain: The pollen grain contains:

- Two male gametes (sperm cells)
- One vegetative nucleus (inside the vegetative cell)

This represents a total of three nuclei distributed across three distinct cellular units.

Step 2: Identify the developmental stage:

- **Two-celled stage:** Consists of one large vegetative cell and one smaller generative cell.
- **Three-celled stage:** The generative cell has already undergone mitotic division to yield two distinct male gametes alongside the vegetative cell.

Step 3: A pollen grain with two male gametes and one vegetative nucleus is in the **three-celled mature pollen stage**.

Final Answer: Three-celled mature pollen stage

Answer: (C)

Go Back to Question 7

Q8.

Solution

Concept: Biological classification is based on unique cellular characteristics, cell wall compositions, and evolutionary histories of different domains and kingdoms.

Solution: Step 1: Analyze each pair:

- **Euglena — Chitinous cell wall:** Incorrect. *Euglena* is a protist that does not possess a cell wall; instead, it has a proteinaceous, flexible outer layer called a pellicle. Chitinous cell walls are unique to Fungi.
- **Cyanobacteria — Membrane-bound nucleus:** Incorrect. Cyanobacteria are prokaryotes, which lack a membrane-bound nucleus and other membrane-bound organelles.
- **Mycoplasma — Absence of cell wall:** Correct. *Mycoplasma* species are unique bacteria that completely lack a cell wall, rendering them pleomorphic and naturally resistant to antibiotics that target cell wall synthesis (such as penicillin).
- **Rhizopus — Prokaryotic organization:** Incorrect. *Rhizopus* is a fungus and has a eukaryotic cellular organization.

Step 2: The only correctly matched pair is Option C.

Final Answer: Mycoplasma — Absence of cell wall

Answer: (C)

Go Back to Question 8

Q9.

Solution

Concept: Viruses display characteristics of both non-living matter and living organisms, placing them at the boundary of life.

Solution: Step 1: Identify the non-living characteristics of viruses: Outside of a living host cell, viruses are completely inert. They lack cellular structures, do not carry out metabolic activities, and can be isolated and crystallized indefinitely like organic chemicals.

Step 2: Identify the living characteristics of viruses: Once inside a compatible living host cell, they utilize the host's cellular machinery to replicate their genetic material, synthesize viral proteins, and reproduce.

Step 3: Evaluate the options:

- Option A is incorrect as most viruses contain only one type of nucleic acid (either DNA or RNA, rarely both simultaneously).
- Option B is incorrect as viruses are obligate intracellular parasites and cannot reproduce independently outside of host cells.
- Option C perfectly captures both sides of the boundary: they crystallize outside host systems (non-living property) but replicate and reproduce inside living cells (living property).

Final Answer: Crystallize outside hosts but reproduce inside living cells

Answer: (C)

Go Back to Question 9

Q10.

Solution

Concept: Class Mammalia is defined by distinct evolutionary features that distinguish mammals from other vertebrate classes (Osteichthyes, Chondrichthyes, Amphibia, Reptilia, and Aves).

Solution: Step 1: Review characteristics shared by mammals and other vertebrates:

- **Four-chambered heart:** Shared with birds (Aves) and crocodilians (Reptilia).
- **Notochord:** Present during embryonic development in all chordates/vertebrates, but generally replaced by a vertebral column in adults.

Step 2: Identify characteristics unique exclusively to mammals:

- **Mammary Glands:** Milk-producing glands used by females to nourish their young.
- **Hair:** Epidermal hair covers the body surface at some stage in their life cycle.

Step 3: Since these two features are exclusive and diagnostic for all members of class Mammalia, Option B is the correct choice.

Final Answer: Mammary glands and hair

Answer: (B)

Go Back to Question 10

Q11.

Solution

Concept: The immune system exhibits a primary response during the first exposure to an antigen, and a secondary (anamnestic) response during subsequent exposures.

Solution: Step 1: Understand the role of initial vaccination: An initial vaccination introduces a harmless antigen, leading to the clonal selection and expansion of antigen-specific lymphocytes. This results in the formation of long-lived **memory B and T cells**.

Step 2: Understand the effect of a booster shot: When a booster dose is administered years later, these pre-existing memory cells immediately recognize the antigen.

