CBSE CLASS 12 2025 Biology Question Paper with Solutions

Time Allowed :3 Hours	**Maximum Marks :**70	**Total Questions :**33

General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 30 questions. All questions are compulsory.
2. The question paper is divided into five sections: Sections A, B, C, D, and E.
3. **Section A:** Questions no. 1 to 17 are Multiple Choice type questions. Each question carries 1 mark.
4. **Section B:** Questions no. 18 and 19 are Source-based questions. Each question carries 3 marks.
5. **Section C:** Questions no. 20 to 23 are Short Answer type questions. Each question carries 3 marks. Answer to these questions shall be written in 80 to 100 words.
6. **Section D:** Questions no. 24 to 28 are Long Answer type questions. Each question carries 5 marks. Answer to these questions shall be written in 120 to 150 words.
7. **Section E:** Questions no. 29 and 30 are Map-based questions. Each question carries 5 marks.
8. In addition to this, NOTE that a separate question has been provided for Visually Impaired candidates in lieu of questions having visual inputs, map etc. Such questions are to be attempted by Visually Impaired candidates only.
9. There is no overall choice given in the question paper. However, an internal choice has been provided in a few questions in all sections other than Section A.

Section-A

1. Some flowers are unisexual, this property of unisexuality of flowers prevents which kind of pollination?

(A) Both Autogamy and Geitonogamy

(B) Both Geitonogamy and Xenogamy

(C) Geitonogamy but not Xenogamy

(D) Autogamy but not Geitonogamy

Correct Answer: (C) Geitonogamy but not Xenogamy

Solution:

Step 1: Understanding the terms involved in the question:

- **Autogamy** refers to self-pollination where the pollen from the same flower or the same plant fertilizes the ovule.
- **Geitonogamy** refers to pollination between flowers of the same plant, but different individuals.
- **Xenogamy** refers to cross-pollination, where the pollen from one plant fertilizes the ovule of a different plant.

Step 2: Analyzing the impact of unisexuality:

- In unisexual flowers, the male and female reproductive organs are separated, so the pollen from a male flower cannot directly pollinate the female flower of the same plant.
- As a result, **Autogamy** is not possible, since self-pollination is blocked by the separation of sexes.
- **Geitonogamy** is also prevented, as it requires pollen to be transferred between different flowers of the same plant.
- However, **Xenogamy**, which involves pollen transfer between different plants, is still possible because it doesn't depend on the same plant's male and female flowers.

Step 3: Conclusion:

The property of unisexuality of flowers prevents **Geitonogamy**, but does not prevent **Xenogamy**. Hence, the correct answer is option (C).

Quick Tip

In unisexual flowers, since the male and female organs are on separate plants or flowers, autogamy and geitonogamy are not possible, but xenogamy (cross-pollination) is still possible.

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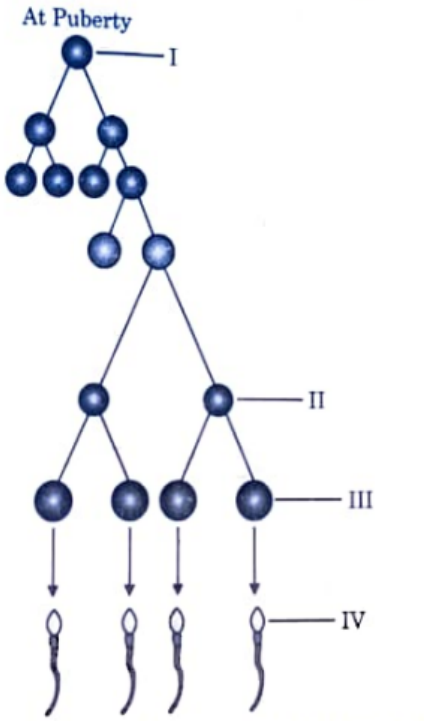
2. Given below is the schematic representation of spermatogenesis in human males:



Choose the option that shows the correct labelling of 'I', 'II', 'III' and 'IV' in the given diagram.

(A) spermatozoa, spermatid, sec. spermatocyte, spermatogonia

(B) spermatid, spermatogonia, sec. spermatocyte, spermatozoa

(C) spermatogonia, sec. spermatocyte, spermatozoa, spermatid

(D) spermatogonia, sec. spermatocyte, spermatid, spermatozoa

Correct Answer: (D) spermatogonia, sec. spermatocyte, spermatid, spermatozoa

Solution:

Step 1: Understanding the process of spermatogenesis:

- Spermatogenesis is the process of sperm cell development in males, which occurs in the seminiferous tubules of the testes.

- The process begins with the primordial germ cells, called spermatogonia, which divide by mitosis to form primary spermatocytes.
- Each primary spermatocyte undergoes meiosis to produce secondary spermatocytes.
- The secondary spermatocytes further divide to form spermatids.
- The spermatids undergo a maturation process (spermiogenesis) to become spermatozoa, which are the mature, motile sperm cells.

Step 2: Analyzing the diagram:
- I represents spermatogonia, the undifferentiated germ cells that divide to produce primary spermatocytes.
- II represents secondary spermatocytes, which are produced after the first meiotic division of primary spermatocytes.
- III represents spermatids, which are formed after the second meiotic division of secondary spermatocytes.
- IV represents spermatozoa, the fully mature sperm cells after spermiogenesis.

Thus, the correct labelling is:
- I: Spermatogonia
- II: Secondary spermatocyte
- III: Spermatid
- IV: Spermatozoa

Step 3: Conclusion:
The correct labelling of 'I', 'II', 'III', and 'IV' is option (D): spermatogonia, sec. spermatocyte, spermatid, spermatozoa.

Quick Tip

In spermatogenesis, the sequence of cell divisions is: Spermatogonia $\rightarrow$ Primary Spermatocytes $\rightarrow$ Secondary Spermatocytes $\rightarrow$ Spermatids $\rightarrow$ Spermatozoa.

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3. Which one of the following options shows the correct evolutionary order of the plants mentioned below?

(i) Ferns

(ii) Ginkgo

(iii) Zosterophyllum

(iv) Gnetales

Choose the correct option.

(A) (i), (iii), (ii), (iv)

(B) (iii), (i), (ii), (iv)

(C) (i), (ii), (iii), (iv)

(D) (iv), (ii), (i), (iii)

Correct Answer: (B) (iii), (i), (ii), (iv)

Solution:

Step 1: Understanding the evolutionary order of plants:

- **Zosterophyllum**: This is one of the earliest vascular plants and is considered to be the most primitive among the options. It lived during the Silurian period and is part of the group of extinct plants called zosterophylls.

- **Ferns**: Ferns are one of the oldest surviving plant groups and are part of the Pteridophytes. They evolved after Zosterophyllum and possess true vascular tissue.

