

## CBSE 12 Biology 2024 Set 3 (57/2/3) 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. The pyramid of biomass in the sea is generally inverted because in the 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:** In marine ecosystems, the biomass pyramid may appear inverted because large fish, though fewer in number, have a greater overall biomass than the abundant yet small phytoplankton. Phytoplankton reproduce quickly but have a low individual biomass, whereas fish are much larger, leading to a higher total biomass. This difference in size and biomass results in the pyramid being inverted.

### Quick Tip

The inversion of the biomass pyramid in marine ecosystems occurs because fish, with their larger size and greater biomass, outweigh the smaller but more numerous phytoplankton.

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**2. Which one of the following is not used as a vector for rDNA technology?**

- (A) Plasmid
- (B) Bacterial cell
- (C) Bacteriophage
- (D) Retrovirus

**Correct Answer:** (B) Bacterial cell.

**Solution:** In recombinant DNA (rDNA) technology, vectors are DNA molecules used to introduce foreign genetic material into a host cell. Common types of vectors include:

Plasmids

Bacteriophages

## Retroviruses

A bacterial cell is not considered a vector; rather, it serves as a host for the replication and expression of the inserted genetic material.

| Quick Tip                                                                                                 |
|-----------------------------------------------------------------------------------------------------------|
| Vectors are used to transfer genetic material into host organisms, but they are not the hosts themselves. |

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### 3. 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:**

**Clostridium butylicum** produces butyric acid.

**Trichoderma polysporum** produces Cyclosporin A, an immunosuppressive drug.

**Streptococcus** produces Streptokinase, which is used to dissolve blood clots.

However, **Monascus purpureus** does not produce citric acid; instead, it produces statins, such as lovastatin.

The pair involving **Monascus purpureus** is incorrectly matched.

| Quick Tip                                                                                 |
|-------------------------------------------------------------------------------------------|
| Always double-check the industrial products of microorganisms to ensure correct pairings. |

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### 4. Allergic reactions are countered by the administration of:

- (A) Glucagon
- (B) Insulin

(C) Antihistamine

(D) Oxytocin

**Correct Answer:** (C) Antihistamine.

**Solution:** Allergic reactions are triggered by the release of histamines, which lead to inflammation, itching, and other symptoms. Antihistamines work by blocking the action of histamines, offering relief from allergic reactions.

Antihistamines are used to alleviate allergy symptoms.

**Quick Tip**

Histamines cause allergy symptoms, while antihistamines effectively suppress these reactions.

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

| Cross                     | 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-(iv), 3-(ii), 4-(i)

(C) 1-(iii), 2-(iv), 3-(i), 4-(ii)

(D) 1-(ii), 2-(iii), 3-(iv), 4-(i)

**Correct Answer:** (C) 1-(iii), 2-(iv), 3-(i), 4-(ii).

**Solution: Matching Column I with Column II:** A Mendelian monohybrid cross produces a 3:1 ratio in the  $F_2$  generation, which corresponds to (iii).

A Mendelian dihybrid cross follows the 9:3:3:1 ratio in the  $F_2$  generation, matching (iv).

Incomplete dominance results in a 1:2:1 ratio in the F<sub>2</sub> generation, which matches (i).

A test cross (monohybrid) results in a 1:1 ratio, which corresponds to (ii).

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

#### Quick Tip

Mendelian inheritance follows specific and predictable phenotypic ratios:

A monohybrid cross gives a 3:1 ratio, while a dihybrid cross produces 9:3:3:1.

Incomplete dominance results in a 1:2:1 ratio, and a test cross yields a 1:1 ratio.

**6. The expected phenotypic ratio amongst the progeny of 60 individuals, obtained from a cross between heterozygous tall pea plant and dwarf pea plant is:**

(A) 45 tall and 15 dwarf

(B) 40 tall and 20 dwarf

(C) 30 tall and 30 dwarf

(D) 35 tall and 25 dwarf

**Correct Answer:** (C) 30 tall and 30 dwarf.

**Solution:** When a heterozygous tall pea plant ( $Tt$ ) is crossed with a dwarf pea plant ( $tt$ ), the genotypic ratio of the offspring is:

$$Tt : tt = 1 : 1.$$

This means half of the progeny will inherit the dominant tall allele (T) and be tall, while the other half will inherit the recessive dwarf allele (t) and be dwarf. For a total of 60 progeny, we calculate:

$$\text{Tall individuals} = \frac{1}{2} \times 60 = 30 \quad \text{and} \quad \text{Dwarf individuals} = \frac{1}{2} \times 60 = 30.$$

Thus, the phenotypic ratio is 30 tall and 30 dwarf. This result aligns with a 1:1 ratio.

#### Quick Tip

In crosses involving a heterozygous and a homozygous recessive plant, the offspring usually exhibit a 1:1 phenotypic ratio, reflecting the segregation of alleles.

