CBSE 12 Biology (57/2/2) 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**: Section A, B, C, D, and E.
3. **Section A:** Questions 1 to 16 are multiple-choice type questions. Each question carries 1 mark.
4. **Section B:** Questions 17 to 21 are very short answer-type questions. Each question carries 2 marks.
5. **Section C:** Questions 22 to 28 are short answer-type questions. Each question carries 3 marks.
6. **Section D:** Questions 29 and 30 are case-based questions. Each question carries 4 marks and has subparts with internal choice in one of the subparts.
7. **Section E:** Questions 31 to 33 are long answer-type questions. Each question carries 5 marks.
8. There is no overall choice. However, **internal choice** has been provided in some questions in Section B, Section C, and Section D. A candidate has to attempt only one of the alternatives in such questions.
9. A separate question paper is available for **Visually Impaired candidates**.
10. Wherever necessary, neat and properly labeled diagrams should be drawn.

SECTION A

1. Homologous organs indicate:

(A) Convergent Evolution

(B) Divergent Evolution

(C) Adaptive Radiation

(D) Natural Selection

Correct Answer: (B) Divergent Evolution

Solution: Understanding homologous organs.

- Homologous organs are structures that share a common anatomical origin but may perform different functions in different species. They arise due to inheritance from a shared ancestor.

Link between homologous organs and divergent evolution.

- Divergent evolution occurs when organisms of a common lineage adapt to various environmental conditions, leading to structural modifications while retaining fundamental similarities.

Example of homologous organs.

- A classic example is the forelimb structure in mammals, such as the human arm, the bat's wing, and the whale's flipper. Although these structures serve different purposes, they exhibit similar skeletal frameworks, demonstrating their shared ancestry.

Homologous organs provide strong evidence for divergent evolution, highlighting how species evolve distinct characteristics while maintaining structural commonalities.

Quick Tip

Divergent evolution results in organisms developing unique adaptations from a common ancestral structure. Homologous organs serve as crucial proof of evolutionary modification over time, emphasizing variations that arise due to environmental pressures and survival needs.

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2. A population is in genetic equilibrium/Hardy-Weinberg equilibrium for a gene with 2 alleles (dominant allele is 'A' and recessive allele 'a'). If the frequency of allele 'A' is

0.6, then the frequency of genotype 'Aa' is:

(A) 0.21

(B) 0.42

(C) 0.48

(D) 0.32

Correct Answer: (C) 0.48

Solution: Understanding Hardy-Weinberg equilibrium.

- The Hardy-Weinberg principle describes a population where allele frequencies remain constant in the absence of evolutionary forces such as natural selection, mutation, migration, or genetic drift.

Applying the Hardy-Weinberg equation.

- The Hardy-Weinberg equation is:

$$p^2 + 2pq + q^2 = 1$$

where: - p is the frequency of the dominant allele A, and - q is the frequency of the recessive allele a.

Given that $p = 0.6$, we calculate q as:

$$q = 1 - p = 1 - 0.6 = 0.4$$

Calculating the heterozygous genotype frequency.

- The frequency of heterozygous genotype Aa is calculated as:

$$2pq = 2(0.6)(0.4) = 0.48.$$

Thus, the correct answer is 0.48.

The frequency of genotype Aa is 0.48.

Quick Tip

Hardy-Weinberg equilibrium is a crucial concept in population genetics. It helps predict genotype frequencies and analyze evolutionary changes by identifying deviations from expected proportions.

3. In the double helical structure of DNA molecule, the strands are:

(A) Identical and complementary

(B) Identical and non-complementary

(C) Anti-parallel and complementary

(D) Anti-parallel and non-complementary

Correct Answer: (C) Anti-parallel and complementary

Solution: Understanding DNA structure.

- DNA is a double-stranded molecule in which each strand is composed of nucleotides arranged in a specific order. These two strands twist around each other to form a right-handed double helix.

Anti-parallel orientation.

- The two strands of DNA run in opposite directions, meaning one strand has a 5' to 3' orientation while the other runs from 3' to 5'. This orientation is referred to as anti-parallel.

Complementary base pairing.

- The bases of the two strands pair specifically: adenine (A) pairs with thymine (T), and guanine (G) pairs with cytosine (C), ensuring an exact replication process during cell division.

The two strands of DNA are anti-parallel and complementary, ensuring precise genetic replication and stability.

Quick Tip

The anti-parallel nature of DNA allows proper base pairing and enzymatic function during replication and transcription. This feature ensures accuracy in genetic information transfer.

4. In a 'transcription unit', the 'terminator' is located towards the:

(A) 3' end of the template strand

(B) 5' end of the template strand

(C) 5’ end of the coding strand

(D) 3’ end of the coding strand

Correct Answer: (D) 3’ end of the coding strand

Solution: Understanding transcription.

- Transcription is the process by which genetic information from DNA is copied into messenger RNA (mRNA). It occurs in three main steps: initiation, elongation, and termination.

Role of the terminator.

- The terminator is a specific DNA sequence that signals RNA polymerase to stop transcription. This prevents further RNA synthesis and allows the newly formed mRNA strand to detach from the template strand.

Location of the terminator.

- The terminator is positioned at the 3’ end of the coding strand. The RNA polymerase moves along the template strand in the 3’ to 5’ direction, and the complementary mRNA is synthesized in the 5’ to 3’ direction. The terminator sequence signals the end of this transcription process at the 3’ end of the coding strand.

Thus, the terminator sequence is found at the 3’ end of the coding strand, marking the conclusion of RNA synthesis.

Quick Tip

The transcription process requires precise regulation, ensuring that only necessary genes are transcribed. The terminator sequence plays a crucial role in stopping RNA synthesis at the correct point.

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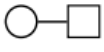
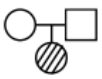
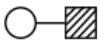
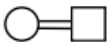
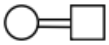
5. Which one of the following options denotes mating between relatives in human pedigree analysis?