- **Ginkgo**: Ginkgo is a gymnosperm, which is an ancient group of seed-producing plants that evolved after ferns and are more advanced in the evolutionary tree.

- **Gnetales**: Gnetales are a group of gymnosperms and are more advanced than Ginkgo. They represent a further evolutionary step in the development of seed plants.

Step 2: Arranging the plants in evolutionary order:

- The correct evolutionary order is:

- Zosterophyllum (the most primitive) $\rightarrow$ Ferns $\rightarrow$ Ginkgo $\rightarrow$ Gnetales.

Thus, the correct evolutionary order is (iii), (i), (ii), (iv).

Step 3: Conclusion:

The correct answer is option (B) (iii), (i), (ii), (iv).

Quick Tip

In evolutionary terms, the earliest plants like Zosterophyllum evolved before ferns, which were followed by the gymnosperms such as Ginkgo, and later the more advanced Gnetales.

4. In molecular biology, who proposed that genetic information flows in one direction?

(A) Hargobind Khorana

(B) Francis Crick

(C) Watson and Crick

(D) Marshall Nirenberg

Correct Answer: (B) Francis Crick

Solution:

Step 1: The concept of the flow of genetic information is central to molecular biology and is often referred to as the central dogma of molecular biology.

- The central dogma states that genetic information flows from DNA to RNA to protein, and it is unidirectional.

- This theory was first proposed by **Francis Crick** in 1957.

Step 2: The central dogma suggests that genetic information flows in the following direction:

- DNA $\rightarrow$ RNA $\rightarrow$ Protein.

- This directional flow was a groundbreaking idea that helped to establish the basic framework of molecular biology.

Step 3: Conclusion:

Thus, the person who proposed that genetic information flows in one direction is **Francis Crick**, making the correct answer option (B).

Quick Tip

The central dogma of molecular biology, proposed by Francis Crick, describes the unidirectional flow of genetic information from DNA to RNA to proteins.

5. Given below is a heterogeneous RNA formed during Eukaryotic transcription:

How many introns and exons respectively are present in the hnRNA?

(A) 7, 7

(B) 8, 7

(C) 8, 8

(D) 7, 8

Correct Answer: (B) 8, 7

Solution:

Step 1: In eukaryotic transcription, the RNA produced is initially a heterogeneous nuclear RNA (hnRNA) that includes both introns and exons.

- **Exons** are the regions that code for the protein.

- **Introns** are the non-coding regions that are spliced out during the processing of hnRNA to mRNA.

Step 2: Examining the given sequence of hnRNA:

- The diagram shows a sequence where the exons are represented as coding regions (usually shown with larger segments).

- The introns are the non-coding regions that interrupt the exons.

Step 3: Counting the introns and exons:

- From the given sequence, there are 8 exons and 7 introns in the hnRNA.

Step 4: Conclusion:

The correct number of introns and exons are 8 and 7, respectively. Hence, the correct answer is option (B).

Quick Tip

In eukaryotes, hnRNA is the precursor to mRNA and contains both exons and introns. Exons code for proteins, while introns are removed during mRNA processing.

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6. Which of the following features correctly show the mechanism of sex-determination in honey-bees?

(i) A zygote formed from the union of a sperm and an egg develops into a male.

(ii) Males have half the number of chromosomes as that of females.

(iii) The females are diploid having 32 chromosomes.

(iv) Males have a father and can produce sons.

Choose the correct option:

(A) (i) and (ii)

(B) (ii) and (iii)

(C) (i) and (iv)

(D) (ii) and (iv)

Correct Answer: (D) (ii) and (iv)

Solution:

Step 1: Understanding the mechanism of sex determination in honey-bees:

- In honey-bees, sex determination follows a haplodiploid system.

- **Males (drones)** are haploid, meaning they have only one set of chromosomes (half the number of chromosomes as females).

- **Females (workers and queens)** are diploid, meaning they have two sets of chromosomes (32 chromosomes in this case).

Step 2: Analyzing the given statements:

- **Statement (i)**: ”A zygote formed from the union of a sperm and an egg develops into a male.”

This statement is incorrect because a male bee (drone) develops from an unfertilized egg (haploid), not from the union of sperm and egg. The fertilized egg results in a female.

- **Statement (ii)**: ”Males have half the number of chromosomes as that of females.”

This statement is correct. Males are haploid, so they have half the number of chromosomes compared to the diploid females.

- **Statement (iii)**: ”The females are diploid having 32 chromosomes.” This statement is correct. Females (workers and queens) are diploid and have 32 chromosomes.

- **Statement (iv)**: ”Males have a father and can produce sons.” This statement is correct. Males (drones) are produced from unfertilized eggs and have a father (the queen). They can mate with females (queens) to produce sons.

Step 3: Conclusion:

The correct statements are (ii) and (iv). Thus, the correct answer is option (D).

Quick Tip

In the haplodiploid system of honey-bees, males are haploid (one set of chromosomes), and females are diploid (two sets of chromosomes).

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7. Study the items of Column-I and those of Column-II:

Column-I	**Column-II**
(a) RNA polymerase I	(i) 18s rRNA
(b) RNA polymerase II	(ii) SnRNAs
(c) RNA polymerase III	(iii) hnRNA

Choose the option that correctly matches the items of Column-I with those of Column-II:

(A) (a) - (i), (b) - (ii), (c) - (iii)

(B) (a) - (iii), (b) - (ii), (c) - (i)

(C) (a) - (ii), (b) - (iii), (c) - (i)

(D) (a) - (i), (b) - (iii), (c) - (ii)

Correct Answer: (A) (a) - (i), (b) - (ii), (c) - (iii)

Solution:

Step 1: Understanding the functions of the RNA polymerases:

- RNA polymerase I: It is responsible for synthesizing rRNA, specifically the 18S rRNA. Thus, it is matched with (i) 18S rRNA.

- RNA polymerase II: It is responsible for synthesizing mRNA and some snRNA. Thus, it is matched with (ii) SnRNAs.

- RNA polymerase III: It is responsible for synthesizing tRNA and other small RNAs such as 5S rRNA and hnRNA. Thus, it is matched with (iii) hnRNA.

Step 2: Conclusion:

The correct match for the items in Column-I with those in Column-II is:

- (a) RNA polymerase I $\rightarrow$ (i) 18S rRNA

- (b) RNA polymerase II $\rightarrow$ (ii) SnRNAs

- (c) RNA polymerase III $\rightarrow$ (iii) hnRNA

Thus, the correct answer is option (A).

Quick Tip

RNA polymerase I synthesizes rRNA (including 18S rRNA), RNA polymerase II synthesizes mRNA and snRNAs, and RNA polymerase III synthesizes tRNA and other small RNAs.