- Memory B cells rapidly differentiate into antibody-secreting plasma cells, producing a very high titer of specific antibodies.
- Memory T cells rapidly proliferate to mediate cellular immune responses.

Step 3: This secondary response is significantly faster, more intense, and longer-lasting because of the immunological memory established during earlier vaccination.

Final Answer: Memory B and T lymphocytes formed earlier

Answer: (B)

Go Back to Question 11

Q12.

Solution

Concept: Many human diseases are caused by specific pathogens (bacteria, fungi, viruses, or protozoa). Accurate identification of these pathogens is central to medical biology.

Solution: Step 1: Evaluate each disease-pathogen pair:

- **Typhoid:** Caused by the bacterium *Salmonella typhi* (not *Plasmodium vivax*).
- **Ringworm:** Caused by fungal genera such as *Trichophyton*, *Microsporum*, or *Epidermophyton* (not *Salmonella typhi*).
- **Malaria:** Caused by protozoan parasites belonging to the genus *Plasmodium* (e.g., *Plasmodium vivax*, *Plasmodium falciparum*). This pairing is correct.
- **Tuberculosis:** Caused by the bacterium *Mycobacterium tuberculosis* (not *Vibrio cholerae*, which causes cholera).

Step 2: The only correctly matched pair is Malaria and *Plasmodium* species.

Final Answer: Malaria — Plasmodium species

Answer: (C)

Go Back to Question 12

Q13.

Solution

Concept: The growth of microorganisms in a closed system (such as a bioreactor) depends heavily on environmental conditions. Factors that support cellular processes accelerate growth, whereas inhibitory factors suppress development.

Solution: Step 1: Analyze the graph:

- The solid line shows rapid growth reaching a higher population density over time, indicative of favorable, uninhibited conditions.
- The dashed line shows a significantly lower growth rate and a reduced maximum population level.

Step 2: Evaluate the proposed conditions:

- **Optimum nutrient supply** (Option A), **adequate aeration** (Option C), and **increased substrate concentration** (Option D) are growth-promoting factors that would shift the curve upward or maintain optimal growth (similar to the solid line).
- **Presence of inhibitory antibiotics** (Option B) hinders cell division and growth, resulting in the suppressed, lower trajectory shown by the dashed curve.

Step 3: Thus, the reduced growth in the dashed curve is due to the presence of an inhibitory substance.

Final Answer: Presence of inhibitory antibiotics

Answer: (B)

Go Back to Question 13

Q14.

Solution

Concept: Decomposers (primarily saprophytic fungi and bacteria) play a vital role in ecosystems by breaking down complex organic molecules in dead organisms and wastes into simple inorganic nutrients.

Solution: Step 1: Understand the primary role of decomposers: Decomposers recycle essential chemical elements (such as nitrogen, phosphorus, and carbon) back into the soil, water, and atmosphere so that producers (plants) can uptake them.

Step 2: Analyze the consequences of their sudden removal:

- Dead organisms, leaves, and waste products would not decay. This leads to the immediate accumulation of dead organic matter on the ground.
- Because the nutrients locked in these dead organisms cannot be released, the biogeochemical cycles (nutrient cycling) will fail.
- Producers would eventually run out of essential inorganic nutrients, leading to a decline (not increase) in primary productivity.

Step 3: Evaluate the options: Option B is the most direct and immediate consequence of removing decomposers.

Final Answer: Accumulation of dead organic matter and nutrient cycling failure

Answer: (B)

Go Back to Question 14

Q15.

Solution

Concept: An ecological pyramid of biomass represents the total dry weight of organisms at each trophic level. In most terrestrial ecosystems, this pyramid is upright. However, in certain aquatic ecosystems, it is inverted.

Solution: Step 1: Define the primary producers and consumers in aquatic ecosystems:

- **Producers:** Mostly microscopic phytoplankton.
- **Primary Consumers:** Zooplankton and small herbivorous fish.

Step 2: Analyze the biomass and turnover rates:

- Phytoplankton have a very small physical size and short lifespan. At any single moment, their standing crop (biomass) is low.
- However, they have an exceptionally high division and reproduction rate (turnover rate).
- This rapid replacement rate allows a small biomass of phytoplankton to produce enough energy to support a significantly larger standing biomass of longer-lived zooplankton and fish.

