SET-3

Biology Question Paper with Solutions

Time Allowed :3 hours	Maximum Marks :70	Total Questions :33

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 33 questions. **All questions are compulsory.**
2. The question paper is divided into **five sections**: Sections **A, B, C, D, and E**.
3. **Section A** – questions number 1 to 16 are **multiple-choice type questions**. Each question carries 1 mark.
4. **Section B** – questions number 17 to 21 are **very short answer type questions**. Each question carries 2 marks.
5. **Section C** – questions number 22 to 28 are **short answer type questions**. Each question carries 3 marks.
6. **Section D** – questions number 29 and 30 are **case-based questions**. Each question carries 4 marks. Each question has subparts with **internal choice** in one of the subparts.
7. **Section E** – questions number 31 to 33 are **long answer type questions**. Each question carries 5 marks.
8. There is **no overall choice.** However, an internal choice has been provided in Sections **B, C, and D** of the question paper. A candidate has to write the answer for **only one of the alternatives** in such questions.
9. Kindly note that there is a separate question paper for **Visually Impaired candidates**.
10. Wherever necessary, **neat and properly labelled diagrams** should be drawn.

SECTION A

Questions no. 1 to 16 are Multiple Choice Type Questions, carrying 1 mark each.
$16 \times 1 = 16$

1. Embryo formation without fertilization is observed in some species of:
(A) Maize
(B) Rose
(C) Mango

(D) Rice

Correct Answer: (C) Mango

Solution: Embryo formation without fertilization is a phenomenon known as apomixis. It is observed in some species of plants like Mango, where seeds can develop without the process of fertilization.

Quick Tip

Apomixis is an asexual mode of reproduction that ensures genetic uniformity in offspring.

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2. The origin of life according to the early Greek philosophers was transfer of unit of life from outer space to the different planets in the form of:
(A) seeds
(B) spores
(C) gemmules
(D) gametes

Correct Answer: (B) spores

Solution: The hypothesis of the origin of life according to early Greek philosophers is referred to as Panspermia. It suggests that life arrived on Earth in the form of spores or microscopic life forms from outer space.

Quick Tip

Panspermia highlights the possibility of life being distributed across the universe through celestial bodies like comets and meteoroids.

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3. The ploidy of apomictic embryos developing from the nucellus and antipodal cells respectively would be:

Options:
(A) 2n, 3n
(B) 2n, n
(C) 3n, 2n
(D) n, 2n

Correct Answer: (B) 2n, n

Solution:
- Apomictic embryos from the nucellus are diploid (2n), as nucellus cells are somatic in origin.

- Antipodal cells, being part of the gametophyte, are haploid (n).

> Quick Tip
>
> Apomixis is a form of asexual reproduction where seeds are formed without fertilization, maintaining the parental genome.

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4. A DNA fragment has 3000 nucleotides, out of which 160 are Guanine. How many bases having double hydrogen bonds between them does this DNA fragment possess?

Options:
(A) 160
(B) 320
(C) 1340
(D) 2680

Correct Answer: (D) 2680

Solution:
- DNA bases forming double hydrogen bonds are Adenine (A) and Thymine (T).
- Bases forming triple hydrogen bonds are Guanine (G) and Cytosine (C).

Given:
- Total nucleotides = 3000.
- Guanine (G) count = 160.
- Cytosine (C) count = 160 (G pairs with C).
- Therefore, A + T = Total nucleotides - (G + C) = 3000 - (160 + 160) = 2680.

> Quick Tip
>
> Remember that A-T forms two hydrogen bonds, while G-C forms three hydrogen bonds.

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5. After the 1850s in the post-industrialization era in England, the expected effect of natural selection on the number of white-winged moths as compared to the dark-winged moths was:

Options:
(A) Less in number
(B) More in number
(C) Both were less in number
(D) Both were more in number

Correct Answer: (A) Less in number

Solution:
- During industrialization, dark-colored moths camouflaged better against soot-covered trees, leading to an increased survival rate.
- White-winged moths were more visible to predators, reducing their population.

> Quick Tip
>
> This phenomenon is an example of industrial melanism, showcasing natural selection in action.

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6. In which of the following chromosomal disorders do the individuals have short stature, small head, furrowed tongue, and partially open mouth?

Options:
(A) Turner's syndrome
(B) Down's syndrome
(C) Klinefelter's syndrome
(D) Edwards' syndrome

Correct Answer: (B) Down's syndrome

Solution:
- Down's syndrome is caused by trisomy of chromosome 21.
- It is characterized by distinct physical features such as short stature, small head, furrowed tongue, and cognitive impairment.

> Quick Tip
>
> Genetic disorders like Down's syndrome can be detected through karyotyping.

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7. A Snapdragon plant bearing pink-colored flowers is crossed with a Snapdragon plant bearing white-colored flowers. Their F1 progeny will show:

Options:
(A) 25% Red : 50% Pink : 25% White
(B) 50% Red : 50% White
(C) 50% Pink : 50% White
(D) 25% Pink : 50% Red : 25% White

Correct Answer: (C) 50% Pink : 50% White

Solution:
- Snapdragon plants exhibit incomplete dominance.
- Crossing a pink (Rr) plant with a white (rr) plant gives:

$$Rr \times rr \quad \rightarrow \quad 50\%Rr(\text{Pink}) + 50\%rr(\text{White})$$

Quick Tip

Incomplete dominance results in a phenotype that is an intermediate of the parent phenotypes.

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8. A patient is suffering from the infection of the alveoli of lungs and is showing the symptoms of fever, chills, cough, headache, and bluish-colored lips and fingernails. The patient was diagnosed to be suffering from the infection of:

Options:
(A) Epidermophyton
(B) Entamoeba histolytica
(C) Haemophilus influenzae
(D) Salmonella typhi

Correct Answer: (C) Haemophilus influenzae

Solution:
- *Haemophilus influenzae* causes pneumonia, an infection of the alveoli of the lungs.
- Symptoms include fever, chills, cough, and cyanosis (bluish lips and nails).