(A) 

(B) 

(C) 

(D) 

Correct Answer: (D) 

Solution: Understanding human pedigree analysis.

- In pedigree charts, consanguineous mating (mating between relatives) is represented by a double line connecting the male and female individuals.

Identifying the correct symbol.

- Option (D) correctly depicts a double horizontal line between individuals, indicating consanguineous marriage. This is a standard convention in human pedigree charts.

Thus, the correct answer is (D), as it correctly denotes mating between relatives in human pedigree analysis.

Quick Tip

In pedigree analysis, consanguineous marriages increase the probability of genetic disorders due to inheritance of recessive alleles. Always look for a double line to identify such cases.

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6. The vector for dengue fever is:

(A) Female *Aedes* mosquito

(B) Female *Anopheles* mosquito

(C) Male *Aedes* mosquito

(D) Female *Culex* mosquito

Correct Answer: (A) Female *Aedes* mosquito

Solution: Understanding the vector.

- Dengue fever is transmitted primarily by the bite of an infected female *Aedes aegypti* mosquito. This mosquito is most active during the day, particularly in the early morning and late afternoon.

Role of the female mosquito.

- Only female mosquitoes bite humans and other animals to obtain blood, which is essential for egg production. Male mosquitoes, on the other hand, do not feed on blood.

Other diseases transmitted by *Aedes* mosquitoes.

- The same *Aedes* mosquitoes that spread dengue fever are also responsible for transmitting diseases such as Zika virus and chikungunya.

The vector for dengue fever is the female *Aedes* mosquito.

Quick Tip

The *Aedes* mosquito is an important vector for several viral diseases. Prevention strategies include controlling mosquito populations and using personal protection such as mosquito nets and repellents.

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7. Which one of the following pairs is not correctly matched?

(A) *Clostridium butylicum* – Butyric acid

(B) *Trichoderma polysporum* – Cyclosporin A

(C) *Monascus purpureus* – Citric Acid

(D) *Streptococcus* – Streptokinase

Correct Answer: (C) *Monascus purpureus* – Citric Acid

Solution: Analyze the matches.

- *Clostridium butylicum* produces butyric acid, which is used in the production of solvents and in the fermentation industry.

- *Trichoderma polysporum* produces cyclosporin A, a potent immunosuppressive agent used in organ transplant medicine.

- *Monascus purpureus* produces statins, a class of cholesterol-lowering drugs, not citric acid.

- *Streptococcus* produces streptokinase, an enzyme that is used to dissolve blood clots.

Monascus purpureus produces statins, not citric acid.

Quick Tip

Statins produced by *Monascus purpureus* lower blood cholesterol levels by inhibiting the enzyme HMG-CoA reductase, which is involved in cholesterol synthesis.

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8. Which of the following is not required for PCR?

(A) Restriction endonuclease

(B) Taq Polymerase

(C) Primer

(D) DNA segment

Correct Answer: (A) Restriction endonuclease

Solution: Essential components for PCR.

- PCR (Polymerase Chain Reaction) requires three main components: - Taq polymerase, which is used for DNA amplification. - Primers to initiate the DNA synthesis process. - DNA segments to act as templates for amplification.

Role of restriction endonuclease.

- Restriction endonuclease is used in genetic engineering for cutting DNA at specific sites, but it is not needed for PCR.

Restriction endonuclease is not required for PCR.

Quick Tip

PCR amplifies DNA using a heat-stable enzyme, Taq polymerase, and does not require restriction enzymes, making it a simpler and faster method for DNA analysis.

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9. The pyramid of biomass in sea is generally inverted because in sea:

(A) Biomass of fishes exceeds that of phytoplankton.

(B) Number of phytoplanktons is more.

(C) Number of phytoplanktons is less.

(D) Large fishes feed on small fishes.

Correct Answer: (A) Biomass of fishes exceeds that of phytoplankton.

Solution: Explanation of inverted biomass pyramid.

- The pyramid of biomass in most ecosystems has a base of producers (e.g., plants) that support higher trophic levels. However, in marine ecosystems, the biomass of larger consumers, such as fishes, can exceed that of primary producers like phytoplankton. This results in an inverted pyramid.

Rapid turnover of phytoplankton.

- Phytoplankton have a very high rate of reproduction and turnover, meaning their biomass is low despite their large numbers. In contrast, large fish accumulate a substantial amount of biomass.

The biomass of fishes exceeds that of phytoplankton, resulting in an inverted biomass pyramid.

Quick Tip

The inverted biomass pyramid in marine ecosystems reflects the high productivity and rapid turnover of phytoplankton, as well as the relatively longer lifespan and larger biomass of marine animals.

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10. In humans, the secondary oocyte completes meiotic division when:

(A) It gets implanted in the uterine endometrium.

(B) It is released from the matured Graafian follicle.

(C) It is penetrated by the sperm cell.

(D) Acrosomal enzymes break down the zona pellucida.

Correct Answer: (C) It is penetrated by the sperm cell.

Solution: Conditions for meiotic completion.

- The secondary oocyte remains arrested in metaphase II of meiosis. It completes meiosis II only after fertilization, specifically upon penetration by a sperm cell.

Trigger for meiotic division.

- The penetration of the secondary oocyte by the sperm triggers the completion of the second meiotic division, leading to the formation of a mature ovum and a second polar body.
The secondary oocyte completes meiotic division upon penetration by the sperm cell.

Quick Tip

Sperm penetration triggers the final steps of oocyte maturation, which is critical for the formation of a zygote and the initiation of embryonic development.