Step 3: Therefore, the pyramid of biomass is inverted because the producers have a low standing crop combined with a high turnover rate.

Final Answer: Phytoplankton possess low standing crop but high turnover rate

Answer: (C)

Go Back to Question 15

Q16.

Solution

Concept: Restriction endonucleases, often referred to as "molecular scissors," are specialized bacterial enzymes used in biotechnology and molecular biology to manipulate DNA.

Solution: Step 1: Understand the mechanism of restriction endonucleases: These enzymes recognize specific, usually palindromic, nucleotide sequences in double-stranded DNA (known as recognition sites) and cleave the phosphodiester backbone at or near these sites.

Step 2: Analyze the function of each option in recombinant DNA technology:

- Joining DNA fragments permanently is carried out by **DNA ligases** (Option A).
- Rapid replication of plasmids is mediated by **DNA polymerases** within host cells or via PCR (Option B).
- Cutting DNA at precise, predictable recognition sequences is the primary role of **restriction endonucleases** (Option C).
- Translation of mRNA into proteins is performed by **ribosomes** (Option D).

Step 3: Therefore, Option C is the correct usage.

Final Answer: Cut DNA at specific recognition sequences

Answer: (C)

Go Back to Question 16

Q17.

Solution

Concept: Colchicine is an alkaloid chemical used in cell biology to study mitosis. It acts as a spindle poison by binding to tubulin, preventing its polymerization into microtubules.

Solution: Step 1: Identify the cell division phase affected: During normal cell division (mitosis), chromosomes line up along the metaphase plate and are subsequently pulled toward opposite poles during anaphase by contracting spindle fibers.

Step 2: Determine the cellular target of colchicine: Spindle fibers are composed of microtubule polymers. Colchicine binds to free tubulin dimers and inhibits microtubule assembly.

Step 3: Analyze the cellular consequence: Without functional **spindle fibers**, the sister chromatids cannot be separated and moved toward opposite poles. This leads to a failure in chromosome segregation, often resulting in polyploidy.

Step 4: Therefore, spindle fibers are the structure directly disrupted.

Final Answer: Spindle fibres

Answer: (B)

Go Back to Question 17

Q18.

Solution

Concept: Mitochondria are the "powerhouses of the cell." Their structure is closely related to their function in aerobic respiration, particularly the electron transport chain (ETC) and ATP synthesis.

Solution: Step 1: Identify the location of the respiratory machinery: The inner mitochondrial membrane contains the electron transport chain complexes, coenzymes, and ATP synthase complexes.

Step 2: Explain the significance of cristae: The cristae are extensive folds of the inner mitochondrial membrane.

Step 3: Relate structure to function: By folding inward, the cristae dramatically **increase the surface area** available for these membrane-bound respiratory proteins. This maximization of surface area directly enhances the cell's capacity to synthesize ATP via oxidative phosphorylation.

Step 4: Evaluate the options:

- Option A (storing genetic info) is primarily handled by the mitochondrial matrix (which contains mtDNA) and the nucleus.
- Option B (increasing surface area for ATP synthesis) is the primary structural role of cristae.

Final Answer: Increase surface area for ATP synthesis

Answer: (B)

Go Back to Question 18

Q19.

Solution

Concept: Photosynthesis consists of two stages: the light-dependent reactions and the light-independent (dark) reactions. Oxygen gas (O_2) is released as a byproduct during the light-dependent reactions.

Solution: Step 1: Write the general chemical equation for photosynthesis:

$$6CO_2 + 12H_2O \xrightarrow{\text{light, chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O$$

Step 2: Determine the origin of the evolved O_2: Historically, it was debated whether the evolved oxygen originated from CO_2 or H_2O. Using isotopic labeling experiments (with the heavy isotope ^{18}O), scientists demonstrated that:

$$H_2^{18}O \longrightarrow \text{photolysis} \longrightarrow^{18} O_2$$

Step 3: Explain the biochemical step: In Photosystem II (PSII), the water-splitting complex (oxygen-evolving complex) catalyzes the photolysis of water in the thylakoid lumen:

$$2H_2O \longrightarrow 4H^+ + 4e^- + O_2 \uparrow$$

This directly demonstrates that the evolved oxygen comes from **water molecules**.