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**7. 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:** The secondary oocyte is arrested at metaphase II during ovulation and completes meiosis II only upon fertilization. When the sperm enters the oocyte, it initiates the final meiotic division, resulting in the formation of a mature ovum and the second polar body. Meiosis in the secondary oocyte is completed when the sperm cell penetrates the oocyte.

| Quick Tip                                                                                                                             |
|---------------------------------------------------------------------------------------------------------------------------------------|
| Meiosis II in oocytes is finalized only after fertilization, triggered by the sperm's entry, ensuring the production of a viable egg. |

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**8. 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:** According to the Hardy-Weinberg principle, genotype frequencies in a population can be calculated using the equation:

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

where  $p$  represents the frequency of allele 'A' and  $q$  represents the frequency of allele 'a'. Given that  $p = 0.6$ , we can calculate  $q$  as follows:

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

The frequency of the heterozygous genotype  $Aa$  is calculated as  $2pq$ , which gives:

$$2pq = 2 \times 0.6 \times 0.4 = 0.48.$$

#### Quick Tip

The Hardy-Weinberg principle enables the calculation of allele and genotype frequencies under the assumption that no evolutionary factors are influencing the population.

### 9. Which one of the following statements is not true?

- (A) Flippers of whales and dolphins are homologous organs.
- (B) Homologous organs have similar anatomical structure, but perform different functions.
- (C) Homology indicates common ancestry.
- (D) Homologous structures are a result of convergent evolution.

**Correct Answer:** (D) Homologous structures are a result of convergent evolution.

**Solution:** Homologous structures, such as the flippers of whales and dolphins, have comparable anatomical features because they originate from a common ancestor. Although these structures may serve different purposes, they share a similar underlying structure. In contrast, convergent evolution leads to analogous structures, which perform similar functions but have different evolutionary origins.

Homologous structures do not arise from convergent evolution.

#### Quick Tip

Homologous structures come from common ancestry, while analogous structures evolve independently in unrelated species that develop similar traits.

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**10. In the absence of fertilization, corpus luteum:**

- (A) degenerates
- (B) produces more oestrogen
- (C) produces more progesterone
- (D) produces both oestrogen and progesterone in equal amount

**Correct Answer:** (A) degenerates.

**Solution:** If fertilization does not take place, the corpus luteum in the ovary breaks down into a corpus albicans and ceases to produce progesterone. The absence of progesterone causes the uterine lining to shed, initiating menstruation.

In the absence of fertilization, the corpus luteum degenerates.

|                                                                                                                                                           |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|
| Quick Tip                                                                                                                                                 |
| The corpus luteum plays a vital role in maintaining pregnancy, but if fertilization does not occur, it degenerates, leading to the start of menstruation. |

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**11. 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:** The two strands of DNA are oriented in opposite directions, known as anti-parallel (one runs from 5' to 3', and the other from 3' to 5'). They are complementary because the nitrogenous bases pair specifically: adenine with thymine and guanine with cytosine. DNA strands are both anti-parallel and complementary.

**Quick Tip**

The anti-parallel structure of DNA ensures proper base pairing, which is crucial for maintaining the stability of the double helix.

**12. 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:** The terminator sequence in a transcription unit signals the end of transcription. It is located at the 3’ end of the template strand. Once RNA polymerase reaches the terminator, it halts transcription and releases the RNA strand.

The terminator is located at the 3’ end of the coding strand.

**Quick Tip**

The terminator in a transcription unit is crucial for halting RNA synthesis, ensuring proper transcription termination.

**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): Virus-infected cells produce interferons.**

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

(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.

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

**Solution:** When cells are infected by a virus, they produce interferons as part of the immune response to limit viral spread. Interferons prompt neighboring cells to produce antiviral proteins, which in turn inhibit viral replication. However, interferons do not directly cause inflammation. Therefore, while Assertion (A) is correct, Reason (R) is incorrect.

Assertion (A) is correct, but Reason (R) is incorrect.

| Quick Tip                                                                                                                                                        |
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| Interferons are signaling proteins released in response to viral infections, and they play a key role in preventing viruses from spreading to surrounding cells. |

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**14. 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.**

(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.

**Correct Answer:** (B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the

correct explanation of Assertion (A).

**Solution:** Overexploitation of natural resources such as excessive hunting, fishing, and deforestation leads to biodiversity loss, which is consistent with Assertion (A). However, the introduction of the non-native species **Clarias gariepinus** causing a decline in native fish species is an example of habitat alteration, not overexploitation. Thus, while both Assertion (A) and Reason (R) are true, Reason (R) does not explain Assertion (A).

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

| Quick Tip                                                                                                                                      |
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| Biodiversity loss can result from multiple factors, including overexploitation, habitat destruction, and the introduction of invasive species. |

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**15. 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.**

(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.

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

**Solution:** RNA is less stable than DNA due to the presence of a 2' – OH group on the ribose sugar. This group makes RNA more susceptible to hydrolysis and degradation, resulting in a higher mutation rate. The 2' – OH group is the key factor behind RNA's instability, which confirms that Reason (R) correctly explains Assertion (A).

Both Assertion (A) and Reason (R) are true, and Reason (R) provides the correct explanation for Assertion (A).