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11. Match the items in Column I with those in Column II and select the correctly matched option from those given below:

	Column I *Cross*		*Column II* *Phenotypic Ratio*
1.	Mendelian monohybrid	(i)	1 : 2 : 1 (F_2)
2.	Mendelian dihybrid	(ii)	1 : 1
3.	Incomplete dominance	(iii)	3 : 1 (F_2)
4.	Test cross (monohybrid)	(iv)	9 : 3 : 3 : 1 (F_2)

(A) 1–(ii), 2–(iv), 3–(i), 4–(iii)

(B) 1–(iii), 2–(i), 3–(iv), 4–(ii)

(C) 1–(iii), 2–(iv), 3–(i), 4–(ii)

(D) 1–(ii), 2–(i), 3–(iv), 4–(iii)

Correct Answer: (C) 1–(iii), 2–(iv), 3–(i), 4–(ii)

Solution: Analyze the columns.

- Mendelian monohybrid results in a $3 : 1$ ratio in the F_2 generation.
- Mendelian dihybrid results in a $9 : 3 : 3 : 1$ ratio in the F_2 generation.
- Incomplete dominance results in a $1 : 2 : 1$ ratio in the F_2 generation.
- A test cross results in a $1 : 1$ ratio.

The correct matching is (C) 1–(iii), 2–(iv), 3–(i), 4–(ii).

Quick Tip

Understanding Mendelian and non-Mendelian inheritance ratios is essential for analyzing genetic crosses. Different patterns of inheritance can result in distinct phenotypic ratios in offspring.

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12. The functional megaspore of an angiosperm develops into:

(A) Embryo sac

(B) Endosperm

(C) Embryo

(D) Ovule

Correct Answer: (A) Embryo sac

Solution: Definition of functional megaspore.

- The functional megaspore is the surviving megaspore after meiosis in the ovule of the plant. It is a haploid cell that will give rise to the female gametophyte.

Development process.

- The functional megaspore undergoes several rounds of mitotic division, resulting in the formation of the embryo sac, which houses the egg cell and other important structures needed for fertilization.

The functional megaspore develops into the embryo sac.

Quick Tip

The embryo sac in angiosperms is crucial for fertilization, as it contains the egg cell, which combines with the sperm cell to form the zygote and initiate seed development.

For Questions number 13 to 16, two statements are given — one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C), and (D) as given below.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of

the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the 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): Loss of biodiversity can occur due to overexploitation of resources.
Reason (R): Introduction of *Clarias gariepinus* in Indian rivers has led to a decline in native Indian fishes.

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

Solution: Analyze Assertion (A).

- Overexploitation of resources, introduction of invasive species, and habitat destruction are significant causes of biodiversity loss.

Analyze Reason (R).

- *Clarias gariepinus* is an invasive species that outcompetes native fish, leading to their decline and loss of biodiversity in Indian rivers. However, this reason does not fully explain the broader issue of biodiversity loss due to overexploitation.

(B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).

Quick Tip

Invasive species like *Clarias gariepinus* disrupt ecosystems by competing with native species for resources, often leading to significant ecological consequences.

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14. Assertion (A): In genetic engineering, antibiotic genes are used as selectable markers.
Reason (R): Selectable markers help us to identify transformants from non-transformants.

Correct Answer: (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

Solution: Explain selectable markers.

- Selectable markers are genes that confer resistance to antibiotics, allowing researchers to distinguish between successfully transformed cells and non-transformants.

Analyze the Reason (R).

- Selectable markers facilitate the identification of transformants by allowing them to survive under selective conditions where non-transformants will not.

(A) Both (A) and (R) are true and (R) explains (A).

Quick Tip

Selectable markers make the identification of successfully transformed cells easier, simplifying genetic engineering experiments and improving their efficiency.

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15. Assertion (A): Virus-infected cells produce interferons.

Reason (R): Interferons can cause inflammation of virus-infected cells.

Correct Answer: (C) Assertion (A) is true, but Reason (R) is false.

Solution: Explain the function of interferons.

- Interferons are proteins produced by virus-infected cells that help inhibit viral replication and enhance the immune response.

Inflammatory response.

- While interferons may indirectly contribute to inflammation, their primary role is in antiviral defense, not inflammation.

(C) Assertion (A) is true, but (R) is false.

Quick Tip

Interferons are key players in the immune response to viral infections, signaling neighboring cells to prepare defenses against virus replication.

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16. Assertion (A): RNA is unstable and can mutate at a faster rate.

Reason (R): The presence of 2'–OH group in every nucleotide of RNA makes it labile and easily degradable.

Correct Answer: (A) Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of the Assertion (A).

Solution: Unstable nature of RNA.

- RNA is more prone to degradation compared to DNA due to its single-stranded structure and the presence of the 2'–OH group.

Role of 2'–OH group.

- The 2'–OH group makes RNA more susceptible to hydrolysis, contributing to its instability and short lifespan within cells.

(A) Both (A) and (R) are true, and (R) explains (A).

Quick Tip

RNA's instability is a key feature that allows it to carry temporary genetic instructions, while DNA remains the stable repository of genetic information in cells.

SECTION B

17. How is the rate of decomposition affected by the nature of detritus and temperature?

Solution: Nature of detritus.

- Decomposition is influenced by the chemical composition of detritus. Material rich in nitrogen, proteins, and soluble substances decomposes rapidly. Conversely, materials with high amounts of lignin and cellulose decompose at a slower rate, as they are more resistant to microbial breakdown.

Effect of temperature.

- Temperature plays a crucial role in the speed of decomposition. Warmer and more humid conditions enhance the activity of decomposers (bacteria, fungi), speeding up the process. In

contrast, low temperatures, especially in dry environments, slow down microbial activity, thus decelerating decomposition.
Decomposition is faster when detritus contains easily degradable substances and when the temperature is warmer.

Quick Tip

The rate of decomposition is a key process in ecosystems, recycling nutrients from dead organic matter back into the environment, essential for sustaining plant and microbial life.

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18. How is a restriction endonuclease named? Explain with the help of a suitable example.