Final Answer: Water molecules

Answer: (C)

Go Back to Question 19

Q20.

Solution

Concept: Myasthenia gravis is a chronic autoimmune neuromuscular disorder. It targets the communication link between motor nerves and skeletal muscles.

Solution: Step 1: Understand normal neuromuscular transmission: When an action potential reaches the presynaptic motor neuron terminal, it stimulates the release of neurotransmitter vesicles into the synaptic cleft.

Step 2: Identify the specific neurotransmitter: At all vertebrate skeletal neuromuscular junctions, the primary excitatory neurotransmitter is **acetylcholine** (ACh).

Step 3: Analyze the disease mechanism of Myasthenia Gravis: In this autoimmune condition, the body's immune system mistakenly produces autoantibodies that bind to and destroy nicotinic acetylcholine receptors (AChRs) on the postsynaptic muscle membrane. This prevents acetylcholine from binding, resulting in failure of muscle contraction and progressive muscle weakness.

Step 4: Therefore, the neurotransmitter that normally binds to these receptors is acetylcholine.

Final Answer: Acetylcholine

Answer: (C)

Go Back to Question 20

Q21.

Solution

Concept: The rate of photosynthesis in plants is influenced by abiotic factors, including light intensity. Different plant species have evolved distinct adaptations to optimize photosynthesis based on their native habitats (sun-loving vs. shade-loving).

Solution: Step 1: Analyze the graph:

- **Plant X (solid line):** Its photosynthetic rate increases steadily and saturates at a relatively high light intensity. It also achieves a higher maximum rate of photosynthesis.
- **Plant Y (dashed line):** Its photosynthetic rate rises quickly at low light intensities but plateaus (saturates) at a much lower light intensity, exhibiting a lower maximum photosynthetic capacity.

Step 2: Match curves to ecological adaptations:

- Plants adapted to deep shade (sciophytes, like Plant Y) saturate at low light intensities because they have lower light compensation points.
- Plants adapted to high light intensity habitats (heliophytes, like Plant X) require and can utilize much stronger light before reaching their light saturation point.

Step 3: Therefore, Plant X is most likely adapted to high light intensity habitats.

Final Answer: High light intensity habitats

Answer: (B)

Go Back to Question 21

Q22.

Solution

Concept: Substrate-level phosphorylation is a metabolic mechanism of ATP generation. It occurs when a phosphate group is transferred directly from a high-energy phosphorylated substrate to ADP.

Solution: Step 1: Distinguish between the types of phosphorylation in respiration:

- **Substrate-Level Phosphorylation:** Direct enzymatic synthesis of ATP (or GTP) without an electron transport chain.
- **Oxidative Phosphorylation:** ATP synthesis driven by the proton motive force across the inner mitochondrial membrane via the ETC.

Step 2: Examine substrate-level phosphorylation events in glycolysis: During glycolysis, there are two steps where this occurs:

(a) Conversion of 1, 3-bisphosphoglycerate to 3-phosphoglycerate, generating ATP.

(b) Conversion of phosphoenolpyruvate (PEP) to pyruvate, generating ATP.

Step 3: Consequently, substrate-level phosphorylation during glycolysis directly results in the formation of **ATP molecules**.

Final Answer: ATP molecules

Answer: (B)

Go Back to Question 22

Q23.

Solution

Concept: A dihybrid cross involves tracking two independent traits. According to Mendel's Law of Independent Assortment, the inheritance of one trait does not influence the inheritance of the other.

Solution: Step 1: Set up the genotypes of the parents:

- Tall is dominant (T) over dwarf (t).
- Yellow seed color is dominant (Y) over green (y).
- Homozygous Tall, Yellow parent: $TTYY$
- Dwarf, Green parent: $ttyy$

Step 2: Determine F_1 and F_2 progeny:

- The F_1 generation is entirely heterozygous: $TtYy$ (Tall, Yellow).
- Selfing the F_1 generation ($TtYy \times TtYy$) yields a phenotypic ratio of $9:3:3:1$ in the F_2 generation:
  - $9/16$ Tall, Yellow (both dominant traits: $T\_Y\_$)
  - $3/16$ Tall, Green (one dominant, one recessive: T_yy)
  - $3/16$ Dwarf, Yellow (one recessive, one dominant: $ttY\_$)
  - $1/16$ Dwarf, Green (both recessive traits: $ttyy$)

Step 3: Find the fraction of F_2 progeny showing both recessive traits: The double recessive phenotype (Dwarf and Green, genotype $ttyy$) represents a fraction of $1/16$ of the total progeny.