Quick Tip

Prompt diagnosis and treatment are crucial for bacterial infections like pneumonia.

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9. The linking of the antibiotic resistance gene with the plasmid vector of *Salmonella typhimurium* by Stanley Cohen and Herbert Boyer was made possible by the enzyme:

Options:
(A) Taq polymerase
(B) DNA ligase
(C) Restriction endonuclease
(D) -galactosidase

Correct Answer: (B) DNA ligase

Solution:
- DNA ligase is used to join the antibiotic resistance gene with the plasmid vector.
- This technique was a pioneering step in recombinant DNA technology.

Quick Tip

DNA ligase acts as a molecular glue in genetic engineering.

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10. In an experiment, *E. coli* is grown in a medium containing $^{14}NH_4Cl$ (^{14}N is the light isotope of Nitrogen) followed by growing it for six generations in a medium having the heavy isotope of nitrogen (^{15}N). After six generations, their DNA was extracted and subjected to CsCl density gradient centrifugation. Identify the correct density (Light/Hybrid/Heavy) and ratio of the bands of DNA in CsCl density gradient centrifugation:

Options:
(A) Hybrid : Heavy, 1 : 16
(B) Light : Heavy, 1 : 31
(C) Hybrid : Heavy, 1 : 31
(D) Light : Heavy, 1 : 05

Correct Answer: (C) Hybrid : Heavy, 1 : 31

Solution:
- After six generations in a medium with heavy nitrogen (^{15}N), most DNA will incorporate ^{15}N, resulting in heavy DNA.
- The ratio of hybrid to heavy DNA will be 1:31 after centrifugation.

Quick Tip

DNA density gradients provide insights into replication patterns.

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11. The population growth curve applicable for a population of beetles growing in nature under unlimited resource conditions available to them will be:

(A) Population density decreases linearly with time.
(B) Sigmoid growth curve.
(C) Exponential growth curve.
(D) Population density increases linearly with time.

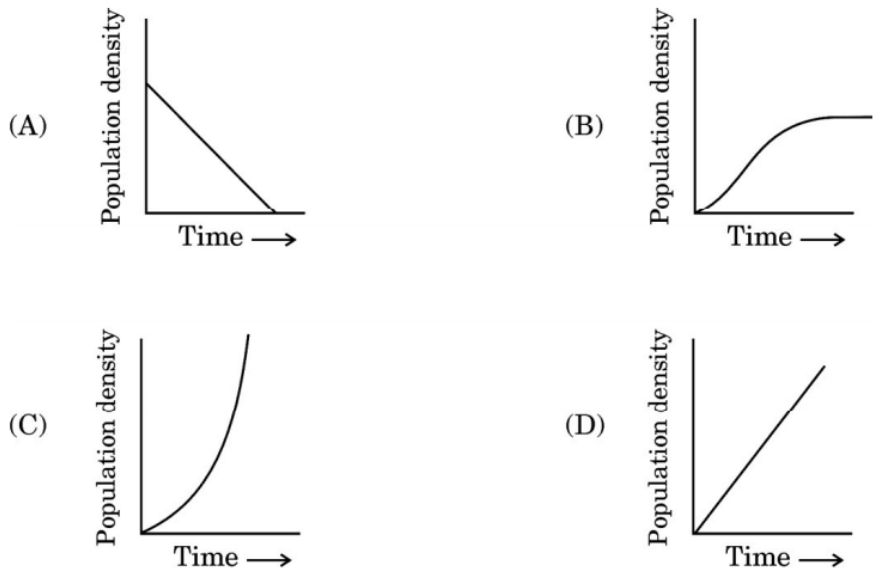

Figure 1: Population Density Graphs Over Time

Correct Answer: (C) Exponential growth curve

Solution: - Under unlimited resource conditions, the population growth curve exhibits exponential growth, represented by a J-shaped curve. - The population size increases at a constant rate due to the absence of limiting factors.

Quick Tip

Exponential growth occurs only in ideal conditions and is rare in natural ecosystems due to resource limitations.

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12. Which one of the following represents the correct annealing of primers to the DNA to be amplified in the PCR?

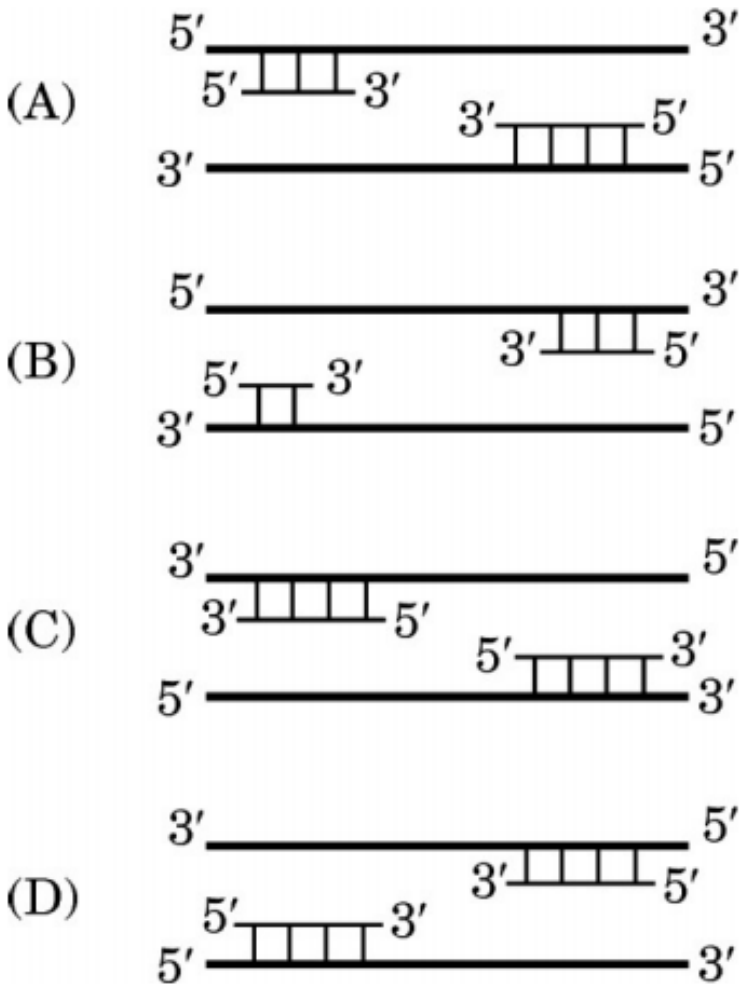

Figure 2: DNA Strand Configurations with 5' and 3' Orientation

(A) Both primers are complementary to the same strand.
(B) Primers anneal in a non-complementary manner.
(C) Both primers are complementary to the opposite strands at their ends.
(D) Primers anneal perfectly in opposite directions to the DNA template.