Solution: Naming convention.
- Restriction endonucleases are named based on their bacterial origin. The naming system follows a specific format: the first letter of the genus, the first two letters of the species, a letter denoting the strain, and a Roman numeral indicating the order of discovery.
- For example, *EcoRI*:
- *E* represents *Escherichia*,
- *co* from *coli*,
- *R* stands for the strain,
- *I* denotes the first enzyme identified from this strain.
Restriction enzymes are named based on the bacterial strain from which they are isolated. An example is *EcoRI*, derived from *Escherichia coli*.

Quick Tip

Restriction enzymes are fundamental tools in molecular biology, enabling precise cutting of DNA sequences at specific locations, essential for genetic manipulation and cloning.

19(a). Name any two copper-releasing intrauterine devices. State two reasons that make them effective contraceptives.

Solution: Examples of copper IUDs.

- Common examples of copper intrauterine devices (IUDs) are CuT and Cu7.

Mechanism of action.

- Copper ions released from the IUD disrupt sperm motility, rendering them incapable of fertilizing an egg. Additionally, copper creates an inflammatory reaction in the uterine lining, making it hostile to both sperm and embryos.

Copper IUDs like CuT and Cu7 are effective because they inhibit sperm motility and create an inhospitable environment for fertilization.

Quick Tip

Copper IUDs are highly effective long-term contraceptive methods, providing continuous protection against pregnancy for up to 10 years, while being hormone-free.

OR

19(b). Name any two outbreeding devices that flowering plants have developed and explain how they help in encouraging cross-pollination.

Solution: Examples of outbreeding devices.

- Two common outbreeding mechanisms in plants are dichogamy and self-incompatibility.
- Dichogamy involves temporal separation of male and female reproductive phases, preventing self-pollination.
- Self-incompatibility refers to genetic mechanisms that prevent self-pollen from fertilizing the ovule.

Role in cross-pollination.

- Both of these devices encourage cross-pollination, which enhances genetic diversity and reduces the risks of inbreeding.

Outbreeding devices like dichogamy and self-incompatibility ensure that plants undergo cross-pollination, increasing genetic diversity.

Quick Tip

Outbreeding mechanisms in plants play a crucial role in maintaining genetic variability and reducing the chances of inbreeding depression, which can impact the health of the plant population.

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20. Although Haemophilia and sickle cell anemia are two blood-related Mendelian disorders, yet, they differ in their pattern of inheritance. State any two differences.

Solution: Analyze the inheritance of Haemophilia.

- Haemophilia is a sex-linked recessive disorder, predominantly affecting males who have only one X chromosome.

Analyze the inheritance of sickle cell anemia.

- Sickle cell anemia is an autosomal recessive disorder, meaning both males and females are equally affected because it is inherited through autosomes, not sex chromosomes.

1. Haemophilia is a sex-linked recessive disorder, while sickle cell anemia is an autosomal recessive disorder.
2. Haemophilia predominantly affects males, whereas sickle cell anemia affects both sexes equally.

Quick Tip

To differentiate between sex-linked and autosomal disorders, consider whether the condition is inherited through sex chromosomes or autosomes, affecting both genders equally in the latter case.

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21. Identify A, B, C, and D in the following table:

Scientific name of the plant	**Drug**	**Effect on the human body/human system**
Papaver somniferum	A	Depressant/slows down body function
Cannabis sativa	Cannabinoids	B
Erythroxylum coca	C	D

Solution: Identify A.

- *Papaver somniferum* is the source of morphine. Thus, A = Morphine.

Identify B and C.

- Cannabinoids act on the nervous system to slow down its activity. Thus, B = Nervous system depressant.

- *Erythroxylum coca* is the source of cocaine. Thus, C = Cocaine.

Identify D.

- Cocaine is a stimulant affecting the central nervous system. Thus, D = Stimulant.

A = Morphine, B = Nervous system depressant, C = Cocaine, D = Stimulant.

Quick Tip

To identify drugs, associate their scientific names with their common effects or uses in medicine or abuse. Understanding their biological actions helps in classification and therapeutic applications.

SECTION C

22. Predation is referred to as a detrimental interaction. Explain any three positive roles, supported by an example each, that a predator plays in an ecosystem.

Solution: Positive roles of predation.

1. Controls prey population: Predators help in controlling the population of prey species, preventing overgrazing or depletion of resources.

Example: Tigers controlling the deer population in forests.

2. Maintains species diversity: By preying on the most dominant species, predators create opportunities for less dominant species to thrive.

Example: Sea otters preying on sea urchins, helping preserve kelp forests.

3. Removes weak and diseased individuals: Predators often target the weak, sick, or injured, ensuring the survival of the fittest.

Example: Lions preying on injured or old antelopes.

Predators regulate prey populations, maintain species diversity, and remove weak individuals, contributing to ecosystem balance.

Quick Tip

Predation is an important ecological process that helps maintain the balance of populations and supports the stability of ecosystems.

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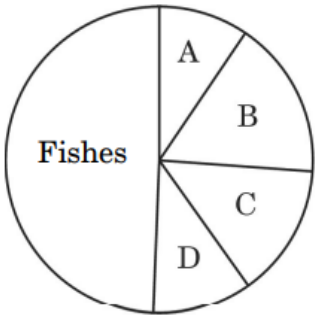
23. Given below is a pie chart representing global diversity of vertebrates.



(a) Redraw the pie chart identifying the groups 'A', 'B', 'C', and 'D' in their respective positions

(b) Mention two examples of recently extinct animals.

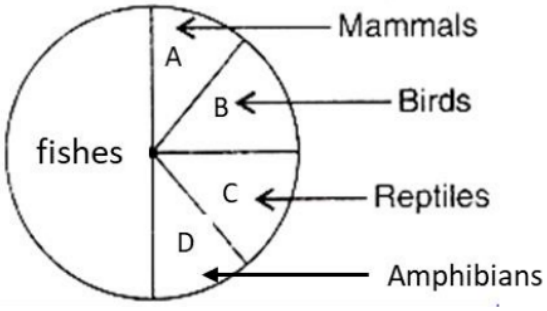
Solution: (a) Identify the groups in the pie chart.