Final Answer: $\boxed{1/16}$

Answer: (A)

Go Back to Question 23

Q24.

Solution

Concept: The retina contains specialized photoreceptor cells (rods and cones) that detect light and transmit visual signals. The optic nerve carries these neural impulses from the retina to the brain.

Solution: Step 1: Understand the anatomy of the posterior eye: Axons of retinal ganglion cells converge at a specific localized region on the posterior wall of the eyeball to form the optic nerve.

Step 2: Identify the "blind spot": This specific exit region is called the **optic disc** (or blind spot). Because this space is physically occupied by the exiting bundle of nerve fibers and retinal blood vessels, there is no physical space for photoreceptor cells (rods and cones).

Step 3: Evaluate the options: The blind spot occurs exactly at the point where the **optic nerve exits the retina** (Option C). Since there are no photoreceptors in this region, light falling here is not detected, leading to a gap in the visual field.

Final Answer: Optic nerve exits the retina

Answer: (C)

Go Back to Question 24

Q25.

Solution

Concept: Seed anatomy varies among plant groups. The endosperm in many seeds contains outer specialized layers that play roles in storage and enzymatic mobilization of nutrients during germination.

Solution: Step 1: Define the aleurone layer: The aleurone layer is the outermost protein-rich cellular layer of the endosperm in seeds. During seed germination, cells in this layer secrete hydrolytic enzymes (such as α-amylase, stimulated by gibberellic acid) to break down stored starches in the endosperm into sugars for the embryo.

Step 2: Identify where it is prominently found: The aleurone layer is a characteristic anatomical feature of **monocot seeds**, particularly in cereals such as maize, barley, wheat, and rice.

Step 3: Evaluate the options: Option A is correct as the aleurone layer is prominently present in monocotyledonous seeds.

Final Answer: Monocot seeds

Answer: (A)

Go Back to Question 25

Q26.

Solution

Concept: Antibiotic resistance in bacterial populations is a classic real-world demonstration of evolutionary mechanisms.

Solution: Step 1: Analyze the process described:

- A bacterial population naturally possesses rare pre-existing genetic mutations that confer resistance to a specific antibiotic.
- When exposed to the antibiotic, non-resistant bacteria are killed, whereas those carrying the resistance gene survive.
- These surviving individuals reproduce, passing the resistance allele to their progeny.
- Over generations of continuous exposure, the resistant genotype becomes dominant in the population.

Step 2: Identify the evolutionary mechanism: The antibiotic acts as a selective pressure in the natural environment. This process, where favorable traits are selected for by environmental pressures and increase in frequency over generations, is called **natural selection**.

Final Answer: Natural selection

Answer: (C)

Go Back to Question 26

Q27.

Solution

Concept: The movement of substances across membranes can be passive or active. When molecules or ions are moved against their concentration gradient (from a region of lower concentration to a region of higher concentration), the cell must expend energy.

Solution: Step 1: Analyze the directional movement: The question specifies that mineral ions move "against a concentration gradient" (into the root cells and then into the vascular cylinder/xylem, where ion concentration is typically higher than in the surrounding soil water).

Step 2: Determine the transport mechanism:

- **Passive processes** (like simple diffusion and osmosis) only allow substances to move *down* their concentration gradient (from high to low concentration) without consuming energy.
- **Active transport** uses specialized carrier proteins (pumps) embedded in the plasma membrane of root epidermal and endodermal cells to actively move ions against their concentration gradient. This process is powered by the hydrolysis of **ATP**.

Step 3: Therefore, the process described is active transport using ATP.

Final Answer: Active transport using ATP

Answer: (B)

Go Back to Question 27

Q28.

Solution

Concept: In nature, populations exhibit different growth patterns depending on resource availability. Unlimited resources yield geometric growth, while limited resources result in restricted growth as the population size reaches the environment's carrying capacity (K).