Correct Answer: (D) Primers anneal perfectly in opposite directions to the DNA template.

Solution:

- In PCR, primers must bind to opposite strands of the DNA template in a complementary manner.
- This ensures the amplification of the region of interest between the primers.

Quick Tip

Primer design is critical for PCR efficiency and specificity. Always ensure primers are complementary to their respective DNA template regions.

Instructions for Questions 13 to 16

For each of the following questions, two statements are provided:

- **Assertion (A):** The first statement describes a fact or observation.
- **Reason (R):** The second statement provides an explanation for the assertion.

Select the correct answer from the following codes:

- **(A):** Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A).
- **(B):** Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
- **(C):** Assertion (A) is true, but Reason (R) is false.
- **(D):** Assertion (A) is false, but Reason (R) is true.

13. Assertion (A): The zygote gives rise to heart-shaped embryo and subsequently proembryo in most angiosperms.
Reason (R): The zygote is present at the micropylar end of the embryo sac and develops into an embryo.

Correct Answer: (C) Both (A) and (R) are true, but (R) is not the correct explanation of (A).

Solution: - The zygote does give rise to a heart-shaped embryo, which subsequently develops into the proembryo in angiosperms. - The micropylar end of the embryo sac is where the zygote is located, facilitating nutrient absorption necessary for its development. - However, the micropylar location (R) is not the reason for the formation of the heart-shaped embryo stage (A). Instead, the heart-shaped stage results from differentiation during embryogenesis.

Quick Tip

Embryogenesis in angiosperms involves distinct stages, including the globular, heart-shaped, and torpedo stages, leading to the formation of a mature embryo.

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14. Assertion (A): The stirrer facilitates the even mixing of oxygen availability in a bioreactor.
Reason (R): Stirred-tank bioreactors generally have a flat base.

Correct Answer: (C)

Solution: - The stirrer ensures uniform oxygen and nutrient mixing, promoting optimal growth conditions. - The flat base is unrelated to oxygen mixing; it provides stability to the bioreactor.

Quick Tip

Bioreactors are designed for large-scale production of biomolecules under controlled conditions.

15. Assertion (A): Primary transcripts in eukaryotes are subjected to splicing to remove the introns.
Reason (R): Primary transcripts contain both exons and introns, and the introns are non-functional in eukaryotes.

Correct Answer: (A)

Solution: - Introns are non-functional regions removed through splicing, leaving only functional exons for protein synthesis. - The reason correctly explains the assertion.

Quick Tip

Alternative splicing allows a single gene to code for multiple proteins, increasing genetic diversity.

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16. Assertion (A): The chronic use of alcohol by a person leads to cirrhosis.
Reason (R): Alcohol addiction at times becomes the cause of mental and financial distress to the entire family of the addicted person.

Correct Answer: (B)

Solution: - Cirrhosis is caused by liver damage due to chronic alcohol consumption. - While addiction impacts family well-being, it does not directly cause cirrhosis.

Quick Tip

Early diagnosis and lifestyle changes can prevent or manage cirrhosis effectively.

SECTION B

17. Amniocentesis is a very useful and important technique, but due to some reason there is a statutory ban on amniocentesis. Justify this statement.

Answer: Amniocentesis is banned to prevent its misuse for:

- Determining the sex of the fetus, which may lead to female feticide.
- Ethical concerns regarding prenatal diagnostics.
- Protecting gender equality and addressing declining female sex ratios.

Quick Tip

Amniocentesis is used to detect genetic abnormalities but is banned for unethical applications like sex determination.

18. With reference to the set-ups (A, B, and C) given below, of the electrophoretic separation of a mixture of DNA fragments of varied lengths, answer the questions that follow:

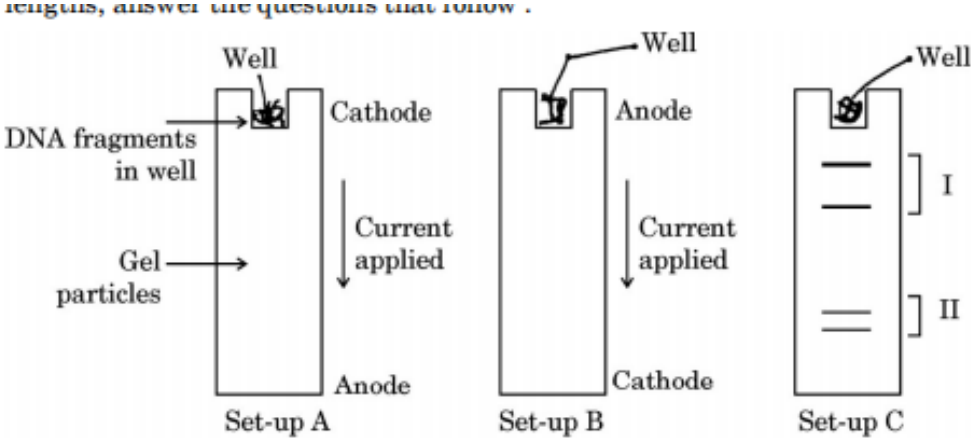

Figure 3: Set-ups showing electrophoresis configurations.