**Quick Tip**

The 2' – OH group in RNA makes it more chemically reactive and unstable compared to DNA, which lacks this group and is more stable.

**16. Assertion (A): A recombinant DNA inserted within the coding sequence of  $\beta$ -galactosidase does not produce blue-colored colonies when treated with a chromogenic substrate.**

**Reason (R): Insertional inactivation occurs when a recombinant DNA is introduced into the coding sequence of the enzyme.**

(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.

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

**Solution:** In recombinant DNA technology, insertional inactivation occurs when foreign DNA is inserted into the coding region of a gene, such as  $\beta$ -galactosidase. This insertion disrupts the enzyme's activity, causing the colonies to fail to turn blue when exposed to a chromogenic substrate like X-gal. The reason is that the  $\beta$ -galactosidase enzyme, which typically breaks down X-gal to produce a blue color, becomes non-functional due to the insertion.

Both Assertion (A) and Reason (R) are true, and Reason (R) correctly explains Assertion (A).

|                                                                                                            |
|------------------------------------------------------------------------------------------------------------|
| Quick Tip                                                                                                  |
| Insertional inactivation is an important method in molecular biology for identifying recombinant colonies. |

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|------------------------------------------------------------------------------------------------------------|
| Insertional inactivation is an important method in molecular biology for identifying recombinant colonies. |
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## Section - B

**17. 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:**

**Understanding the Inheritance of Haemophilia.**

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

**Understanding the Inheritance of Sickle Cell Anemia.**

Sickle cell anemia is an autosomal recessive disorder, meaning it equally affects both males and females, as it is inherited through autosomes, not sex chromosomes.

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

|                                                                                                                   |
|-------------------------------------------------------------------------------------------------------------------|
| Quick Tip                                                                                                         |
| X-linked disorders are more common in males, whereas autosomal recessive disorders require two defective alleles. |

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|-------------------------------------------------------------------------------------------------------------------|
| X-linked disorders are more common in males, whereas autosomal recessive disorders require two defective alleles. |
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**18. Identify A, B, C, and D in the following table:**

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

**Correct Answer:** 1. A = Morphine 2. B = Affects cardiovascular system 3. C = Cocaine 4. D = Stimulates central nervous system (CNS)

**Solution:** 1. **Papaver somniferum** produces morphine, which functions as a depressant by slowing down the central nervous system (CNS). 2. Cannabinoids from **Cannabis sativa** impact the cardiovascular system by modifying heart rate and blood pressure. 3. **Erythroxylum coca** produces cocaine, a stimulant that enhances CNS activity, boosting alertness and energy.

#### Quick Tip

Drugs derived from natural sources affect specific bodily systems according to their chemical properties.

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

**Solution:**

#### 1. Nature of Detritus:

Detritus that is rich in nutrients (such as sugars and proteins) decomposes more quickly. Detritus containing complex compounds like lignin and cellulose decomposes more slowly.

#### 2. Temperature:

Warmer and more humid conditions speed up decomposition due to increased microbial activity.

Low temperatures or dry conditions slow down the process of decomposition.

The rate of decomposition is influenced by both the composition of detritus and the surrounding temperature.

|                                                                                             |
|---------------------------------------------------------------------------------------------|
| Quick Tip                                                                                   |
| Decomposition is most efficient under warm temperatures and when detritus is nutrient-rich. |

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|---------------------------------------------------------------------------------------------|
| Decomposition is most efficient under warm temperatures and when detritus is nutrient-rich. |
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**20(a). Name any two copper-releasing intra-uterine devices. State two reasons that make them effective contraceptives.**

**Correct Answer:** Copper-releasing IUDs:

1. Cu-T
2. Cu-7

**Solution:**

**Reasons for Effectiveness:**

1. Copper ions released by these devices inhibit sperm motility and their ability to fertilize the egg.
2. The copper ions also create an inflammatory response in the uterus, making the environment unsuitable for implantation of a fertilized egg.

|                                                                                    |
|------------------------------------------------------------------------------------|
| Quick Tip                                                                          |
| Copper IUDs are long-lasting, reversible contraceptive methods with high efficacy. |

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|------------------------------------------------------------------------------------|
| Copper IUDs are long-lasting, reversible contraceptive methods with high efficacy. |
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**20(b). Name any two outbreeding devices that flowering plants have developed and explain how they help in encouraging cross-pollination.**

**Solution:**

1. Self-Incompatibility: Prevents self-pollination by rejecting pollen from the same plant. This mechanism ensures that pollen grains from the same flower or plant cannot fertilize its own ovules, thereby encouraging cross-pollination.
2. Dichogamy: Involves the maturation of anthers and stigma at different times to avoid self-pollination.