- A = Amphibians, B = Reptiles, C = Birds, D = Mammals. Fish is already labeled.

Examples of recently extinct animals.

- Passenger pigeon (extinct 1914).
- Tasmanian tiger (extinct 1936).

(a) A = Amphibians, B = Reptiles, C = Birds, D = Mammals.



Solution: (b) Examples of recently extinct animals: Passenger pigeon, Tasmanian tiger.

Quick Tip

To analyze biodiversity, always associate each group with its unique traits and representative examples.

24(a). Differentiate between humoral immune response and cell-mediated immune response.

Solution:

	Humoral immune response	Cell-Mediated immune response
(i)	Mediated by B-lymphocytes	Mediated by T- lymphocytes
(ii)	Antibodies are produced by B-lymphocytes in the blood.	T- cells do not secrete antibodies but help B-cells to produce them.
(iii)	This is not responsible for graft rejection.	This is responsible for the graft rejection.

Quick Tip

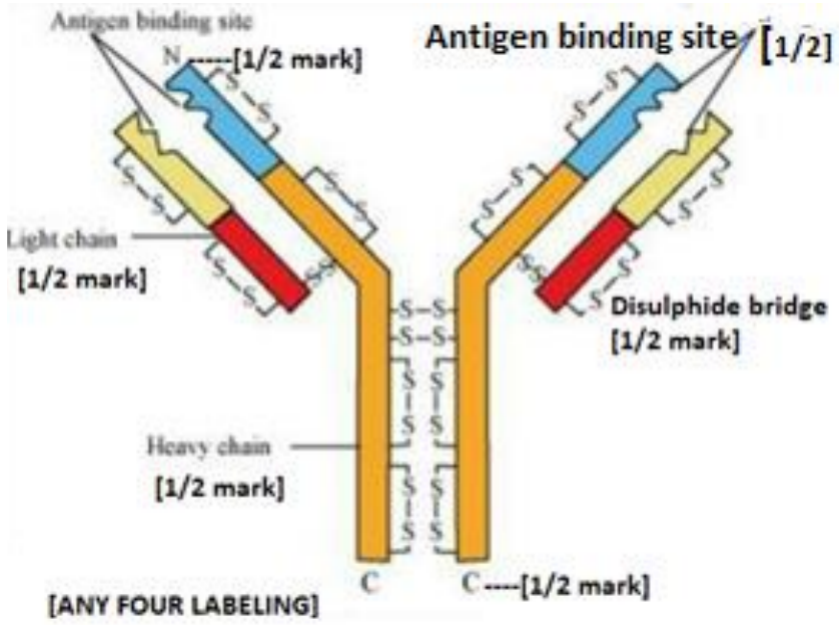
Humoral immunity primarily fights extracellular pathogens, while cell-mediated immunity is more effective against intracellular pathogens like viruses.

24(b). Draw a schematic diagram of an antibody molecule and label any four parts.

Solution: - The antibody molecule consists of two light chains and two heavy chains forming a Y-shaped structure.

- Label: Antigen-binding site, Light chain, Heavy chain, and Disulfide bonds.

The antibody molecule diagram includes its antigen-binding sites, light and heavy chains, and disulfide bonds.



Quick Tip

Antibodies are crucial for immune defense, and their variable regions allow them to recognize a wide range of antigens, contributing to specificity in immune responses.

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25. Explain the mechanism of haplo-diploid pattern of sex determination with the help of a suitable example. Why is this pattern so called?

Solution: Define haplo-diploid pattern.

- In haplo-diploidy, males develop from unfertilized haploid eggs, and females develop from fertilized diploid eggs.

Example.

- Observed in honeybees:
- Haploid males (drones) arise from unfertilized eggs.
- Diploid females (workers and queens) arise from fertilized eggs.

Reason for name.

- Called haplo-diploid because it involves haploid males and diploid females.

In haplo-diploidy, males are haploid, and females are diploid, as seen in honeybees.

Quick Tip

Haplo-diploidy is an efficient mechanism that leads to a division of labor in social insects, such as honeybees, with specialized reproductive and non-reproductive roles.

OR.

T.S. Morgan and his colleagues worked with *Drosophila melanogaster* for their experiments. State the findings they arrived at and explain how.

Solution: Findings of T.S. Morgan's experiments:

- T.S. Morgan and his colleagues studied linkage and recombination in fruit flies (*Drosophila melanogaster*).
- They discovered that certain genes tend to be inherited together because they are located on the same chromosome, leading to the concept of gene linkage.
- Through their experiments, they showed that linked genes can undergo recombination during crossing over in meiosis, which creates genetic diversity.
- They proposed the chromosomal theory of inheritance, reinforcing the idea that genes are arranged linearly on chromosomes and that their relative distance affects recombination frequency.
- Morgan's work provided evidence for sex-linked inheritance, demonstrating that genes on sex chromosomes follow unique inheritance patterns, as seen in his studies on white-eyed mutants in *Drosophila*.

How they arrived at these findings:

- Morgan performed breeding experiments with fruit flies, analyzing traits such as eye color and wing shape across generations.
- He observed deviations from Mendelian ratios when certain traits were inherited together, suggesting that they were linked on the same chromosome.
- By analyzing recombination frequencies, he and his team constructed genetic maps showing gene positions based on crossover rates.
- These findings were crucial in establishing chromosome mapping techniques still used in modern genetics.

Quick Tip

T.S. Morgan's experiments with *Drosophila melanogaster* laid the foundation for modern genetics. His work on linkage, recombination, and chromosome mapping remains fundamental in understanding inheritance patterns.

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26. "Human blood group (ABO group) inheritance is a good example of multiple allelism and co-dominance." Justify the statement.