(a) In which one of the two Set-ups, A or B, would you see the DNA fragments separated and why?

Answer: Set-up B. The DNA fragments are negatively charged and move toward the anode in an electric field.

(b) In Set-up C, which one of the two, I/II, are the bands of longer fragments of DNA? Justify your answer.

Answer: Band II contains longer DNA fragments as larger molecules move more slowly through the gel matrix compared to smaller fragments.

> Quick Tip
>
> Electrophoresis is a technique used to separate biomolecules based on their size and charge.

19. Consider the given data of a hypothetical small portion of mRNA that codes for a functional polypeptide chain and answer the questions that follow:

mRNA Sequence: 5'– UCAUUAACCCAGAUCUUCUUAAAAGGA –3'

(a) How many amino acids will be formed from the given codons, if substitution of 'U' by 'C' takes place at the 5th codon? Explain your answer.

Answer: The sequence changes to 5'- UCAUUAACCCAGACCUUCUUAAAAGGA-3'. The 5th codon changes from UCU to CCU, coding for Proline instead of Serine. Amino acids = Total codons – Stop codon = 8.

> Quick Tip
>
> Substitutions in codons can change amino acids, altering protein structure and function.

(b) Write the number of amino acids that would be in the polypeptide synthesised by a similar mRNA as above, where in the fourth codon instead of 'C' there is 'U'. Justify your answer.

Answer: The sequence changes, causing the appearance of a premature stop codon. Translation halts earlier, producing a shorter polypeptide chain.

> Quick Tip
>
> Premature stop codons caused by mutations can lead to truncated proteins and loss of function.

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20. Write important features of 'humus' formed during the decomposition cycle in a terrestrial ecosystem.

Answer: Features of humus:

- Dark, organic material resulting from decomposed plants and animals.
- Improves soil fertility and water retention.
- Provides nutrients to plants over time.

> Quick Tip
>
> Humus enhances microbial activity in the soil, contributing to nutrient cycling.

OR

(b) (i) Graphically represent the relationship between species richness and area on a log-log scale for bats and fishes.

Answer: The graph shows a logarithmic relationship, with species richness increasing with area.

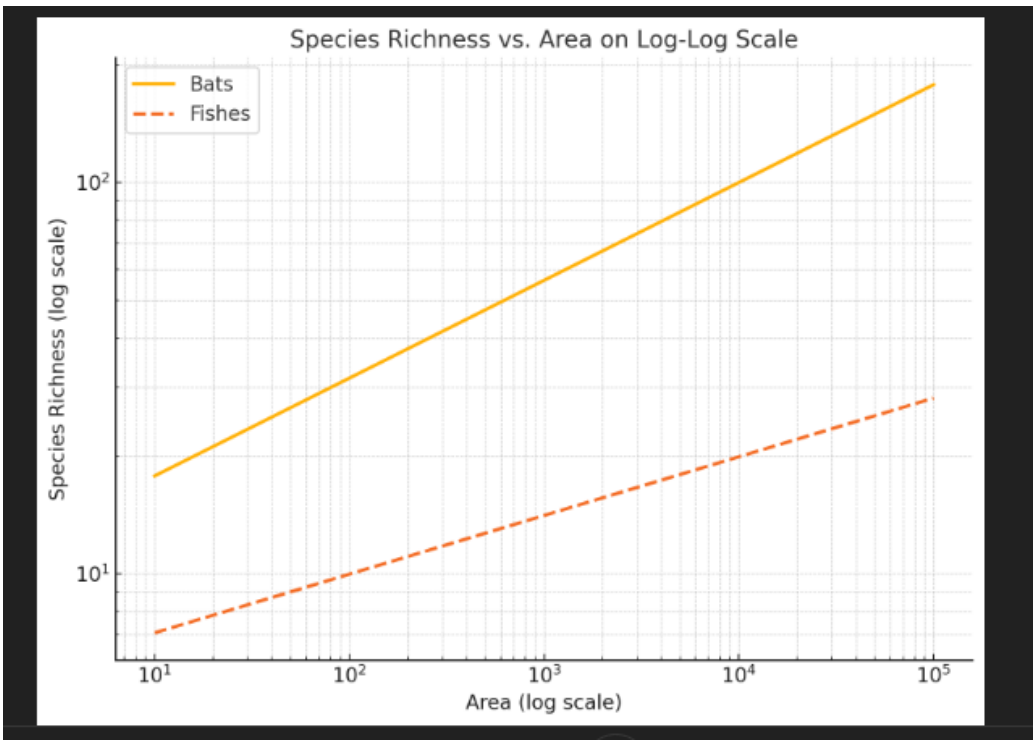

Figure 4: Species Richness vs. Area on Log-Log Scale for Bats and Fishes.

Quick Tip

Species richness often shows a logarithmic growth trend with habitat area.

(ii) Write the equation for the relationship as on a logarithmic scale.

Answer: $\mathbf{S = cA^z}$, where:

- S = Species richness.
- A = Area.
- c = Constant.
- z = Slope of the line (logarithmic).

Quick Tip

The species-area relationship demonstrates how biodiversity scales with habitat size.

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21. What is a vaccine? Write the basis on which it acts when administered in the body.

Answer: A vaccine is a biological preparation that provides active acquired immunity to a particular disease.

- Contains inactivated or weakened pathogens/antigens.

- Stimulates the immune system to produce memory cells for future protection.

> Quick Tip
>
> Vaccines are crucial for preventing infectious diseases and promoting global health.