By ensuring that the stigma and anthers are functional at separate times, cross-pollination is promoted.

|                                                                                         |
|-----------------------------------------------------------------------------------------|
| Quick Tip                                                                               |
| Outbreeding mechanisms are crucial for enhancing genetic diversity in flowering plants. |

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|-----------------------------------------------------------------------------------------|
| Outbreeding mechanisms are crucial for enhancing genetic diversity in flowering plants. |
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**21. How is Ti plasmid of *Agrobacterium tumefaciens* modified to act as a cloning vector?**

**Solution:**

1. The Ti plasmid, which causes crown gall disease, is altered by removing its tumor-inducing genes.
2. The modified plasmid is then used to introduce foreign genes for cloning.
3. To assist with gene identification and insertion, selectable marker genes and restriction sites are incorporated.

The Ti plasmid is modified to serve as a cloning vector by eliminating its pathogenic genes and adding essential elements for cloning.

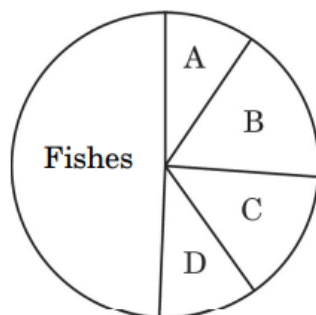
|                                                                                    |
|------------------------------------------------------------------------------------|
| Quick Tip                                                                          |
| Modified Ti plasmids are commonly used in genetic engineering to transform plants. |

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|------------------------------------------------------------------------------------|
| Modified Ti plasmids are commonly used in genetic engineering to transform plants. |
|------------------------------------------------------------------------------------|

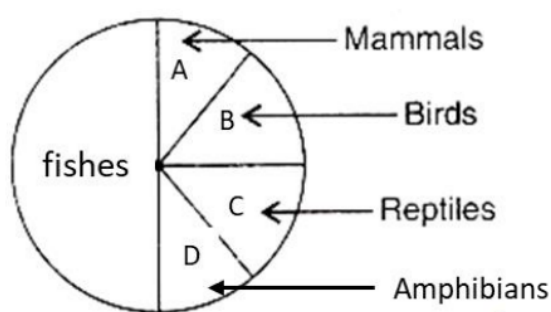
## Section C

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

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



**Solution:**



The largest section of the pie chart should represent fish, with the following sections for amphibians, reptiles, birds, and mammals. This distribution corresponds to the evolutionary history of these animal groups, highlighting their relative abundance and importance in ecological systems.

### Quick Tip

Pie charts in biology often represent the relative abundance of species in an ecosystem. Understanding their distribution can help analyze evolutionary patterns and biodiversity trends over time.

**22(b). Mention two examples of recently extinct animals.**

**Correct Answer:** 1. Passenger pigeon 2. Tasmanian tiger

**Solution:**

1. Passenger Pigeon:

The passenger pigeon (*Ectopistes migratorius*) was once one of the most numerous bird species in North America. However, it went extinct in 1914 due to overhunting and habitat destruction. The pigeons were heavily hunted for food, and their natural habitats were destroyed as forests were cleared for agriculture and urban development. Despite their vast numbers, they were unable to recover from the combined pressure of hunting and habitat loss.

2. Tasmanian Tiger:

The Tasmanian tiger (*Thylacinus cynocephalus*), also known as the thylacine, was native to Tasmania, Australia, and New Guinea. The species went extinct in 1936, with hunting, habitat destruction, and the introduction of non-native species, such as dogs, playing major roles. The Tasmanian government offered bounties for the thylacines, leading to extensive hunting, and the species' decline was further exacerbated by the encroachment of agriculture and human settlement into its natural habitat.

Both species, the passenger pigeon and the Tasmanian tiger, were driven to extinction primarily due to human activities such as habitat destruction, overhunting, and the disruption of their ecosystems.

**Quick Tip**

Human activities, including habitat destruction and hunting, have been the primary causes of the extinction of many species. Conservation efforts are crucial to prevent further loss of biodiversity.

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**23. 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:**

### **1. Population Control:**

Predators play a crucial role in controlling the population of prey species, preventing overpopulation.

Example: Wolves hunting deer in forests regulate the deer population, preventing overgrazing and ensuring the health of the ecosystem.

### **2. Maintaining Species Diversity:**

Predation promotes biodiversity by preventing one prey species from dominating, ensuring a diverse range of species in the ecosystem.

Example: Starfish preying on mussels helps maintain the diversity of other species in tidal pools.

### **3. Promoting Natural Selection:**

Predators remove the weaker individuals from prey populations, promoting natural selection by favoring stronger, healthier individuals.

Example: Lions targeting weaker zebras in the wild ensures that only the fittest survive and pass on their genes.

Predators play essential roles in regulating populations, maintaining biodiversity, and supporting the survival of the fittest within ecosystems.

#### **Quick Tip**

Predation, although it may seem harmful, is an essential ecological process that ensures the health and balance of ecosystems.

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**24. The first clinical gene therapy was given in 1990 to a 4-year-old girl with ADA deficiency.**

**(a) Mention the cause of this disorder.**

**(b) List the possible treatments available for this disorder.**

**(c) How can this disorder be cured permanently?**

**Solution:**

(a) ADA deficiency is caused by a mutation in the gene responsible for producing the enzyme adenosine deaminase. This enzyme is crucial for the immune system to function

effectively. Without it, the immune system is severely compromised.