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8. A child with blood group A has father with blood group B and the mother with blood group AB. Choose the option that gives the correct genotypes of father, mother, and the child:

Father	Mother	Child
(A) I^Ai	I^Bi	I^Ai
(B) I^AI^B	I^Ai	I^AI^A
(C) I^Bi	I^AI^B	I^Ai
(D) I^BI^B	I^AI^B	I^AI^A

Correct Answer: (A) I^Ai, I^Bi, I^Ai

Solution:

Step 1: Blood group inheritance follows Mendelian genetics. The genotypes are determined by the alleles inherited from the parents.

- Blood group A is represented by genotype I^Ai, where I^A is the A allele and i is the recessive O allele.

- Blood group B is represented by genotype I^Bi, where I^B is the B allele and i is the recessive O allele.

- Blood group AB is represented by genotype I^AI^B, as both A and B alleles are expressed.

Step 2: Analyzing the given parental blood groups:

- Father has blood group B, so his genotype is $I^B i$.

- Mother has blood group AB, so her genotype is $I^A I^B$.

- The child has blood group A, meaning the child must have inherited the I^A allele.

Therefore, the child must have genotype $I^A i$, receiving I^A from the mother and i from the father.

Step 3: Conclusion:

Thus, the genotypes of the father, mother, and child are:

- Father: $I^B i$

- Mother: $I^A I^B$

- Child: $I^A i$

Hence, the correct answer is option (A).

Quick Tip

Blood group inheritance follows Mendelian principles, where the A and B alleles are dominant over the O allele. The child's blood group is determined by the alleles inherited from both parents.

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9. The decrease in the T-Lymphocytes count in human blood will finally result in

(A) decrease in antigens

(B) decrease in antibodies

(C) increase in antibodies

(D) increase in antigens

Correct Answer: (B) decrease in antibodies

Solution:

Step 1: Understanding the role of T-lymphocytes:

- T-lymphocytes (T-cells) play a crucial role in the immune response by recognizing and attacking infected cells, as well as coordinating the immune system.

- They are essential for the production and regulation of antibodies by activating other immune cells, such as B-cells, which are responsible for antibody production.

Step 2: Effects of a decrease in T-lymphocyte count:

- A decrease in the T-lymphocyte count results in impaired immune response because fewer T-cells are available to activate B-cells.
- Without sufficient activation, B-cells will produce fewer antibodies.

Step 3: Conclusion:

The decrease in T-lymphocyte count will lead to a decrease in antibody production, not an increase. This results in a weakened immune response.

Thus, the correct answer is option (B).

Quick Tip

T-lymphocytes are essential for activating B-cells, which in turn produce antibodies. A decrease in T-cells leads to reduced antibody production, impairing the immune response.

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10. If Meselson and Stahl's experiment is continued for 80 minutes (till III generation), then what would be the ratio of DNA containing $N^{15}/N^{15} : N^{15}/N^{14} : N^{14}/N^{14}$ in the medium?

(A) 1:1:0

(B) 0:1:3

(C) 0:1:8

(D) 1:4:0

Correct Answer: (C) 0:1:8

Solution:

Step 1: Meselson and Stahl's experiment is a landmark experiment that demonstrated the semi-conservative replication of DNA. The experiment used nitrogen isotopes N^{15} (heavy nitrogen) and N^{14} (light nitrogen) to label the DNA strands.

Step 2: In the experiment:

- The parental DNA was initially grown in a medium containing N^{15}.
- After one round of DNA replication in N^{14}, the newly synthesized strands contained N^{14}, while the parental strands retained the N^{15} label.
- In subsequent generations, the proportion of DNA containing only N^{14} increases, while the

amount of DNA with both N^{15} and N^{14} decreases.

Step 3: Analysis of DNA after 80 minutes (till III generation):

- In the first generation, the DNA will be of the type N^{15}/N^{14} (one strand of N^{15} and the other strand of N^{14}).

- In the second generation, DNA of type N^{14}/N^{14} will appear along with the DNA of type N^{15}/N^{14}.

- In the third generation, the ratio will be dominated by N^{14}/N^{14} and N^{15}/N^{14} in a 1:8 ratio, with the DNA of type N^{15}/N^{15} being absent.

Step 4: Conclusion:

Thus, the ratio of DNA containing $N^{15}/N^{15} : N^{15}/N^{14} : N^{14}/N^{14}$ in the medium after 80 minutes will be 0:1:8.

Hence, the correct answer is option (C).

Quick Tip

In semi-conservative DNA replication, after each replication cycle, the amount of DNA with one strand labeled N^{15} and the other labeled N^{14} increases, while the amount of DNA with both strands labeled N^{15} decreases.

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11. Select the correct statement from the following biotechnological procedures:

(A) The polymerase enzyme joins the gene of interest and the vector DNA.

(B) Gel electrophoresis is used for amplification of a DNA segment.

(C) PCR is used for isolation and separation of the gene of interest.

(D) Plasmid DNA acts as a vector to transfer the piece of DNA attached to it.

Correct Answer: (D) Plasmid DNA acts as a vector to transfer the piece of DNA attached to it.

Solution:

Step 1: Analyzing the given statements:

- Statement (A): ”The polymerase enzyme joins the gene of interest and the vector DNA.” This is incorrect. While polymerase enzymes (e.g., Taq polymerase in PCR) are crucial for DNA replication, they do not join the gene of interest and the vector DNA. This is typically

done by DNA ligase, not polymerase.

- Statement (B): ”Gel electrophoresis is used for amplification of a DNA segment.”

This is incorrect. Gel electrophoresis is used to separate DNA fragments based on their size, not to amplify them. PCR (Polymerase Chain Reaction) is used to amplify DNA segments.

- Statement (C): ”PCR is used for isolation and separation of the gene of interest.”

This is incorrect. PCR amplifies specific DNA segments, but it does not isolate or separate genes. Gel electrophoresis is used for separation, and other techniques like restriction enzymes are used for isolation.

- Statement (D): ”Plasmid DNA acts as a vector to transfer the piece of DNA attached to it.”

This is correct. In genetic engineering, plasmid DNA is commonly used as a vector to carry and transfer the gene of interest into a host cell.

Step 2: Conclusion:

The correct statement is option (D), where plasmid DNA acts as a vector to transfer the DNA into a host organism for further study or use.

Quick Tip

Plasmids are commonly used as vectors in genetic engineering to introduce new genes into host cells. They can replicate independently and carry foreign genes for expression in host organisms.

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12. For commercial and industrial production of citric acid, which one of the following microbes is used?

(A) Aspergillus niger

(B) Lactobacillus sp.

(C) Clostridium butylicum

(D) Saccharomyces cerevisiae

Correct Answer: (A) Aspergillus niger

Solution:

Step 1: Understanding the production of citric acid:

- Citric acid is commonly used in food and pharmaceutical industries. The production of

citric acid is an important biotechnological process, usually carried out by fungi under aerobic conditions.