SECTION C

22. Draw a T.S. of a mature anther of an angiosperm. Label its any three wall layers and mention their functions.

Answer:

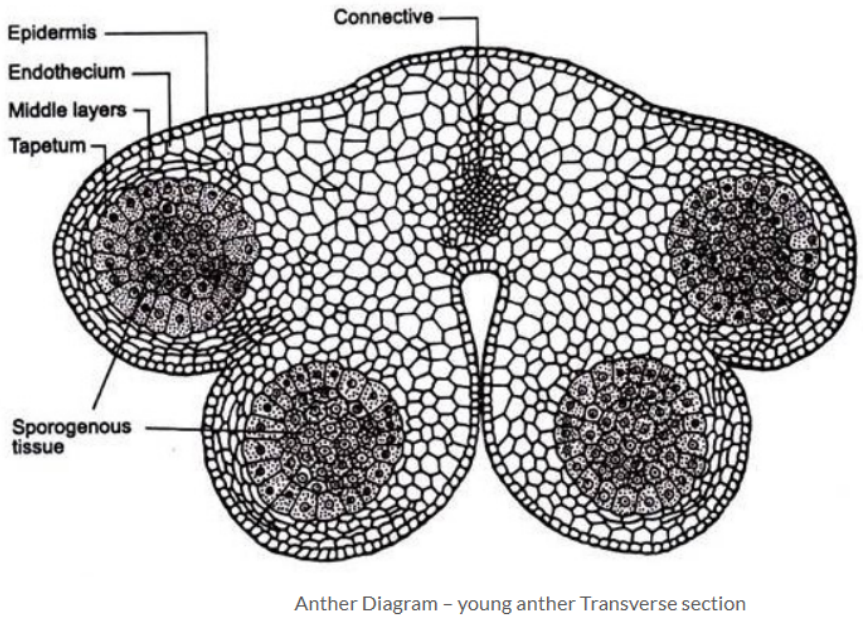

Figure 5: Anther.

The transverse section (T.S.) of a mature anther includes the following wall layers:

- **Epidermis:** Protective outermost layer.
- **Endothecium:** Helps in the dehiscence of the anther to release pollen.
- **Tapetum:** Provides nourishment to the developing pollen grains.

> Quick Tip
>
> The anther wall layers play essential roles in protecting and nurturing pollen development.

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23. A population of snakes lived in a desert with brown sand. Study the drawings given below showing the change in the population from 'one' to 'two' over time and

answer the question that follows. Brown snakes and Grey snakes are represented by alleles A/a (Dominant/recessive).

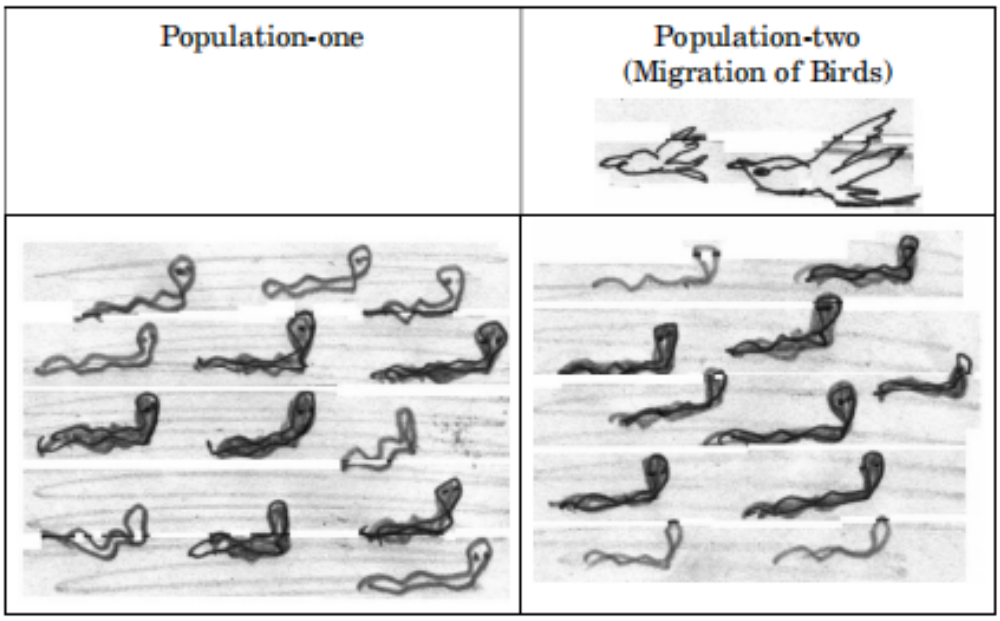

Figure 6: Comparison between Population-one and Population-two (Migration of Birds)

(a) If the frequency of the recessive trait is 9% in population-one, work out the frequency of homozygous dominant and heterozygous dominant snakes.

Answer: Given: Recessive trait frequency $(aa) = 9\% = 0.09$.

$$q^2 = 0.09 \implies q = \sqrt{0.09} = 0.3.$$

$$p + q = 1 \implies p = 1 - 0.3 = 0.7.$$

Homozygous dominant (AA) frequency: $p^2 = (0.7)^2 = 0.49 = 49\%$.

Heterozygous dominant (Aa) frequency: $2pq = 2(0.7)(0.3) = 0.42 = 42\%$.

Quick Tip

The Hardy-Weinberg principle helps estimate allele and genotype frequencies in a population.

(b) Name the mechanism of evolution that must have operated so that population-two evolved from population-one.

Answer: The mechanism is **Natural Selection**. Over time, brown snakes, being better camouflaged in the desert, had a survival advantage over grey snakes.

Quick Tip

Natural selection drives evolutionary changes by favoring advantageous traits in a given environment.

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24. (a) (i) List two major reasons for using cow-dung in a biogas plant instead of using domestic sewage.
Answer:

- Cow-dung contains methanogenic bacteria that efficiently produce biogas.
- It is readily available and environmentally sustainable.

Quick Tip

Cow-dung is an ideal substrate for biogas production due to its high microbial content and availability.

(ii) Mention one use of the unspent slurry of the biogas plant.
Answer: Unspent slurry is used as a nutrient-rich organic fertilizer.

Quick Tip

The unspent slurry from biogas plants serves as an excellent soil conditioner and organic fertilizer.