(b) 1. Bone marrow transplantation, which can provide a source of functional ADA-producing cells. 2. Enzyme replacement therapy with the purified ADA enzyme to restore immune function.

(c) The disorder can be cured permanently through gene therapy. A functional copy of the defective gene is inserted into the patient's lymphocytes, and these modified cells are reintroduced into the body, thereby restoring normal immune function.

| Quick Tip                                                                                                            |
|----------------------------------------------------------------------------------------------------------------------|
| Gene therapy is a groundbreaking approach for treating genetic disorders by addressing the underlying genetic cause. |

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**25. Describe any three assisted reproductive techniques practised to treat infertility.**

**Solution:**

**1. In Vitro Fertilization (IVF):**

In this process, eggs are retrieved from the female and fertilized with sperm in a laboratory setting. Once fertilization occurs, the resulting embryo is implanted into the uterus for further development.

**2. Zygote Intrafallopian Transfer (ZIFT):**

A fertilized egg (zygote) is transferred directly into the fallopian tube, where it can continue to develop naturally.

**3. Intracytoplasmic Sperm Injection (ICSI):**

A single sperm cell is directly injected into an egg to aid fertilization, particularly beneficial for cases of male infertility.

These assisted reproductive technologies provide solutions to infertility by aiding in fertilization and implantation.

**Quick Tip**

Assisted reproductive technologies have greatly increased the likelihood of conception for couples dealing with infertility issues.

**26. (a) (i) Write the karyotype and the genetic disorder of an individual who has developed from a zygote formed from an 'XX' egg fertilized by a 'Y' sperm.**

**Solution: Karyotype:**

The karyotype of this individual will be **XY**, as the X chromosome is provided by the egg and the Y chromosome comes from the sperm.

**Genetic Disorder:**

The individual may have **Klinefelter syndrome**, a condition characterized by the presence of an additional X chromosome (XXY), which can result in male infertility along with other physical and developmental characteristics.

**Quick Tip**

Klinefelter syndrome occurs when a male has an extra X chromosome. The usual karyotype in this case is XXY, rather than XY.

**26. (a) (ii) Mention any two symptoms of this genetic disorder.**

**Solution:** Two common symptoms of Klinefelter syndrome are:

1. Infertility: Resulting from underdeveloped testes and decreased sperm production.
2. Increased height and long limbs: Individuals with this condition are often taller than average, with longer arms and legs.

**Quick Tip**

Klinefelter syndrome causes infertility and characteristic physical traits, such as increased height and longer limbs, due to the presence of an extra X chromosome.

**26. (a) (iii) Write the possible reason that leads to the formation of this 'XX' egg.**

**Solution:** The creation of an XX egg can happen due to a mistake in meiosis, particularly during oogenesis. This mistake, referred to as non-disjunction, results in an egg containing two X chromosomes instead of one.

**Quick Tip**

Non-disjunction during meiosis can cause gametes to have an incorrect number of chromosomes, which may lead to genetic disorders such as Klinefelter syndrome.

---

**OR**

**26. (b) In case of any dispute, a very small sample of tissue or even a drop of blood can help us to determine the paternity of a child. Provide a scientific explanation to substantiate the statement.**

**Solution:** The DNA in a small sample of tissue or blood contains unique genetic markers (alleles) inherited from both parents. By comparing the DNA of the child with the DNA of the alleged father, we can identify matching markers that confirm or rule out paternity. This process is called DNA fingerprinting.

**Quick Tip**

DNA fingerprinting is a powerful tool for paternity testing, as it compares genetic markers to establish biological relationships.

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**27(a). List the salient features of Darwin's theory of natural selection.**

**Solution:**

1. Overproduction: Organisms produce more offspring than can survive.
2. Struggle for existence: Limited resources lead to competition among organisms.
3. Variation: Individuals exhibit variations in traits that can affect survival.
4. Survival of the fittest: Individuals with advantageous traits are more likely to survive and reproduce.
5. Descent with modification: Over generations, favorable traits accumulate in the population.

**Quick Tip**

Darwin's theory forms the foundation of evolutionary biology, explaining how species adapt and evolve through natural selection.

---

**27(b). Microbes have proved to be suitable examples to study evolution by natural selection. Justify giving reasons.**

**Solution:**

1. Short Generation Time: Microbes reproduce rapidly, allowing for the observation of evolutionary changes over short time scales.
2. Antibiotic Resistance: Bacteria can evolve resistance to antibiotics, showcasing the role of natural selection.
3. Genetic Variation: Microbial populations exhibit genetic variation due to mutations, which drive evolutionary changes.

Microbes are ideal for studying evolution due to their quick reproduction and the ability to observe genetic changes in real time.

**Quick Tip**

Antibiotic resistance in bacteria is a prime example of natural selection in action, showing how organisms evolve to survive environmental pressures.

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

**Solution:** Humoral immune response: This response involves the production of antibodies by B cells to neutralize pathogens and prevent infections. It is primarily mediated by the action of antibodies in bodily fluids.