- Several microorganisms are used for citric acid production, but the most widely used microorganism is **Aspergillus niger**, a fungus.

Step 2: Explanation of the options:

- Option (A) Aspergillus niger: This microorganism is the most commonly used in the industrial production of citric acid due to its ability to efficiently produce citric acid during fermentation processes.
- Option (B) Lactobacillus sp.: While Lactobacillus species are important for lactic acid production, they are not used for citric acid production.
- Option (C) Clostridium butylicum: This bacterium is involved in butyric acid production, not citric acid.
- Option (D) Saccharomyces cerevisiae: This yeast is primarily used for ethanol production, not citric acid production.

Step 3: Conclusion:

The correct microbe used for the commercial and industrial production of citric acid is **Aspergillus niger**. Hence, the correct answer is option (A).

Quick Tip

Aspergillus niger is a filamentous fungus widely used in the fermentation industry for citric acid production, as it is highly efficient in converting carbohydrates into citric acid.

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13. Assertion (A): Corpus luteum secretes the hormone, progesterone. **Reason (R):** Hormone Progesterone is essential for maintenance of the endometrium.

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

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

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

(D) (A) is false, but (R) is true.

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

Solution:

Step 1: Analyzing the assertion:

- The corpus luteum is a temporary endocrine structure in the ovaries that forms after ovulation.

- It secretes the hormone **progesterone**, which is essential for the regulation of the menstrual cycle and for the maintenance of the endometrium during pregnancy.

Step 2: Analyzing the reason:

- Progesterone is indeed necessary for the maintenance of the endometrium. It prepares the uterine lining for possible implantation of a fertilized egg and helps in maintaining the lining during early pregnancy.

Step 3: Conclusion:

- Both Assertion (A) and Reason (R) are true, and the reason provides the correct explanation for the assertion. Thus, the correct answer is option (A).

Quick Tip

The corpus luteum is crucial for the secretion of progesterone, which is essential in maintaining the endometrial lining for embryo implantation and early pregnancy.

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14. Assertion (A): The number of white winged moths decreased after industrialisation in England. **Reason (R):** Effects of industrialisation were more marked in rural areas of England.

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

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

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

(D) (A) is false, but (R) is true.

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

Solution:

Step 1: Analyzing the assertion:

- The industrial revolution in England led to increased pollution, particularly soot in urban areas, which caused a change in the environment.

- The white-winged moths were previously more prevalent in these areas due to their

camouflage on the light-colored tree trunks. However, after industrialization, the darker tree trunks (due to soot) caused a decrease in the number of white-winged moths.

Step 2: Analyzing the reason:

- The effects of industrialization were more marked in **urban areas**, not rural areas. In rural areas, there was less industrial pollution, so the change in the population of moths was not as dramatic as in urban areas.

- Therefore, while the assertion is true, the reason is incorrect because the effects were more marked in urban areas, not rural areas.

Step 3: Conclusion:

Thus, the correct answer is option (C): (A) is true, but (R) is false.

Quick Tip

The industrial melanism phenomenon, which is the increase in dark-colored individuals in polluted areas, is a classic example of natural selection due to environmental changes.

15.

Assertion (A): Streptococcus pneumoniae and *Haemophilus influenzae* are responsible for causing infectious disease in human beings.

Reason (R): A healthy person acquires the infection by inhaling the aerosols released by an infected person.

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

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

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

(D) (A) is false, but (R) is true.

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

Solution:

Step 1: Analyzing the assertion:

- *Streptococcus pneumoniae* and *Haemophilus influenzae* are well-known pathogens that can cause respiratory infections, such as pneumonia, in humans.

- These bacteria are indeed responsible for a variety of infectious diseases in humans,

including pneumonia and other respiratory tract infections.

Step 2: Analyzing the reason:

- It is a well-established fact that these bacteria are transmitted through airborne droplets (aerosols) released when an infected person coughs, sneezes, or talks.
- This method of transmission is a common means by which healthy individuals acquire these infections.

Step 3: Conclusion:

Both Assertion (A) and Reason (R) are true, and Reason (R) correctly explains Assertion (A). Therefore, the correct answer is option (A).

Quick Tip

Streptococcus pneumoniae and Haemophilus influenzae are spread through respiratory droplets, making airborne transmission a key factor in the spread of these infections.

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16. Assertion (A): Restriction endonuclease recognises palindromic sequence in DNA and cuts them. **Reason (R):** Palindromic sequence has two unique recognition sites PstI and PvuI recognised by restriction endonuclease.

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

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

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

(D) (A) is false, but (R) is true.

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

Solution:

Step 1: Analyzing the assertion:

- Restriction endonucleases are enzymes that cut DNA at specific sites. These enzymes typically recognize palindromic sequences, which are sequences of nucleotides that read the same forwards and backwards on complementary strands of DNA.
- The assertion is correct because restriction endonucleases do indeed recognize and cleave palindromic sequences in the DNA.

Step 2: Analyzing the reason:

- Palindromic sequences are recognized by various restriction endonucleases, but the reason given is incorrect in naming the specific recognition sites for PstI and PvuI.
- PstI recognizes the palindromic sequence 5'-CTGCAG-3', and PvuI recognizes the palindromic sequence 5'-CAGCTG-3', which are not the only recognition sites for restriction endonucleases.
- Therefore, the reason is partially incorrect because it mentions the specific sites PstI and PvuI, but these are just examples and not applicable to all restriction endonucleases.

Step 3: Conclusion:

- The assertion is correct, but the reason provided is incorrect because it gives a misleading explanation.

Thus, the correct answer is option (C): (A) is true, but (R) is false.

Quick Tip

Restriction endonucleases are enzymes that recognize specific palindromic sequences in DNA. Each enzyme has a distinct recognition site, and they cut the DNA at or near these sequences.

Section-B

17.

(A) Comment upon the mode of pollination in Vallisneria and Zostera.

OR

(B) Mention any four strategies adopted by flowering plants to prevent self-pollination.

Solution:

(A) Pollination in Vallisneria and Zostera:

- **Vallisneria** and **Zostera** are aquatic plants that exhibit **hydrophilous pollination**, meaning they rely on water for pollination.
- In Vallisneria, the male flowers are submerged in the water, and the female flowers float on the surface. Pollination occurs when the male flowers are carried by water currents to the floating female flowers, where they release their pollen.

- In Zostera, pollination also takes place through water currents, with the flowers being partially submerged, allowing for the transfer of pollen between male and female flowers under water.