Solution: Explain multiple allelism.

- The ABO blood group is determined by three alleles: I^A, I^B, and i.

- A person inherits any two of these alleles.

Explain co-dominance.

- I^A and I^B are co-dominant, meaning both are expressed in individuals with the AB blood group.

ABO blood groups exhibit multiple allelism (I^A, I^B, i) and co-dominance (I^A and I^B expressed together in AB blood group).

Quick Tip

In co-dominance, both alleles contribute equally to the phenotype without blending, as seen in the AB blood group, where both I^A and I^B are expressed.

27(a). Why is "in vitro fertilization (IVF)" so named? State its importance.

Solution: Meaning of IVF.

- "In vitro" means "in glass," referring to fertilization occurring outside the body in a laboratory.

Importance.

- IVF helps couples with infertility conceive.

- It allows genetic screening of embryos to prevent genetic disorders.

IVF is named for its laboratory fertilization process and is important for treating infertility

and genetic disorders.

Quick Tip

IVF is a breakthrough in reproductive technology, offering hope for couples facing infertility or genetic disorders, allowing for successful conception.

27(b). Distinguish between GIFT and ZIFT.

Solution:

GIFT	ZIFT
Transfer of an ovum collected from a donor into the fallopian tube of another female who cannot produce one but can provide suitable environment for fertilization.	Transfer of zygote or early embryos (with upto 8 blastomeres) into the fallopian tube.

GIFT involves transferring gametes, while ZIFT involves transferring a fertilized zygote into the fallopian tube.

Quick Tip

GIFT and ZIFT are assisted reproductive techniques that help with infertility, using different stages of fertilization.

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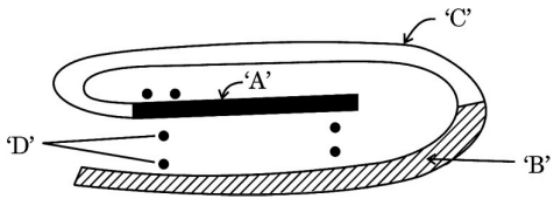
28. The diagram given below is a biomolecule needed for sugar metabolism in human beings.

(a) Name this biomolecule and mention whether it is in active state or inactive

(b)Identify the parts marked as ‘A’, ‘B’, ‘C’ and ‘D’.



Solution: (a) Name the biomolecule.

- The biomolecule is insulin, shown in its active state.

Quick Tip

Insulin plays a crucial role in regulating blood sugar levels, facilitating glucose uptake in cells and maintaining energy homeostasis.

Solution: (b)Identify parts.

- A = Alpha chain, B = Beta chain, C = Disulfide bond, D = Connecting peptide (C-peptide). The biomolecule is insulin in its active state. Parts: A = Alpha chain, B = Beta chain, C = Disulfide bond, D = Connecting peptide.

Quick Tip

The labeled parts represent key regions of the enzyme, such as the active site, sheath, and regulatory components. Identifying these helps in understanding enzyme function.

SECTION D

Questions No. 29 and 30 are case-based questions. Each question has 3 subparts with internal choice in one subpart.

Question 29: Read the following passage and answer the questions that follow.

In 1981, the health workers of United States of America had become aware of the increased frequency of Kaposi's sarcoma, cancer of the skin and blood vessels and another disease pneumocystis pneumonia, a respiratory infection caused by a protozoan. Both these diseases were very rare in the general population, but occurred frequently in more severely "immunosuppressed" individuals. This led to the recognition of the immune system disorder that was named Acquired Immune Deficiency Syndrome (AIDS).

In 1983, virologists working in the USA and France had identified a causative agent for

'AIDS', now known as Human Immunodeficiency Virus (HIV). 'HIV' follows a set path to attack the human body to cause the disease.

(a) Name the group of cells the HIV attacks after gaining entry into the human body and write the various events that occur within this cell.

Solution: Identify the target cells.

- HIV primarily attacks CD4+ T-lymphocytes (helper T cells).

Events occurring within the cell.

1. HIV binds to CD4 receptors on the surface of T cells.
2. Viral RNA enters the cell and is reverse transcribed into DNA.
3. The viral DNA integrates into the host genome.
4. New viral particles are synthesized and released, destroying the T cell.

HIV targets CD4+ T-lymphocytes, integrates its DNA, and destroys the cell to produce new viruses.

Quick Tip

CD4+ T cells play a critical role in immunity; their destruction leads to immune system failure in AIDS.

(b) Write the expanded form of the diagnostic test used for detecting AIDS. Write the possible treatment available for the disease at present.

Solution: Name the diagnostic test.

- Expanded form: Enzyme-Linked Immunosorbent Assay (ELISA).

Current treatment.

- Antiretroviral therapy (ART) is the primary treatment, using drugs like reverse transcriptase inhibitors and protease inhibitors to suppress viral load.

The diagnostic test is ELISA, and treatment involves antiretroviral therapy (ART).

Quick Tip

Early diagnosis through ELISA and adherence to ART can significantly improve the quality of life for AIDS patients.

(c) Mention any two steps suggested by WHO for preventing the spread of this disease.

Solution: Preventive measures.

1. Promoting the use of condoms to prevent transmission through sexual contact.
2. Ensuring safe blood transfusions and use of sterilized needles.

WHO recommends safe sexual practices and sterilized medical procedures to prevent AIDS.

Quick Tip

Prevention strategies like education and awareness are key to reducing HIV spread.

OR

(c) "A patient suffering from AIDS does not die of this disease but from some other infection." Justify the statement.

Solution: Impact of AIDS on immunity.

- AIDS weakens the immune system by destroying CD4+ T-lymphocytes, making the body vulnerable to opportunistic infections.

Cause of death.

- Patients often succumb to secondary infections like tuberculosis, pneumonia, or cancers rather than the virus itself.