Solution: Step 1: Identify the characteristics of the graph:

- The graph shows an S-shaped (sigmoid) curve.
- There is an initial slow lag phase, followed by a rapid exponential acceleration phase, which then decelerates and eventually plateaus as the population size reaches carrying capacity.

Step 2: Define the types of growth:

- **Exponential growth** is J-shaped and occurs under unlimited resources.
- **Logistic growth** is S-shaped (sigmoid) and occurs when growth rate decreases as the population reaches the carrying capacity due to limited resources.

Step 3: Therefore, the curve shown represents logistic growth.

Final Answer: Logistic growth

Answer: (B)

Go Back to Question 28

Q29.

Solution

Concept: DNA replication is a highly coordinated process requiring a set of specific enzymes to copy the genetic material accurately.

Solution: Step 1: Identify the roles of the enzymes listed:

- **Ligase:** Catalyzes the formation of phosphodiester bonds to seal nicks in the sugar-phosphate backbone (joining Okazaki fragments).
- **Primase:** Synthesizes short RNA primers that provide the 3′-OH group needed for DNA polymerase to begin synthesis.
- **Helicase:** Uses energy from ATP hydrolysis to break the hydrogen bonds between complementary nitrogenous bases, thereby unwinding the double-stranded DNA helix at the replication fork.
- **Polymerase I:** Removes RNA primers and replaces them with DNA nucleotides.

Step 2: Match the enzyme to the unwinding action: The enzyme responsible for unwinding the DNA double helix is helicase.

Final Answer: Helicase

Answer: (C)

Go Back to Question 29

Q30.

Solution

Concept: Insulin is a hormone produced by the β-cells of the islets of Langerhans in the pancreas. It lowers blood glucose levels by facilitating cellular uptake of glucose.

Solution: Step 1: Define the physiological effects of insulin deficiency: When the pancreas fails to secrete sufficient insulin, cells cannot efficiently absorb glucose from the blood. This results in hyperglycemia (persistently high blood glucose levels) and glucose excretion in urine.

Step 2: Differentiate between the diseases listed in the options:

- **Diabetes mellitus:** A metabolic disorder characterized by chronic hyperglycemia resulting from defects in insulin secretion, insulin action, or both.
- **Diabetes insipidus:** Caused by a deficiency of antidiuretic hormone (ADH) from the posterior pituitary, leading to excessive urination and thirst, unrelated to blood sugar.
- **Addison's disease:** An autoimmune disorder characterized by hyposecretion of adrenal cortex hormones (aldosterone and cortisol).
- **Acromegaly:** Caused by the hypersecretion of growth hormone (GH) in adults.

Step 3: Thus, a lack of sufficient insulin results primarily in diabetes mellitus.

Final Answer: Diabetes mellitus

Answer: (A)

Go Back to Question 30

Q31.

Solution

Concept: An antibody (immunoglobulin) is a Y-shaped protein produced by plasma cells that binds specifically to foreign targets (antigens). It is comprised of two heavy chains and two light chains.

Solution: Step 1: Examine the structure of an antibody molecule:

- **Fc region (Fragment crystallizable):** The stem of the Y-shaped molecule, composed of constant domains. It mediates effector functions (binding to immune cells or complement proteins).
- **Fab region (Fragment antigen-binding):** The two Y-shaped arms. The variable domains at the very ends of these arms form the paratope (antigen-binding site).

Step 2: Determine where antigens bind: The variable domains form unique three-dimensional clefts specifically designed to bind epitopes at the outer tips of the Y-shaped arms.

Final Answer: At the tips of the Y-shaped arms

Answer: (A)

Go Back to Question 31

Q32.

Solution

Concept: Plant hormones (phytohormones) regulate plant growth, development, and responses to stimuli. Each hormone plays specific developmental roles.

Solution: Step 1: Analyze the physiological functions of each listed phytohormone:

- **Ethylene:** Gaseous hormone primarily responsible for fruit ripening and senescence.
- **Auxin:** Promotes cell elongation (via the acid growth hypothesis) and is responsible for phototropism, gravitropism, and maintaining apical dominance (where the growing main shoot bud inhibits the development of lateral buds).
- **Cytokinin:** Promotes cell division (cytokinesis) and delays leaf senescence.
- **Abscisic acid (ABA):** Inhibits growth, induces seed dormancy, and coordinates stress responses (such as stomatal closure during drought).