OR

(b) Name the bioactive molecule and its microbial source generally used by physicians to treat the patients for:

- **(i) Myocardial infarction:** Streptokinase (source: *Streptococcus*).
- **(ii) High blood cholesterol level:** Statins (source: *Monascus purpureus*).
- **(iii) Organ transplantation:** Cyclosporine A (source: *Trichoderma polysporum*).

Quick Tip

Bioactive molecules like streptokinase, statins, and cyclosporine A are pivotal in modern medicine for treating diverse conditions.

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25. Differentiate between spermatogenesis and oogenesis in humans on the basis of the following:

(a) When the process is initiated.

Answer:

- **Spermatogenesis:** Begins at puberty.
- **Oogenesis:** Begins during fetal development.

(b) Number of functional gametes produced per primary spermatocyte/oocyte.

Answer:

- **Spermatogenesis:** Produces four functional sperm.
- **Oogenesis:** Produces one ovum and two polar bodies.

(c) Specific site at which meiosis II is completed.

Answer:

- **Spermatogenesis:** Completed in the seminiferous tubules.
- **Oogenesis:** Completed in the fallopian tubes after fertilization.

> Quick Tip
>
> Spermatogenesis and oogenesis are crucial for sexual reproduction, ensuring the formation of male and female gametes.

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26. Three crosses were carried out in pea plants with respect to flower colour violet/white (V/v) and flower position axial/terminal (A/a). Study in the table the crosses 'a', 'b' and 'c' where parental phenotypes and their F_1 progeny phenotypes are given. Find the genotypes of each of the parental pairs of crosses 'a', 'b' and 'c'.

Parental plants (Phenotypes)	*F_1 Progeny (Phenotypes)*
(a) Violet, axial × white, axial	6/16 white, axial 2/16 white, terminal 6/16 violet, axial 2/16 violet, axial
(b) Violet, axial × white, terminal	1/4 violet, axial 1/4 violet, terminal 1/4 white, axial 1/4 white, terminal
(c) Violet, axial × violet, axial	3/4 violet, axial 1/4 white, axial

Figure 7: Phenotypic distribution of F_1 progeny from parental plants.

Answer: (a) Cross: Violet, axial × White, axial Genotype of parents: $VvAa \times vvAa$ Explanation:

- 6/16 Violet, axial: $VvAa$
- 2/16 White, terminal: $vvAa$
- 6/16 Violet, axial: $VvAa$
- 2/16 Violet, axial: $VvAa$

(b) Cross: Violet, axial × White, terminal Genotype of parents: $VvAa \times vvaa$ Explanation:

- 1/4 Violet, axial: $VvAa$
- 1/4 Violet, terminal: $Vvaa$
- 1/4 White, axial: $vvAa$
- 1/4 White, terminal: $vvaa$

(c) Cross: Violet, axial × Violet, axial Genotype of parents: $VvAa \times VvAa$ Explanation:

- 3/4 Violet, axial: $VvAa$

- 1/4 White, axial: *vvAa*

Quick Tip

In dihybrid crosses, phenotypic ratios can help deduce parental genotypes based on Mendelian inheritance patterns.

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27. Explain any three roles of 'predation' in an ecosystem with the help of suitable examples.

Answer: Roles of predation:

- **Maintains species diversity:** Predators control the population of prey, preventing any single species from dominating. Example: Lions preying on zebras in savannahs.
- **Regulates ecosystem balance:** Predators ensure a balance between herbivores and plants. Example: Wolves controlling deer populations.
- **Promotes natural selection:** Predation exerts pressure on prey to evolve defensive mechanisms. Example: Camouflage in stick insects.

Quick Tip

Predation is crucial for maintaining ecological equilibrium and promoting evolutionary adaptations.

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28. (a) Give the scientific name of the bacteria widely used in biotechnology to create a GM cotton crop resistant to bollworm attacks.

Answer: *Bacillus thuringiensis (Bt).*

Quick Tip

Bacillus thuringiensis is commonly used in agriculture to naturally manage pest populations.

(b) Explain how GM cotton crop is able to resist insect attacks.

Answer: GM cotton expresses a gene from *Bacillus thuringiensis* that produces a toxic protein:

- The Bt toxin is ingested by bollworms.
- The toxin binds to receptors in the insect gut, causing cell lysis and death.

Quick Tip

Bt crops reduce the dependency on chemical pesticides, promoting sustainable agriculture.

SECTION D

29. Read the passage given below and answer the questions that follow:

In recombinant DNA technology, restriction enzymes are used as they recognize and cut DNA within a specific recognition sequence. BamHI is one such restriction enzyme which binds at the recognition sequence 5'-G↓GATCC-3' and cleaves this sequence between G and G on each strand, whereas AluI binds at the recognition sequence 5'-AG↓CT-3' and cleaves these sequences between G and C on each strand.

(a) If Alu I is used to cut the given DNA strand, how many DNA fragments would be formed? Write the sequence of each fragment formed with its polarity.

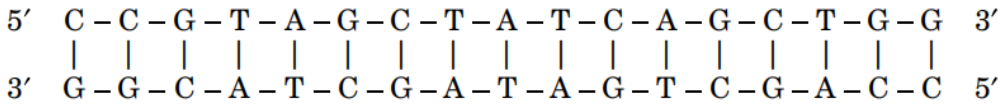

Figure 8: DNA sequence representation with complementary base pairing.

Answer: The sequence contains three Alu I recognition sites. Fragments formed:

- 5'– CCGG–3'
- 5'– ATCCTG–3'
- 5'– CGAT–3'

Quick Tip

Alu I is a restriction enzyme that recognizes specific palindromic sequences, cutting them to produce blunt ends.

(b) Which one of the two restriction enzymes BamHI or AluI will preferably be used on the same given DNA strand to make a recombinant DNA molecule and why?

Answer: BamHI is preferred as it produces sticky ends, facilitating the formation of recombinant DNA.

Quick Tip

Sticky ends generated by enzymes like BamHI are crucial for the formation of stable recombinant DNA molecules.

(c) After binding to the two strands of the double helix DNA, where specifically does the restriction enzyme act to cut the two strands of DNA? Write the specific term used for the specific nucleotide sequences of DNA recognised by a restriction endonuclease.