(B) Strategies to Prevent Self-Pollination:

Flowering plants have evolved several strategies to prevent self-pollination, which ensures genetic diversity. Four of these strategies are:

1. Dioecism: Male and female reproductive organs are on separate plants, preventing self-pollination.
2. Temporal Separation: The male and female flowers mature at different times (e.g., male flowers release pollen before the female flowers are receptive, or vice versa).
3. Physical Barriers: Flowers may have structural adaptations, such as longer stamens or styles, preventing the transfer of pollen from the same flower.
4. Heterostyly: Plants have different flower forms, such as short-styled and long-styled flowers, preventing self-pollination by ensuring that pollen from a short style cannot fertilize a short-style flower.

Quick Tip

Hydrophilous pollination in aquatic plants like Vallisneria and Zostera ensures efficient pollen transfer through water currents. To prevent self-pollination, plants use strategies such as dioecism, temporal separation, and structural barriers.

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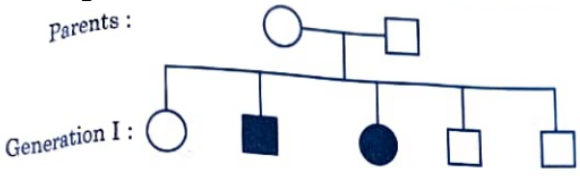
18. Study the given pedigree chart in which neither of the parents shows the trait but the trait is present in both male and female children.



Answer the following questions:

(a) Write about the trait, also explain the inheritance of such a trait in the progeny on the basis of the given pedigree chart.

Solution:

Step 1: Analyzing the pedigree chart:

- In the pedigree chart, neither of the parents shows the trait (as both the father and mother are represented without filled circles or squares).
- However, both the male and female children (represented by filled circles and squares) show the trait.
- This suggests that the trait is recessive in nature. Both parents are carriers of the trait (heterozygous) and pass it on to the offspring.

Step 2: Explanation of the inheritance pattern:

- The trait is inherited in a recessive manner, and both parents must be carriers of the recessive allele (genotype Aa) for the trait to be expressed in their children.
- Since the trait is expressed in both male and female children, this suggests autosomal inheritance.

Step 3: Conclusion:

- The parents are carriers of a recessive allele (genotype Aa), and the trait is autosomal recessive. The children inherited the recessive allele from both parents (genotype aa), resulting in the expression of the trait.

(b) Give one example of such a trait in human beings.

Solution:

One example of an autosomal recessive trait in human beings is **cystic fibrosis**. This genetic disorder is caused by a recessive allele, and it can be passed on to children even if neither parent exhibits the trait, as both parents may be carriers.

Quick Tip

In autosomal recessive inheritance, both parents must be carriers of the recessive allele for the trait to be expressed in the offspring. Affected individuals inherit one recessive allele from each parent.

19.

Student to attempt either option (A) or (B).

(A) Describe any two situations where a medical doctor would recommend injection of

pre-formed antibodies (antitoxins) into the body of a patient.

OR

(B) The symptoms of malaria do not appear immediately after the entry of sporozoites into the human body when bitten by female Anopheles mosquito. Explain why it happens.

Solution:

(A) Situations where a medical doctor would recommend injection of pre-formed antibodies (antitoxins):

1. Tetanus infection:

- A doctor may recommend the injection of tetanus antitoxin when a person is injured with a contaminated object or is exposed to tetanus-causing bacteria. Since the body has not yet produced antibodies to the toxin, the immediate administration of pre-formed antibodies can neutralize the tetanus toxin and prevent infection.

2. Snakebite (venom):

- If a person is bitten by a venomous snake, the doctor may administer snake antivenom (which contains pre-formed antibodies against the snake's venom). This is done to neutralize the venom before it can spread and cause severe harm to the body.

(B) Why symptoms of malaria do not appear immediately after the entry of sporozoites into the human body:

- The delay in the appearance of malaria symptoms is due to the time it takes for the sporozoites to mature into merozoites.
- When a female Anopheles mosquito bites a person, it injects sporozoites into the bloodstream. These sporozoites travel to the liver, where they mature into schizonts.
- The schizonts then release merozoites into the bloodstream, which invade red blood cells.
- The symptoms of malaria, such as fever and chills, occur when the merozoites rupture red blood cells, causing the release of toxins into the bloodstream. This process can take days to weeks, which is why the symptoms of malaria do not appear immediately after the mosquito bite.

Quick Tip

Pre-formed antibodies (antitoxins) provide immediate protection against specific toxins or venoms, as they neutralize harmful substances before the body has a chance to produce its own immune response.

20.

(a) Write the scientific name of the source organism of the thermostable DNA polymerase used in PCR.

(b) State the advantage of using thermostable DNA polymerase.

Solution:

(a) Scientific name of the source organism of thermostable DNA polymerase used in PCR:

- The thermostable DNA polymerase used in PCR is **Taq polymerase**, which is derived from the bacterium *Thermus aquaticus*.
- Thermus aquaticus is a thermophilic bacterium found in hot springs, making it suitable for the high-temperature conditions required in the PCR process.

(b) Advantage of using thermostable DNA polymerase:

- The main advantage of using thermostable DNA polymerase, like *Taq polymerase*, is its ability to withstand the high temperatures required during the denaturation step of PCR (usually around 94-98°C).
- This allows the enzyme to remain active throughout the PCR process, eliminating the need to add fresh enzyme after each cycle, thus making the process more efficient and time-saving.

Quick Tip

Thermostable DNA polymerases such as Taq polymerase allow for continuous amplification of DNA without the need for enzyme replenishment at each cycle, making PCR highly efficient.

Section-C

21.

State the conclusions derived by David Tilman's long-term ecosystem experiments using outdoor plots.

Solution:

David Tilman's long-term ecosystem experiments, conducted using outdoor plots, led to several important conclusions regarding the functioning of ecosystems:

1. Biodiversity and Ecosystem Stability:

- Tilman's experiments showed that higher biodiversity leads to greater ecosystem stability. In plots with a higher number of plant species, the ecosystem was more resilient to environmental stresses such as droughts or nutrient imbalances.

2. Ecosystem Productivity:

- The experiments demonstrated that diverse ecosystems tend to have higher productivity. This is because different species utilize different resources, reducing competition and increasing overall efficiency in resource use.

3. Nutrient Cycling:

- Tilman found that ecosystems with higher biodiversity are more efficient in nutrient cycling. A variety of species contribute to the breakdown of organic matter and the cycling of nutrients, which is crucial for ecosystem health.

4. Species Interactions:

- His research highlighted the importance of interspecies interactions in maintaining ecosystem functions. For example, some species might facilitate the growth of others, leading to more efficient ecosystem processes.

Step 2: Conclusion:

- Tilman's experiments have greatly contributed to the understanding of biodiversity-ecosystem functioning relationships, emphasizing the importance of maintaining biodiversity for ecosystem stability and productivity.