Cell-mediated immune response: This response is carried out by T cells, particularly cytotoxic T cells, which target and destroy infected cells or cancerous cells. It does not involve antibodies.

### Quick Tip

Humoral immunity is antibody-based and targets pathogens in bodily fluids, while cell-mediated immunity involves T cells attacking infected or cancerous cells directly.

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

### Solution:

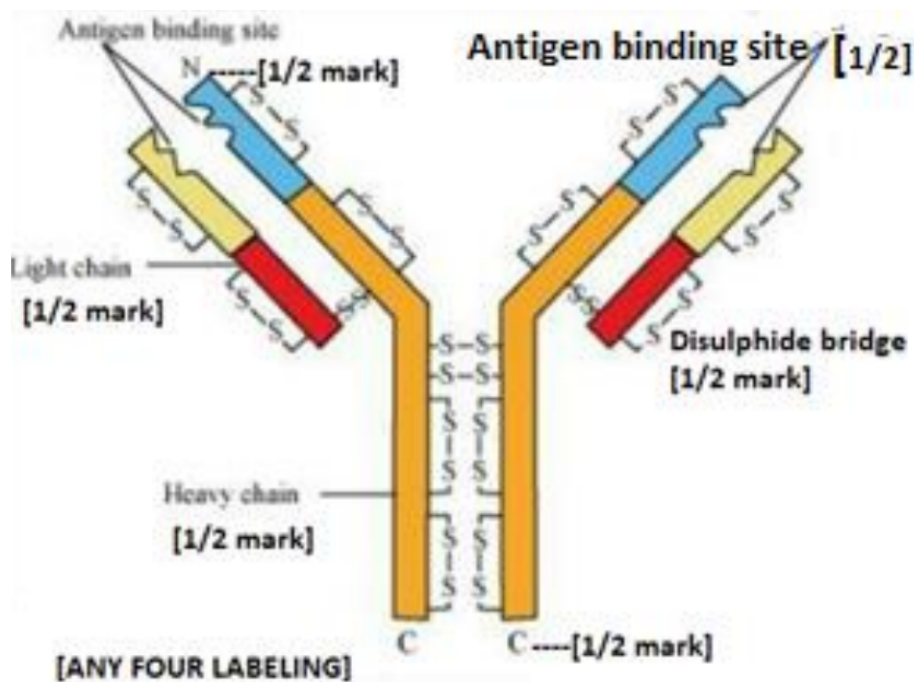
An antibody molecule has a "Y" shaped structure with two heavy chains and two light chains.

Variable region: Located at the tips of the Y, it binds to the antigen.

Constant region: The stem of the Y, which determines the class of antibody (IgG, IgM, etc.).

Hinge region: Located between the arms of the Y, allows flexibility.

Disulfide bonds: Hold the heavy and light chains together.



### Quick Tip

Antibodies are essential for identifying and neutralizing foreign antigens, playing a crucial role in the immune response.

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## Section D

**29.**

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. **Read the following passage and answer the questions that follow.**

**In 1981, the health workers of the 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:**

**HIV attacks CD4+ T-helper cells.**

**After entering the host cell:**

- 1. The viral RNA is reverse transcribed into DNA by reverse transcriptase.**
- 2. The viral DNA integrates into the host’s genome.**
- 3. The host cell machinery is used to produce viral proteins and RNA.**
- 4. New viral particles are assembled and released, destroying the host cell.**

**Quick Tip**

**CD4+ T-helper cells are crucial for immunity, and their destruction leads to immunosuppression in AIDS patients.**

---

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

**Solution:**

- 1. Expanded Form of Diagnostic Test: Enzyme-Linked Immunosorbent Assay (ELISA).**
- 2. Treatment: Anti-retroviral therapy (ART), which involves a combination of drugs to inhibit viral replication and manage the infection.**

**Quick Tip**

**Early detection using ELISA and consistent ART can significantly improve the quality of life of AIDS patients.**

---

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

**Solution:**

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

**OR**

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

**Solution: HIV weakens the immune system by destroying CD4+ T-helper cells, leaving the body vulnerable to opportunistic infections and cancers, such as tuberculosis or Kaposi’s sarcoma. These secondary infections are the actual cause of death in AIDS patients.**

**Quick Tip**

**Preventing opportunistic infections through regular health monitoring is vital for 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.**

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

**Solution: Location of FSH Action.**

**Follicle Stimulating Hormone (FSH) targets Sertoli cells within the seminiferous tubules.**

**Action of FSH.**

**FSH stimulates Sertoli cells to produce androgen-binding proteins, which aid in maintaining high concentrations of testosterone in the seminiferous tubules.**

**Additionally, Sertoli cells provide nourishment and structural support to developing spermatocytes, enabling their maturation into sperm cells.**

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

**Quick Tip**

**FSH plays a key role in sperm development within the testes by promoting the function of Sertoli cells.**

**OR**

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

**Solution: Function of LH.**

**Luteinizing Hormone (LH) activates Leydig cells in the testes.**

**Leydig cells are responsible for producing testosterone, which plays a vital role in spermatogenesis by supporting sperm maturation.**