Step 2: Since cell elongation and apical dominance are hallmarks of auxin action, Option B is correct.

Final Answer: Auxin

Answer: (B)

Go Back to Question 32

Q33.

Solution

Concept: ABO blood groups in humans are determined by the I gene, which has three alleles: I^A, I^B, and i. Alleles I^A and I^B are codominant, while allele i is recessive.

Solution: Step 1: Determine the genotype of the child: The child has blood group O, which corresponds to the homozygous recessive genotype:

$$\text{Genotype of child} = ii$$

Step 2: Identify parental inheritance rules: The child must inherit one recessive i allele from each parent. Thus, both parents must carry at least one i allele in their genotype.

Step 3: Analyze the phenotypes of the parents:

- **Parent 1 (Blood group A):** Must possess the I^A allele. Because they must also have an i allele, their genotype must be I^Ai.
- **Parent 2 (Blood group B):** Must possess the I^B allele. Because they must also have an i allele, their genotype must be I^Bi.

Step 4: Cross validation:

$$\text{Parents: } I^Ai \times I^Bi \longrightarrow F_1 \text{ genotypes: } I^AI^B \text{ (AB)}, I^Ai \text{ (A)}, I^Bi \text{ (B)}, ii \text{ (O)}$$

There is a 25% chance (1/4) of producing an O-group child.

Final Answer: IAi and IBi

Answer: (B)

Go Back to Question 33

Q34.

Solution

Concept: The ozone layer (O_3) is located in the lower stratosphere, approximately 15–35 km above the Earth's surface. It acts as a protective shield against incoming solar radiation.

Solution: Step 1: Understand the nature of the radiation emitted by the sun: Solar radiation contains a broad spectrum of electromagnetic wavelengths, including ultraviolet (UV), visible light, and infrared (heat) radiation.

Step 2: Determine the role of the ozone layer: Ozone molecules are highly efficient at absorbing high-energy **ultraviolet (UV) radiation** (specifically UV-B and UV-C wavelengths).

Step 3: Explain the significance: By filtering out over 97–99% of this harmful UV radiation, the ozone layer protects terrestrial life from DNA damage, skin cancers, cataracts, and crop damage.

Final Answer: Ultraviolet radiation

Answer: (C)

Go Back to Question 34

Q35.

Solution

Concept: The central dogma of molecular biology outlines the flow of genetic information:

$$\text{DNA} \xrightarrow{\text{Replication}} \text{DNA} \xrightarrow{\text{Transcription}} \text{RNA} \xrightarrow{\text{Translation}} \text{Protein}$$

Solution: Step 1: Define each term listed in the options:

- **Translation:** The process of decoding mRNA to synthesize a polypeptide chain (protein).
- **Replication:** The process of duplicating double-stranded DNA to form two identical DNA molecules.
- **Transcription:** The enzymatic process by which an RNA molecule (like mRNA, tRNA, or rRNA) is synthesized using a complementary DNA strand as a template.
- **Transformation:** The uptake and incorporation of foreign exogenous DNA by a bacterial cell.

Step 2: Based on these definitions, RNA synthesis from a DNA template is known as transcription.

Final Answer: Transcription

Answer: (C)

Go Back to Question 35

Q36.

Solution

Concept: A food chain represents the linear transfer of energy through an ecosystem via feeding. Organisms are classified into trophic levels based on their source of nourishment.

Solution: Step 1: Trace the trophic levels in the given food chain:

$$\text{Grass} \longrightarrow \text{Rabbit} \longrightarrow \text{Snake} \longrightarrow \text{Hawk}$$

- **Grass:** Primary Producer (1st Trophic Level) — captures solar energy via photosynthesis.
- **Rabbit:** Primary Consumer (2nd Trophic Level) — an herbivore that feeds on the primary producer.
- **Snake:** Secondary Consumer (3rd Trophic Level) — a carnivore that feeds on the primary consumer.
- **Hawk:** Tertiary Consumer (4th Trophic Level) — a top carnivore that feeds on the secondary consumer.