Quick Tip

Biodiversity plays a crucial role in enhancing the resilience and productivity of ecosystems. Diverse species can utilize resources in different ways, leading to greater efficiency and stability in ecosystems.

22.

(a) List two reasons that make copper releasing IUDs as effective contraceptives.

(b) Explain how the intake of oral contraceptive pills prevent pregnancy in humans.

Solution:

(a) Two reasons that make copper releasing IUDs effective contraceptives:

1. Toxic to sperm:

- The copper released by the IUD creates a toxic environment for sperm, impairing their motility and ability to fertilize the egg.

2. Prevention of implantation:

- Copper IUDs alter the lining of the uterus, making it inhospitable for a fertilized egg to implant and grow, thus preventing pregnancy.

(b) How the intake of oral contraceptive pills prevent pregnancy in humans:

- Oral contraceptive pills contain synthetic hormones (typically a combination of estrogen and progesterone) that work in several ways to prevent pregnancy:

1. Inhibition of ovulation:

- The hormones prevent the release of eggs from the ovaries, making ovulation impossible.

2. Thickening of cervical mucus:

- The pills cause the mucus in the cervix to thicken, which blocks the entry of sperm into the uterus.

3. Altering the uterine lining:

- They also alter the lining of the uterus, making it less likely for a fertilized egg to implant.

Quick Tip

Copper IUDs provide long-term, reversible contraception by creating an inhospitable environment for sperm and preventing implantation. Oral contraceptives work by regulating hormonal levels, inhibiting ovulation, and making the cervix less permeable to sperm.

23.

(a) A bilobed dithecous anther has 200 microspore mother cells per microsporangium. How many male gametophytes can be produced by this anther?

(b) Write the composition of intine and exine layers of a pollen grain.

Solution:

(a) Male gametophytes produced by a bilobed dithecous anther:

- A bilobed dithecous anther consists of two lobes, and each lobe has two microsporangia (pollen sacs).
- Each microsporangium contains 200 microspore mother cells (microsporocytes).
- Each microspore mother cell undergoes meiosis to produce four haploid microspores.
- Thus, the number of male gametophytes produced by one microspore mother cell is 4.
- As there are 200 microspore mother cells per microsporangium, the number of microspores (male gametophytes) produced by one microsporangium will be $200 \times 4 = 800$.
- Since there are two microsporangia in each lobe and two lobes in the anther, the total number of male gametophytes produced by the anther will be:

$$\text{Total male gametophytes} = 800 \times 2 \times 2 = 3200$$

Thus, the anther can produce 3200 male gametophytes.

(b) Composition of intine and exine layers of a pollen grain:

- Exine layer:
- The exine is the outermost layer of the pollen grain. It is composed of a complex substance called sporopollenin, which is highly resistant to degradation.
- Sporopollenin is made of biopolymeric compounds like lipids and phenolic compounds and

gives the pollen grain its rigidity and protection against environmental stress.

- Intine layer:

- The intine is the inner layer of the pollen grain and is mainly composed of cellulose and pectin.

- It is more flexible than the exine and allows for the formation of the pollen tube during fertilization.

Quick Tip

The exine's strong and durable sporopollenin protects the pollen grain during its transport, while the intine aids in the development of the pollen tube for fertilization.

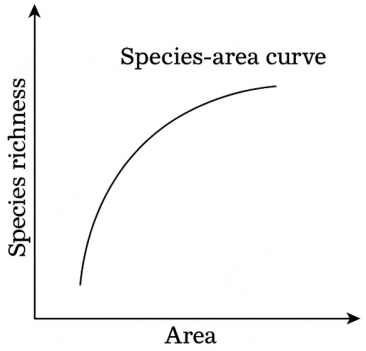
24.

How does the process of Natural Selection affect Hardy-Weinberg equilibrium? Explain with the help of graphs.

Solution:

The Hardy-Weinberg equilibrium is a theoretical concept in population genetics that describes the genetic variation in a population at equilibrium, assuming no evolutionary influences. The equilibrium occurs when allele frequencies remain constant from generation to generation. The five conditions required for Hardy-Weinberg equilibrium are:

1. No mutation.
2. No natural selection.
3. Random mating.
4. Large population size.
5. No gene flow (migration).



Effect of Natural Selection on Hardy-Weinberg equilibrium:

Natural selection is one of the key evolutionary forces that can disrupt Hardy-Weinberg equilibrium. It acts on individuals in a population by favoring those with advantageous traits, which leads to changes in allele frequencies over time. This is not in accordance with the assumption of no natural selection in Hardy-Weinberg equilibrium.

In a population where natural selection is acting:

- Alleles that provide a survival advantage increase in frequency over time.
- Alleles that reduce fitness decrease in frequency.
- This results in a change in genotype and allele frequencies, which causes the population to evolve, thereby deviating from Hardy-Weinberg equilibrium.

Graphical Explanation:

1. Graph 1: Hardy-Weinberg equilibrium (no selection)

When there is no natural selection, allele frequencies remain constant over generations, represented as a straight line. The population is at equilibrium.

2. Graph 2: Effect of natural selection

When natural selection is introduced, the advantageous allele increases in frequency over time, while the disadvantageous allele decreases in frequency, leading to evolution. This is represented by a curve showing the change in allele frequency.

The graph demonstrates that, with natural selection, the population will evolve, and the allele frequencies will shift, causing the population to deviate from Hardy-Weinberg equilibrium.

Quick Tip

Natural selection causes changes in allele frequencies over time by favoring individuals with advantageous traits. This disrupts Hardy-Weinberg equilibrium and leads to evolution in a population.

25.

Using a Punnett square, work out the distribution of an autosomal phenotypic feature in the first filial generation after a cross between a homozygous female and a heterozygous male for a single locus.

Solution:

Let us assume the autosomal gene for the trait is represented by the letter ”A”, where ”A” is the dominant allele and ”a” is the recessive allele.

- The female is homozygous dominant, meaning her genotype is AA.

- The male is heterozygous, meaning his genotype is Aa.

We will use a Punnett square to determine the genotype and phenotype distribution in the first filial generation (F1).

Punnett Square:

	A	A
A	AA	AA
a	Aa	Aa

Step 1: Genotype Distribution:

- The genotypes of the F1 generation will be:

- AA (homozygous dominant) with a probability of 50- Aa (heterozygous) with a probability of 50

Step 2: Phenotype Distribution:

Since A is dominant, both AA and Aa will show the dominant phenotype. Therefore, the F1 generation will show the dominant phenotype.

- 100(%) of the F1 generation will display the dominant phenotype.

Conclusion:

In the first filial generation, 50(%)will be homozygous dominant (AA) and 50(%) will be heterozygous (Aa). All offspring will exhibit the dominant phenotype due to the presence of at least one dominant allele.