Answer: Restriction enzymes act at specific recognition sites or sequences on the double-stranded DNA. These sites are typically palindromic sequences, where the enzyme cuts the DNA to generate sticky or blunt ends.

- The specific term used for the nucleotide sequences recognised by a restriction endonuclease is **recognition sequence**.

Quick Tip

Recognition sequences in DNA are palindromic, enabling restriction enzymes to bind and cut at precise locations.

OR

(c) Write the specific sequence of DNA segment recognised by the restriction endonuclease EcoRI.

Answer: EcoRI recognises the sequence 5'-GAATTC-3' and cuts between G and A.

Quick Tip

EcoRI is a widely used restriction enzyme in molecular biology for generating sticky ends in DNA fragments.

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30. Study the figures given below that depict the comparative age distribution of human populations in Sweden and Rwanda (International Data Base 2003) and answer the questions that follow:

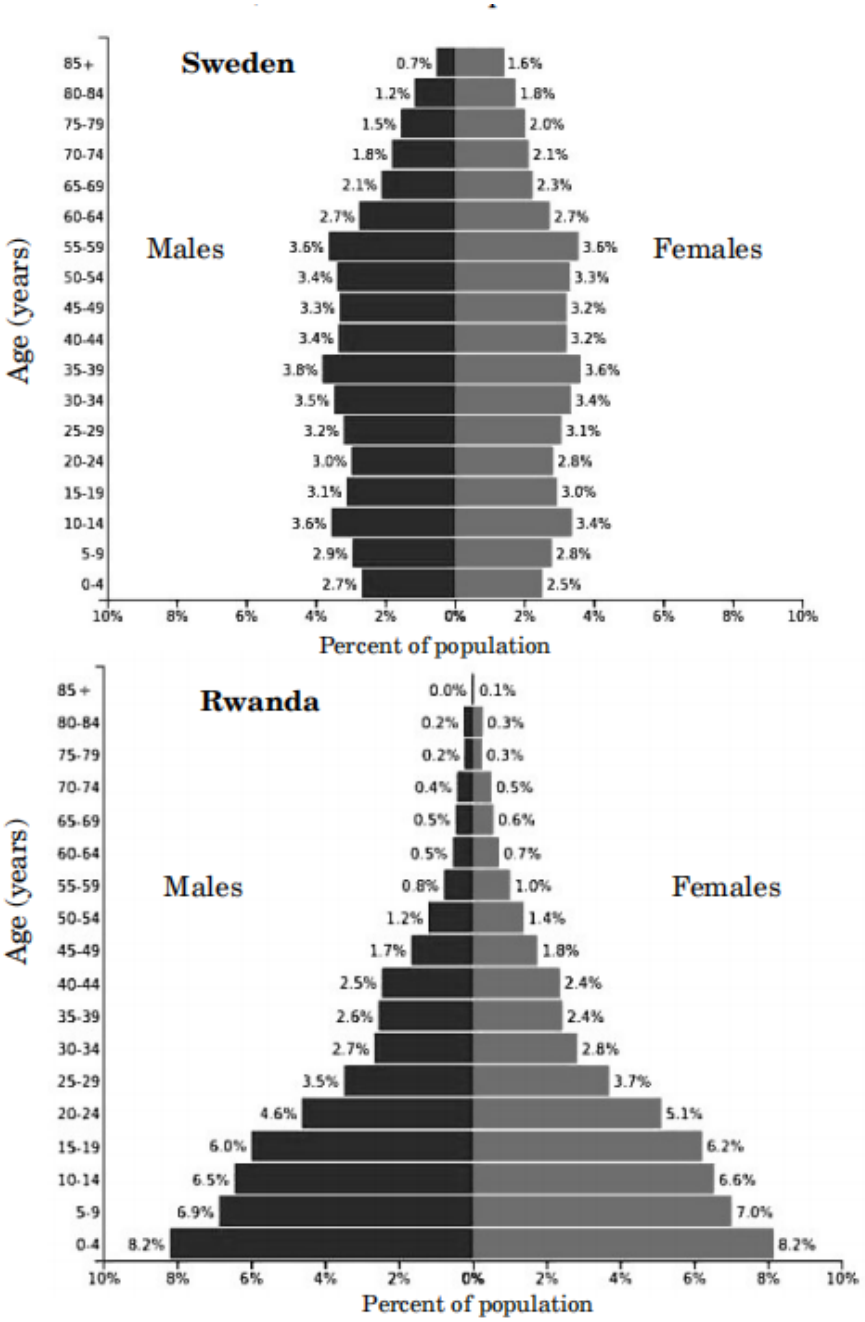

Figure 9: Population pyramids of Sweden and Rwanda showing age and gender distribution.

(a) What can be inferred from the very broad base of Rwanda's age pyramid? Support your answer with the data provided in the figure.

Answer:
The broad base of Rwanda's age pyramid indicates:

- A high birth rate and rapid population growth.
- A large percentage of the population consists of younger individuals, as shown by the higher proportions in the 0-14 age group.

Quick Tip

Age pyramids are graphical representations of population distribution and are useful in analyzing demographic trends.

(b) Sweden has an age distribution that is approximately of the same width near its base as at the apex. What does this indicate?

Answer:
Sweden's age pyramid indicates:

- A stable population with low birth and death rates.
- The percentage of individuals in all age groups is nearly uniform, suggesting a balanced demographic.

Quick Tip

Stable age pyramids reflect nations with consistent growth rates, often due to effective healthcare and low mortality rates.

(c) Name the type of age pyramid shown above for Sweden.
Answer: Stationary age pyramid.

Quick Tip

A stationary pyramid represents countries with low birth and death rates, leading to a stable population structure with nearly equal proportions across age groups.

(d) Name the type of age pyramid shown above for Rwanda.

Answer:
Expanding age pyramid.

Quick Tip

Expanding pyramids indicate rapid population growth, typical of developing countries with high birth rates.