AIDS patients die due to secondary infections or complications caused by a compromised immune system.

Quick Tip

Preventing opportunistic infections through regular monitoring can extend the life expectancy of AIDS patients.

Question 30: Read the following passage and answer the questions that follow.

Spermatogenesis is an important primary sex characteristic in humans and all other vertebrates. The process is coordinated and controlled under the influence of hormones. It starts with the onset of puberty in humans and thereafter continues. The primordial cells within the embryonic testis which differentiate into spermatogonia are the precursors of the sperms. These are located at the outer walls of the seminiferous tubules where the process of spermatogenesis proceeds.

(a) State the site of action of FSH in the testes and describe its action thereafter.

Solution: Site of action of FSH.

- Follicle Stimulating Hormone (FSH) acts on Sertoli cells in the seminiferous tubules.

Action of FSH.

- FSH stimulates Sertoli cells to produce androgen-binding proteins, which help in the concentration of testosterone in the seminiferous tubules.
- Sertoli cells also provide nourishment and structural support to developing spermatocytes, facilitating their growth into mature sperm cells.

FSH acts on Sertoli cells, enhancing their function to support spermatogenesis.

Quick Tip

FSH plays a critical role in supporting the development of sperm within the testes by enhancing the function of Sertoli cells.

OR

(a) Describe the role of LH in the process of spermatogenesis.

Solution: Role of LH.

- Luteinizing Hormone (LH) stimulates Leydig cells in the testes.
- Leydig cells are responsible for producing testosterone, which is essential for the process of spermatogenesis by promoting the maturation of sperm.

LH stimulates Leydig cells to secrete testosterone, which regulates spermatogenesis.

Quick Tip

Testosterone produced by Leydig cells is crucial for the progression and maintenance of spermatogenesis.

(b) Name the cells and their products which undergo:

(i) Mitosis and Differentiation

(ii) Meiosis I and Meiosis II during the process of spermatogenesis.

Solution: Cells undergoing mitosis and differentiation.

- Spermatogonia undergo mitosis to form primary spermatocytes.

Cells undergoing meiosis.

- Primary spermatocytes undergo Meiosis I to form secondary spermatocytes.

- Secondary spermatocytes undergo Meiosis II to form spermatids.

Mitosis produces primary spermatocytes, and meiosis produces spermatids.

Quick Tip

The sequence of mitosis and meiosis ensures the production of haploid spermatids from diploid spermatogonia.

(c) Name the accessory ducts that the sperms travel through from seminiferous tubules to reach the epididymis.

Solution: List the accessory ducts.

- Rete testis.

- Vasa efferentia.

Sperms travel through the rete testis and vasa efferentia to reach the epididymis.

Quick Tip

Accessory ducts like the rete testis and vasa efferentia are essential for transporting and maturing sperm from the seminiferous tubules to the epididymis.

SECTION E

31(a)(i) Why should a cell be made competent to take up an alien DNA? How can a bacterial cell be made competent using calcium ions? Explain.

Solution: Need for competence.

- Competent cells can take up foreign DNA during genetic transformation.

Using calcium ions.

- Treat bacterial cells with calcium chloride to make them competent.
- The calcium ions create pores in the bacterial cell wall, allowing the foreign DNA to enter.

Cells must be competent for transformation. Calcium chloride treatment makes bacterial cells porous to DNA.

Quick Tip

Competence is a crucial step in genetic engineering for introducing foreign DNA into cells.

31(a)(ii) (1) State the importance of gel electrophoresis in biotechnology.

Solution: Importance of Gel Electrophoresis in Biotechnology:

- Gel electrophoresis is a crucial technique in biotechnology used for DNA, RNA, and protein analysis.
- It helps in DNA fingerprinting, genetic mapping, and molecular cloning.
- This technique is widely used in forensic science, disease diagnosis, and recombinant DNA technology.
- It allows the separation and purification of biomolecules based on their size and charge, enabling further analysis.

(2) Explain the principle on which this technique works.

Principle of Gel Electrophoresis:

- Gel electrophoresis works on the principle that charged molecules migrate through a gel matrix under the influence of an electric field.
- Negatively charged DNA or RNA molecules move towards the positively charged anode, with smaller molecules moving faster than larger ones.
- The separation occurs due to molecular sieving, where the gel acts as a filter, allowing smaller molecules to pass through more easily.

(3) Mention why ethidium bromide is used in this technique.

Role of Ethidium Bromide in Gel Electrophoresis:
- Ethidium bromide (EtBr) is a fluorescent dye used to stain DNA and RNA in gel electrophoresis.
- It intercalates between the base pairs of nucleic acids, allowing visualization under UV light.
- EtBr makes it easier to detect DNA fragments after separation, aiding in analysis and documentation.

Quick Tip

Gel electrophoresis is a vital technique in molecular biology. Ethidium bromide is commonly used for visualization, but safer alternatives like SYBR Green are also available to reduce toxicity.

OR

(b) Bt cotton , the genetically modified crop, has greatly helped the cotton farmers to increase their crop yield.

(b)(i) How was Bt cotton plant made resistant to bollworm? Explain.

Solution: Introducing Bt gene.
- A gene from *Bacillus thuringiensis* (Bt), which produces Cry proteins toxic to bollworms, is inserted into cotton plants.

Expression of Bt toxin.

- The genetically modified Bt cotton expresses Cry proteins that are activated in the alkaline gut of bollworms, killing them.
Bt cotton expresses Cry proteins toxic to bollworms, preventing infestation.

Quick Tip

Genetic engineering enables crops to produce specific proteins that target pests effectively, reducing the need for chemical pesticides.

(b)(ii) Describe the mechanism that leads to the death of bollworms feeding on Bt cotton plants.