Quick Tip

In a cross between a homozygous dominant female and a heterozygous male, 50

26.

Samples of blood and urine of a sports person are collected before any sports event for drug tests.

(a) Why is there a need to conduct such tests?

(b) Name the drugs the authorities usually look for.

(c) Write the generic names of two plants from which these drugs are obtained.

Solution:

(a) Why is there a need to conduct such tests?

- Drug testing in sports is essential to ensure fairness and integrity in competitions.
- Performance-enhancing drugs (PEDs) can provide an unfair advantage, and their use is prohibited by most sports organizations.
- Conducting drug tests helps to maintain a level playing field and protect the health of athletes.
- It also helps prevent the use of banned substances that may cause long-term health issues and affect the athlete's career.

(b) Name the drugs the authorities usually look for.

- Authorities typically look for the following types of drugs in sports drug tests:

1. Anabolic steroids (used to increase muscle mass and strength).
2. Stimulants (used to enhance alertness and reduce fatigue).
3. Diuretics (used for weight loss and masking other drugs).
4. Blood doping agents (such as EPO to increase red blood cell count).
5. Beta-blockers (used to reduce anxiety and steady hand movements, mainly in shooting and archery).

(c) Write the generic names of two plants from which these drugs are obtained.

- Erythropoietin (EPO): A synthetic version of a hormone that enhances red blood cell production, often derived from recombinant DNA technology but originally inspired by the hormone produced in the kidneys.
- Caffeine: A stimulant obtained from plants like Coffea arabica (coffee) and Camellia sinensis (tea). It is used to enhance alertness and reduce fatigue in athletes.

Quick Tip

Drug tests in sports help ensure that competitions are fair and that athletes are not using substances that give them an unnatural advantage or harm their health.

27.

An application of biotechnology in agriculture involves the production of pest-resistant plants, using "cry" gene from a bacterium, *Bacillus thuringiensis*.

(a) Proteins coded by which specific Bt. toxin gene control corn borer?

(b) How does Bt. toxin produced by the bacterium kill the insect? Explain.

Solution:

(a) Proteins coded by which specific Bt. toxin gene control corn borer?

- The specific Bt. toxin gene that controls corn borer is the cry1Ab gene.

- The cry genes in *Bacillus thuringiensis* code for proteins called Cry proteins (insecticidal proteins). The Cry1Ab protein is toxic to the larvae of the corn borer (*Ostrinia nubilalis*).

(b) How does Bt. toxin produced by the bacterium kill the insect? Explain.

- The Cry protein produced by *Bacillus thuringiensis* is ingested by the larvae of the corn borer when they feed on the Bt. cotton or Bt. corn.

- Once ingested, the Cry protein is activated in the insect's alkaline digestive system. The protein binds to specific receptors in the insect's gut cells, forming pores in the gut lining.

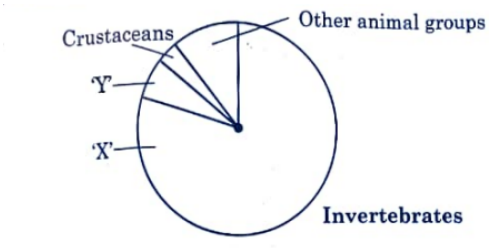
- These pores cause the gut cells to break down, leading to the loss of the gut's permeability, disrupting digestion. This results in the death of the insect due to starvation and septicemia.

Quick Tip

The Cry proteins from *Bacillus thuringiensis* act as insecticides by forming pores in the insect's gut, leading to cell damage, digestive failure, and eventually the death of the pest.

28.

Study the pie chart given below, representing the global biodiversity and proportionate number of species of major taxa.



Answer the following questions:

(a) Identify 'X' and 'Y' in the given pie chart.

(b) Which one of the two 'X' or 'Y' is the most species-rich taxonomic group and by what percentage?

(c) Name the level of Biodiversity represented by the following:

(i) Estuaries and alpine meadows in India.

(ii) The medicinal plant *Rauwolfia vomitoria*.

Solution:

(a) Identify 'X' and 'Y' in the given pie chart.

- Based on the pie chart, we can identify 'X' and 'Y' as follows:
- 'X' represents Invertebrates.
- 'Y' represents Crustaceans.

(b) Which one of the two 'X' or 'Y' is the most species-rich taxonomic group and by what percentage?

- 'X' (Invertebrates) is the most species-rich taxonomic group.
- Invertebrates make up a significant percentage of global biodiversity, estimated at around 75(%) of total species richness.
- Therefore, 'X' (Invertebrates) is the most species-rich taxonomic group with approximately 75(%) of the species.

(c) Name the level of Biodiversity represented by the following:

(i) Estuaries and alpine meadows in India:

- The level of biodiversity represented by estuaries and alpine meadows is Ecosystem Diversity.
- These ecosystems are rich in diverse species, including plants, animals, and microorganisms, contributing to the diversity of the environment.

(ii) The medicinal plant *Rauwolfia vomitoria*:

- The level of biodiversity represented by the medicinal plant *Rauwolfia vomitoria* is Species Diversity.

- *Rauwolfia vomitoria* represents a single species, contributing to the overall diversity of plant species.

Quick Tip

In ecosystem diversity, the variety of ecosystems in a particular area is key. In species diversity, the variety of species, such as *Rauwolfia vomitoria*, contributes to the richness of biodiversity.

Section-D

29.

Immunity in our body is of two types: (i) Innate immunity and (ii) acquired immunity. Innate immunity is a non-specific defence mechanism, whereas acquired immunity is pathogen-specific; it is called specific immunity too. Acquired immunity is characterised by memory. Antibodies are specific to antigens and there are different types of antibodies produced in our body: they are IgA, IgE, IgG, IgC, and IgM. It shows primary response when it encounters the pathogen for the first time and secondary response during the subsequent encounters with the same antigen/pathogen.

(a) Name the two types of specialised cells which carry out the primary and secondary immune response.

(b) Why is the antibody-mediated immunity also called humoral immune response?

Attempt either sub-part (c) or (d):

(c) The organ transplants are often rejected if not taken from suitable compatible persons.

(i) Mention the characteristic of our immune system that is responsible for the graft rejection.

(ii) Name the type of immune response and the cell involved in it.

OR

(d) How is active immunity different from passive immunity?

Solution:

(a) The two types of specialised cells which carry out the primary and secondary immune response:

1. B-cells (B lymphocytes): These cells are responsible for the production of antibodies during both the primary and secondary immune responses. The primary response occurs when the body encounters the pathogen for the first time, and the secondary response occurs during subsequent encounters with the same pathogen.
2. T-cells (T lymphocytes): These cells assist in the immune response by either helping B-cells produce antibodies (Helper T-cells) or directly killing infected cells (Cytotoxic T-cells).

(b) Why is the antibody-mediated immunity also called humoral immune response?