**LH stimulates Leydig cells to produce testosterone, which regulates the process of spermatogenesis.**

| Quick Tip                                                                                                         |
|-------------------------------------------------------------------------------------------------------------------|
| Testosterone, produced by Leydig cells, is essential for both the progression and maintenance of spermatogenesis. |

---

**30(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 Involved in Mitosis and Differentiation.**

**Spermatogonia undergo mitosis to produce primary spermatocytes.**

**Cells Involved in Meiosis.**

**Primary spermatocytes undergo Meiosis I, resulting in secondary spermatocytes.**

**Secondary spermatocytes then undergo Meiosis II to produce spermatids.**

**Mitosis generates primary spermatocytes, while meiosis results in the formation of spermatids.**

| Quick Tip                                                                                                   |
|-------------------------------------------------------------------------------------------------------------|
| The process of mitosis and meiosis ensures the generation of haploid spermatids from diploid spermatogonia. |

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

**Solution:**

**Accessory Ducts in the Male Reproductive System:** The male reproductive system has several accessory ducts that facilitate the transportation and maturation of sperm. These ducts play a crucial role in moving sperm from the seminiferous tubules, where sperm is produced, to the epididymis for storage and further maturation. The key accessory ducts are:

**1. Rete Testis:**

The rete testis is a network of tubules located within the testes. It serves as the primary passageway for sperm from the seminiferous tubules to the vasa efferentia. The sperm move from the seminiferous tubules into the rete testis, where they begin their journey to the next duct in the system.

**2. Vasa Efferentia:**

The vasa efferentia are small tubes that connect the rete testis to the epididymis. These ducts transport sperm from the rete testis to the epididymis, where the sperm will mature and gain motility. The vasa efferentia help in the concentration of sperm as they move through the ducts.

**Pathway of Sperm Movement:** Sperm are produced in the seminiferous tubules of the testes. From there, they move into the rete testis, where they pass through a network of tubules.

Next, the sperm enter the vasa efferentia, which leads them to the epididymis.

The epididymis is the site where sperm mature and gain the ability to swim, which is essential for fertilization.

These ducts are essential for the proper functioning of the male reproductive system as they facilitate the movement, concentration, and maturation of sperm.

| Quick Tip                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The accessory ducts, including the rete testis and vasa efferentia, are integral to the transport and maturation of sperm from the seminiferous tubules to the epididymis. Proper functioning of these ducts ensures that sperm are stored and ready for fertilization. |

## Section E

**31. Answer the following questions that are based on “Hershey and Chase” experiment using *E. coli* and bacteriophage:**

**Why did they use radioactive sulphur  $^{35}\text{S}$  and radioactive phosphorus  $^{32}\text{P}$  in their respective culture media for growing *E. coli* population which subsequently were infected by bacteriophage?**

**Solution:**

**Radioactive Sulphur ( $^{35}\text{S}$ ):** Used to label the protein coat of the bacteriophage, as sulphur is a component of proteins (such as methionine and cysteine) but is absent in DNA.

**Radioactive Phosphorus ( $^{32}\text{P}$ ):** Used to label the DNA of the bacteriophage, since phosphorus is a component of the DNA sugar-phosphate backbone and not present in proteins.

| Quick Tip                                                                                                                 |
|---------------------------------------------------------------------------------------------------------------------------|
| The use of radioactive markers allowed the distinction between DNA and protein as the genetic material in bacteriophages. |

---

**31(a)(ii). State the purpose of their using the following:**

**Solution:**

**(1) Blender:** Used to separate the protein coat of the bacteriophage from the bacterial cell after infection. This step was essential to isolate the viral components.

**(2) Centrifuge:** Used to separate the heavier bacterial cells from the lighter viral components, enabling the identification of the components that entered the bacterial cell.

**31(a)(iii). Write the observations they made during the course of their experiment.**

**Solution:**

1. When bacteriophages labeled with  $^{35}\text{S}$  were used, radioactivity was detected in the supernatant, indicating the protein coat stayed outside the bacterial cell.
2. When bacteriophages labeled with  $^{32}\text{P}$  were used, radioactivity was found in the bacterial pellet, indicating that DNA entered the bacterial cell.

31(a)(iv). Based on the results, write the conclusion they arrived at the end of their experiment.

**Solution:** The experiment concluded that DNA is the genetic material responsible for the transmission of genetic information in the bacteriophage. The protein coat did not enter the bacterial cell, reinforcing that DNA carries the genetic instructions.

| Quick Tip                                                                                                                      |
|--------------------------------------------------------------------------------------------------------------------------------|
| The Hershey-Chase experiment was pivotal in proving that DNA is the genetic material, providing clarity in molecular genetics. |

---

**OR**

31(b)(i). Describe the process of transcription in prokaryotes with respect to initiation, elongation, and termination.