Step 2: Therefore, the snake occupies the position of a secondary consumer.

Final Answer: Secondary consumer

Answer: (C)

Go Back to Question 36

Q37.

Solution

Concept: In recombinant DNA technology, cloning vehicles or carriers are required to transport genes of interest into a host organism.

Solution: Step 1: Define a plasmid: A plasmid is a small, circular, double-stranded, extrachromosomal DNA molecule found naturally in bacteria. They replicate independently of the bacterial chromosome.

Step 2: Analyze the role of plasmids in biotechnology:

- Plasmids can be isolated, cut with restriction enzymes, and ligated with a foreign gene of interest.
- The resulting recombinant plasmid is introduced into a host cell (such as *E. coli*), where it replicates, carrying and expressing the foreign DNA.
- Therefore, in genetic engineering, plasmids act as **vectors carrying foreign DNA** (Option B).

Final Answer: Vectors carrying foreign DNA

Answer: (B)

Go Back to Question 37

Q38.

Solution

Concept: Chlorophyll is the green pigment responsible for absorbing light energy during photosynthesis. Its biosynthesis involves a sequence of metabolic steps, some of which are strictly light-dependent in angiosperms.

Solution: Step 1: Analyze the process of chlorophyll synthesis: In angiosperms, the conversion of protochlorophyllide (a yellowish precursor) to chlorophyllide (a green precursor) is catalyzed by the light-dependent enzyme *protochlorophyllide oxidoreductase*. This enzyme requires the direct absorption of light to carry out the reduction reaction.

Step 2: Analyze the physiological effect of prolonged darkness: Without light, plants cannot perform this critical biochemical step. Instead, they undergo **etiolation**, where leaves fail to synthesize chlorophyll, turn pale yellow (chlorosis), and stems elongate rapidly.

Step 3: Therefore, chlorophyll synthesis requires light, either directly or indirectly.

Final Answer: Light indirectly or directly

Answer: (B)

Go Back to Question 38

Q39.

Solution

Concept: Skeletal muscle contraction is explained by the Sliding Filament Theory (proposed by Hugh Huxley and Jean Hanson).

Solution: Step 1: Identify the main structural proteins involved in muscle contraction: Myofibrils in skeletal muscle fibers consist of two types of interdigitating protein filaments:

- **Thin filaments:** Composed primarily of the protein **actin** (along with regulatory proteins troponin and tropomyosin).
- **Thick filaments:** Composed of the motor protein **myosin**.

Step 2: Describe the contraction mechanism: During contraction, myosin heads attach to binding sites on actin filaments to form cross-bridges. Using ATP energy, the myosin heads bend (the power stroke), sliding the thin actin filaments inward along the thick myosin filaments toward the center of the sarcomere (M-line). This reduces the overall length of the sarcomere without any change in the physical length of the filaments themselves.

Step 3: Therefore, skeletal muscle contraction occurs due to the sliding of actin and myosin filaments.

Final Answer: Actin and myosin filaments

Answer: (B)

Go Back to Question 39

Q40.

Solution

Concept: Xerophytes are plants adapted to survive in dry, arid habitats (like deserts), where water is scarce and transpirational demand is very high.

Solution: Step 1: Evaluate plant adaptations to dry conditions: The primary challenge for xerophytes is to conserve water. This is accomplished through several specific structural adaptations:

- **Thick waxy cuticle:** Prevents water loss through the epidermal surface.
- **Sunken stomata:** Stomata located in deep pits create a pocket of humid air, reducing the concentration gradient of water vapor and lowering the rate of transpiration.
- **Reduced leaf surface area:** Leaves are often modified into spines to reduce transpiration.

Step 2: Analyze the other options:

- Large, thin leaves (Option A) are typical of hydrophytes or shade-loving mesophytes, which would lose water too rapidly in deserts.
- Extensive aerenchyma (Option B) is an adaptation of aquatic plants (hydrophytes) to facilitate buoyancy and gas transport.
- Absence of vascular tissue (Option D) is characteristic of bryophytes, which require moist environments.

Step 3: Thus, a thick cuticle and sunken stomata are highly characteristic adaptations of xerophytic plants.

Final Answer: Thick cuticle and sunken stomata

Answer: (C)

Go Back to Question 40

Answer Key

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