Solution: Ingestion of Bt toxin.
- Bollworms ingest Cry proteins from Bt cotton.
Activation of toxin.
- In the alkaline gut of the bollworm, Cry proteins are activated and bind to specific receptors.
Disruption of gut lining.
- The activated toxins create pores in the gut lining, causing leakage, leading to starvation and death.
Bt toxins disrupt the gut lining of bollworms, leading to their death.

Quick Tip

Bt crops provide targeted pest control by using proteins to kill pests without harming beneficial organisms.

32(a)(i) Explain the process of double fertilization in an angiosperm starting from the germination of pollen grains on the stigma, mentioning the ploidy of the end products formed at the end. State the role of synergids during the course of the process.

Solution: Germination of pollen grains.
- Pollen grains germinate on the stigma, forming a pollen tube carrying two male gametes.

Entry into ovule.

- The pollen tube enters the ovule through the micropyle and discharges the male gametes.

Double fertilization.

- One male gamete fuses with the egg cell, forming a diploid zygote.
- The second male gamete fuses with the two polar nuclei, forming a triploid primary endosperm nucleus.

Step 4: Role of synergids.

- Synergids guide the pollen tube to the egg cell and help in the process of fertilization.

Double fertilization results in a diploid zygote and triploid endosperm, facilitated by synergids.

Quick Tip

Double fertilization is a unique process in angiosperms that ensures the formation of both an embryo and a nutritive tissue for seed development.

(a)(ii) Why does the development of endosperm precede that of the embryo?

Solution: Function of endosperm.

- Endosperm provides nutrients to the developing embryo.

Sequence of development.

- The embryo develops only after the endosperm is formed, ensuring a steady nutrient supply.

Endosperm formation precedes embryo development to provide essential nutrients.

Quick Tip

Endosperm ensures the embryo receives necessary nutrients during seed development.

OR

(b)(i) Mention the site where fertilization of the ovum occurs in a human female. Explain the process of fertilization and mention how polyspermy is prevented.

Solution: Site of fertilization.

- Fertilization occurs in the ampullary region of the fallopian tube.

Process of fertilization.

- Sperm penetrates the ovum's protective layers, leading to the fusion of male and female nuclei.

Prevention of polyspermy.

- The cortical reaction alters the zona pellucida, preventing additional sperm from entering the ovum.

Fertilization occurs in the fallopian tube, and polyspermy is prevented by the cortical reaction.

Quick Tip

Polyspermy prevention is crucial for ensuring the correct number of chromosomes in the zygote.

(b)(ii) Name the embryonic stage that gets implanted in the uterus. Explain the process of implantation in a human female.

Solution: Embryonic stage.

- The blastocyst stage implants in the uterine wall.

Process of implantation.

- The blastocyst adheres to the endometrium.
- Trophoblast cells invade the uterine lining, anchoring the embryo.

The blastocyst implants in the uterus through adhesion and invasion of the endometrium.

Quick Tip

Implantation is a critical step in early pregnancy, as it establishes a connection between the embryo and maternal blood supply.

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33. (a) (i) State Mendel's law of independent assortment.

Solution: Mendel's Law of Independent Assortment:

- According to this law, the inheritance of one trait is independent of the inheritance of another trait, provided the genes for these traits are located on different chromosomes.
- This means that during gamete formation, the alleles of different genes assort independently, resulting in genetic variation.

(ii) Explain this law by taking the example of a cross between two heterozygous parents of pea plants with respect to flower colour and flower position using Punnett Square.

Dihybrid Cross in Pea Plants:
- Consider a cross between two pea plants heterozygous for flower colour (P = purple, p = white) and flower position (A = axial, a = terminal).
- The genotype of both parents is PpAa.
- A Punnett Square for this dihybrid cross shows a 9:3:3:1 phenotypic ratio, confirming independent assortment.

	PA	Pa	pA	pa
PA	$PPAa$	$PPAa$	$PpAA$	$PpAa$
Pa	$PPAa$	$PPaa$	$PpAa$	$Ppaa$
pA	$PpAA$	$PpAa$	$ppAA$	$ppAa$
pa	$PpAa$	$Ppaa$	$ppAa$	$ppaa$

Phenotypic Ratio: - 9 Purple-Axial - 3 Purple-Terminal - 3 White-Axial - 1 White-Terminal
This confirms independent assortment, as the inheritance of flower colour does not affect the inheritance of flower position.

Quick Tip

Mendel's law of independent assortment explains how genetic traits are inherited independently. This law holds true for genes on different chromosomes but may not apply when genes are linked on the same chromosome.

OR

(b) Explain Griffith's experiment conducted in search of genetic material and write the conclusion he arrived at. How did Avery, MacLeod and McCarty establish the biochemical nature of the "Genetic Material" identified by Griffith?

Griffith's Experiment:

- Frederick Griffith, in 1928, conducted experiments on Streptococcus pneumoniae bacteria to study genetic material.
- He worked with two bacterial strains: - S (Smooth) strain – Virulent, caused pneumonia. - R (Rough) strain – Non-virulent, harmless.
- His experiment involved: - Injecting live S strain into mice $\rightarrow$ Mice died. - Injecting live R strain into mice $\rightarrow$ Mice lived. - Injecting heat-killed S strain into mice $\rightarrow$ Mice lived. - Injecting a mixture of heat-killed S strain + live R strain $\rightarrow$ Mice died.
- This suggested that the R strain transformed into the virulent S strain, leading to the concept of Transformation Principle.

Avery, MacLeod, and McCarty's Contribution:

- In 1944, Avery, MacLeod, and McCarty identified DNA as the genetic material.
- They treated the heat-killed S strain extract with enzymes that degrade proteins, RNA, and DNA.
- Transformation occurred when proteins and RNA were destroyed but did not occur when DNA was destroyed.
- This confirmed that DNA is the genetic material, carrying hereditary information.

Quick Tip

Mendel's law of independent assortment explains genetic variation, while Griffith's and Avery's experiments established DNA as the hereditary material, laying the foundation for molecular genetics.