**Solution:**

1. **Initiation:** RNA polymerase binds to the promoter region of the DNA, causing the DNA strands to unwind and begin transcription.
2. **Elongation:** RNA polymerase moves along the DNA template strand, synthesizing a complementary RNA strand by adding RNA nucleotides.
3. **Termination:** Transcription stops when RNA polymerase reaches a terminator sequence on the DNA, causing the RNA to be released and the transcription process to cease.

31(b)(ii). Write how many types of RNA polymerases are used in transcription in:

- (1) Prokaryotes:
- 2) Eukaryotes:

**Solution:**

**1. Prokaryotes:**

In prokaryotic cells, there is only one type of RNA polymerase that is responsible for synthesizing all forms of RNA, including mRNA, tRNA, and rRNA.

**2. Eukaryotes:**

Eukaryotic cells use three types of RNA polymerases:

**RNA polymerase I:** Synthesizes rRNA (ribosomal RNA) in the nucleolus.

**RNA polymerase II:** Synthesizes mRNA (messenger RNA) and some snRNA (small nuclear RNA).

**RNA polymerase III:** Synthesizes tRNA (transfer RNA) and other small RNAs.

| Quick Tip                                                                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| In prokaryotes, a single RNA polymerase is sufficient for all transcription, whereas eukaryotes require three distinct RNA polymerases to transcribe different types of RNA. |

---

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

**Solution: Competency:**

A cell must be made competent to allow the uptake of foreign DNA. This is crucial for genetic transformation, which allows processes like cloning, genetic modification, or producing recombinant proteins.

Competent cells can incorporate new genetic material, which is then expressed, contributing to desired traits or characteristics.

**Using Calcium Ions:**

Calcium ions are used to make bacterial cells competent by weakening the cell membrane. The calcium ions help to destabilize the membrane's structure, which increases its permeability. As a result, the membrane becomes more receptive to the foreign DNA, allowing it to enter the cell more easily during the transformation process.

**Quick Tip**

**Making cells competent is a critical step in genetic engineering, enabling them to take up foreign DNA and allowing for modifications in their genetic makeup.**

---

**32(a)(ii). State the importance of gel electrophoresis in biotechnology.**

**Solution:**

**Gel electrophoresis is an essential technique in biotechnology used to separate DNA, RNA, or protein fragments based on their size and charge. The technique allows researchers to analyze genetic material, identify specific genes, determine the size of DNA fragments, and study mutations. It is widely used in molecular biology for tasks like gene mapping, forensic analysis, and checking the purity of DNA samples.**

**Quick Tip**

**Gel electrophoresis is crucial in biotechnology, allowing researchers to separate and analyze biomolecules, aiding in genetic research and diagnostic applications.**

---

**32(a)(iii). Mention why ethidium bromide is used in this technique.**

**Solution: Ethidium bromide is a chemical stain that intercalates (binds) to DNA. Under ultraviolet (UV) light, it fluoresces, allowing scientists to visualize DNA fragments after they have been separated by gel electrophoresis. This makes it easier to detect and analyze the size and pattern of DNA fragments, which is especially useful in confirming the results of PCR (Polymerase Chain Reaction) or other genetic tests.**

**Quick Tip**

**Gel electrophoresis is a key tool in molecular biology, allowing for the separation and analysis of genetic material for various applications in research and diagnostics.**



**OR**

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

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

**Solution:** Bt cotton was genetically modified by introducing the cry gene from *Bacillus thuringiensis*, a bacterium that produces a protein toxic to bollworms, making the cotton plant resistant to these pests.

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

**Solution:** The Cry protein from Bt cotton binds to the epithelial cells of the bollworm's gut, forming pores that disrupt the cell's function, leading to gut paralysis and the death of the insect.

| Quick Tip                                                                                                                    |
|------------------------------------------------------------------------------------------------------------------------------|
| Bt cotton is an example of biotechnology reducing the need for chemical pesticides, promoting sustainable farming practices. |

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**33(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.**

**Solution:**

- 1. The pollen grain germinates on the stigma, forming a pollen tube that carries two male gametes to the ovule.**
- 2. One male gamete fuses with the egg cell (syngamy) to form a diploid zygote (2n).**
- 3. The other male gamete fuses with two polar nuclei (triple fusion) to form a triploid endosperm (3n).**

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

**Solution:** The endosperm provides essential nutrients to the developing embryo, which is why its development occurs first to ensure proper nourishment.

**Quick Tip**

Endosperm development in angiosperms is crucial for supporting embryonic growth by providing nutrients.

---

**OR**

**33(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:** Fertilization occurs in the ampullary-isthmic junction of the fallopian tube.

**Process:**

1. The sperm penetrates the zona pellucida of the ovum.
2. The sperm nucleus fuses with the egg nucleus to form a zygote.

**Prevention of Polyspermy:**

1. Cortical reaction creates a fertilization membrane, preventing additional sperm entry.

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

**Solution:**

**Stage:** Blastocyst.

**Process:** The blastocyst attaches to the uterine wall and embeds into the endometrium, where it establishes a connection for nutrient exchange.

**Quick Tip**

Implantation ensures that the embryo receives the nutrients it needs to develop within the uterus.