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31. (a) "The influence of both the alleles in a heterozygous state is clearly expressed in codominance." Explain with the help of inheritance of ABO blood group in humans.

Answer:
Codominance is observed when both alleles in a heterozygous state express equally.

- Example: ABO blood group inheritance.
- **IA and IB alleles:** These are codominant, while the i allele is recessive.
- A person with the **IAIB genotype** has an AB blood group because both **IA** and **IB** are expressed.

Quick Tip
Codominance allows the expression of both alleles simultaneously, demonstrating a unique pattern of inheritance.

OR

(b) (i) Explain the mechanism of switching 'on' of the structural genes of *lac operon.*

Answer:
In the presence of lactose:

- Lactose binds to the repressor protein, inactivating it.
- The repressor can no longer bind to the operator region.
- RNA polymerase transcribes the structural genes, producing enzymes for lactose metabolism.

Quick Tip
The *lac operon* illustrates an inducible system where genes are transcribed only in the presence of lactose.

(ii) "Regulation of *lac operon* is referred to be negatively regulated." Justify giving a reason.

Answer:
The *lac operon* is negatively regulated because:

- The repressor protein inhibits gene expression by binding to the operator region in the absence of lactose.
- Gene transcription is only initiated when lactose is available to inactivate the repressor.

Quick Tip
Negative regulation ensures efficient resource usage by blocking unnecessary transcription.

32. (a) Describe the life cycle of *Plasmodium* from the time it enters the human body till a female *Anopheles* mosquito bites an infected person.

Answer:
The life cycle of *Plasmodium*:

- Sporozoites enter the human bloodstream via a mosquito bite and infect liver cells.
- They multiply in liver cells to form merozoites, which are released into the bloodstream.
- Merozoites infect red blood cells, multiply, and cause cell rupture.
- Gametocytes are formed and circulate in the blood.
- When a mosquito bites, gametocytes are taken up, continuing the cycle.

Quick Tip
Understanding the *Plasmodium* life cycle is crucial for malaria prevention and treatment strategies.

(b) Mention the two events of *Plasmodium* life cycle that occur within the female *Anopheles* body.

Answer:

- Gametocytes develop into male and female gametes.
- Zygote formation occurs, followed by the development of sporozoites, which migrate to the salivary glands of the mosquito.

Quick Tip
Vector control methods, such as using insecticide-treated nets and eliminating stagnant water, are key strategies in preventing malaria transmission.

OR

(b) (i) Write two differences between malignant tumor and benign tumor.

Answer:

- **Malignant Tumor:**
  - These are cancerous tumors that invade and destroy surrounding tissues.

- They can metastasize, meaning they spread to distant parts of the body through blood or lymph.

- **Benign Tumor:**
  - These are non-cancerous tumors that grow slowly and remain localized.
  - They do not invade surrounding tissues or spread to other parts of the body.

Quick Tip
Malignant tumors are harmful and require immediate medical attention, whereas benign tumors are less harmful but should still be monitored.

(b) (ii) Explain any three diagnostic techniques for the detection of cancer.

Answer:
Three diagnostic techniques for the detection of cancer are:

- **Biopsy:** A small tissue sample is removed from the suspected area and examined under a microscope to detect cancerous cells.
- **Imaging Techniques:**
  - *X-rays:* Used to detect abnormalities in bones or organs.
  - *MRI (Magnetic Resonance Imaging):* Provides detailed images of soft tissues to detect tumors.
- **Blood Tests:** Detect tumor markers (specific proteins or substances) produced by cancer cells.

Quick Tip
Early detection of cancer improves treatment outcomes. Regular check-ups and awareness of symptoms are crucial for timely diagnosis.

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33. (a) (i) Explain any four devices that flowering plants have developed to encourage cross-pollination.

Answer: Flowering plants have developed the following devices to encourage cross-pollination:

- **Dichogamy:** Temporal separation of male and female reproductive organ maturity (e.g., protandry in sunflower).
- **Self-incompatibility:** Genetic mechanism that prevents self-pollen germination (e.g., Brassica).
- **Herkogamy:** Physical barrier between male and female organs to prevent self-pollination (e.g., hibiscus).

- **Monoecy and Dioecy:** Separation of male and female flowers on the same or different plants (e.g., maize and papaya).

Quick Tip
Cross-pollination ensures genetic diversity, which is essential for plant adaptability and evolution.

(ii) Why do plants discourage self-pollination? State any one reason.

Answer:
Self-pollination is discouraged as it leads to inbreeding depression, reducing genetic variability and adaptability in plants.

Quick Tip
Plants rely on mechanisms like genetic self-incompatibility and pollinator attraction to maintain genetic diversity through cross-pollination.

OR

(b) Explain the ovarian and uterine events taking place along with the role of pituitary and ovarian hormones, during menstrual cycle in a normal human female under the following phases:

(i) Follicular phase/proliferative phase

Answer:

- **Ovarian events:** Development of primary follicle into a mature Graafian follicle.
- **Uterine events:** Regeneration of the endometrium.
- **Hormones:** Secretion of FSH and estrogen stimulates follicular growth and endometrial repair.

Quick Tip
The follicular phase prepares the ovary and uterus for ovulation and potential implantation.

(ii) Luteal phase/secretory phase

Answer:

- **Ovarian events:** Formation of corpus luteum from the ruptured follicle.
- **Uterine events:** Thickening of the endometrium for implantation.
- **Hormones:** Progesterone secretion by the corpus luteum prepares the uterus for implantation.

Quick Tip
The luteal phase focuses on maintaining a suitable uterine environment for potential pregnancy.

(iii) Menstrual phase

Answer:

- **Ovarian events:** Degeneration of corpus luteum if fertilization does not occur.
- **Uterine events:** Shedding of the endometrial lining and bleeding.
- **Hormones:** Decrease in progesterone and estrogen levels triggers menstruation.

Quick Tip
The menstrual phase marks the beginning of a new cycle if fertilization does not occur.