- Antibody-mediated immunity is called humoral immunity because the antibodies are secreted into the bloodstream or bodily fluids (humors) to target and neutralize pathogens.
- The term ”humoral” comes from the body fluids (blood, lymph, etc.) that carry these antibodies.

(c) The organ transplants are often rejected if not taken from suitable compatible persons.

(i) Characteristic of the immune system responsible for graft rejection:

- The immune system’s ability to recognize ”self” from ”non-self” antigens is responsible for graft rejection.
- This is due to the presence of Major Histocompatibility Complex (MHC) molecules, which are unique to each individual. If the donor’s MHC is different from the recipient’s, the immune system recognizes the graft as foreign and mounts an immune response against it.

(ii) Type of immune response and the cell involved in it:

- The type of immune response is Cell-mediated immunity.
- The primary cells involved are Cytotoxic T-cells (CD8+ T-cells), which directly attack and destroy the foreign cells (graft).

OR

(d) How is active immunity different from passive immunity?

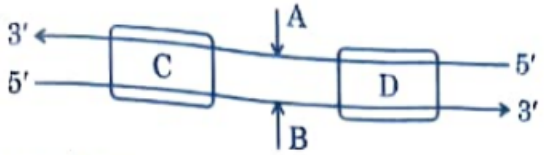
- Active immunity:
- Occurs when an individual's own immune system produces antibodies or T-cells to fight off a pathogen or after vaccination.
- This immunity is long-lasting because memory cells are produced.
- Passive immunity:
- Occurs when antibodies are transferred from another individual, such as through breast milk or from an injection of immunoglobulins.
- This immunity is temporary because the body does not produce its own antibodies and has no memory cells.

Quick Tip

In organ transplants, immune rejection occurs when the recipient's immune system recognizes the donor tissue as foreign due to differences in MHC molecules. Cell-mediated immunity, involving T-cells, plays a key role in this process.

30.

The process of copying the genetic information from one strand of DNA into RNA is termed as transcription. The principle of complementarity of bases governs the process of transcription, also except that uracil comes in place of thymine.
Study the complete transcription unit given below and answer the following questions:



(a) Name the main enzyme involved in the process of transcription.

(b) Identify coding strand and template strand of DNA in the transcription unit.

(c) Identify (C) and (D) in the diagram, mention their significance in the process of transcription.

(d) Describe the location of (C) and (D) in the transcription unit.

Solution:

(a) Name the main enzyme involved in the process of transcription.

- The main enzyme involved in the process of transcription is RNA polymerase.
- RNA polymerase synthesizes the RNA strand by adding RNA nucleotides complementary to the template strand of DNA.

(b) Identify coding strand and template strand of DNA in the transcription unit.

- The coding strand is the strand of DNA that has the same sequence as the mRNA (except for the substitution of uracil for thymine). In the diagram, it is represented as the strand labeled as C.
- The template strand is the strand of DNA that serves as the template for RNA synthesis. It is complementary to the mRNA sequence and in the diagram, it is represented as the strand labeled as D.

(c) Identify (C) and (D) in the diagram, mention their significance in the process of transcription.

- (C) Coding Strand: This is the DNA strand whose sequence is identical to the RNA transcript (except that RNA has uracil instead of thymine). It is not directly involved in RNA synthesis, but its sequence reflects the sequence of the newly synthesized mRNA.
- (D) Template Strand: This is the strand that is used by RNA polymerase to synthesize the complementary RNA strand. It is the strand that RNA polymerase binds to and reads in the 3' to 5' direction to create a complementary RNA strand in the 5' to 3' direction.

OR

(d) Describe the location of (C) and (D) in the transcription unit.

- (C) Coding Strand: The coding strand is located opposite the template strand and is read in the 5' to 3' direction. It contains the same sequence as the RNA (except for the substitution of uracil for thymine).
- (D) Template Strand: The template strand is located adjacent to the coding strand and is read in the 3' to 5' direction by RNA polymerase to create the complementary RNA strand.

Quick Tip

RNA polymerase synthesizes the RNA strand using the template DNA strand, creating a complementary sequence that mirrors the coding strand (with uracil replacing thymine).

Section-E

31.

Student to attempt either option (A) or (B).

(A)

(i) Give a schematic representation of oogenesis in human females.

(ii) Mention the number of chromosomes at each stage. Correlate the life phases of the individual with the stages of the process.

OR

(B)

(i) Describe the three types of pollination that can occur in a chasmogamous bisexual flower.

(ii) Draw the diagram of a mature pollen grain released at the two-celled stage and label four parts in it.

Solution:

(A) Oogenesis in Human Females:

(i) Schematic representation of oogenesis:

Oogenesis is the process by which the female gametes, or ova, are produced in the ovaries. The stages of oogenesis are as follows:

- Oogonium (2n): The initial germ cells that undergo mitosis.
- Primary oocyte (2n): These are the oogonia that have entered prophase I of meiosis.
- Secondary oocyte (n): After completing meiosis I, the primary oocyte divides to form a secondary oocyte and a polar body.
- Mature ovum (n): The secondary oocyte completes meiosis II upon fertilization, forming a mature ovum and another polar body.

Oogonium (2n)	Primary Oocyte (2n)
Undergoes mitosis	Undergoes meiosis I

(ii) Chromosome number at each stage:

- Oogonium (2n): The chromosome number is diploid (46 chromosomes in humans).
- Primary oocyte (2n): Still diploid (46 chromosomes), but the cell is arrested in prophase I of meiosis.
- Secondary oocyte (n): Haploid (23 chromosomes). The primary oocyte undergoes meiosis I to form one secondary oocyte and one polar body.
- Mature ovum (n): Haploid (23 chromosomes). It completes meiosis II upon fertilization.

Life Phases and Oogenesis Stages:

- Pre-puberty: Oogonia undergo mitosis.
- At puberty: Primary oocytes begin meiosis I but arrest in prophase I until ovulation.
- During ovulation: A secondary oocyte is released.
- Fertilization: The secondary oocyte completes meiosis II to form the mature ovum.

(B) Pollination in Chasmogamous Bisexual Flowers:

(i) Three types of pollination:

1. Self-pollination: Pollen from the same flower or plant fertilizes the ovule. It can be autogamy (within the same flower) or geitonogamy (between different flowers of the same plant).
2. Cross-pollination: Pollen from one plant fertilizes the ovule of a different plant. This increases genetic diversity.
3. Insect pollination: Pollen is transferred between flowers by insects, such as bees, enhancing cross-pollination.

(ii) Diagram of a mature pollen grain at the two-celled stage:

The mature pollen grain consists of two cells:

- Generative cell: It divides to form two sperm cells during fertilization.
- Vegetative cell: It is larger and controls the growth of the pollen tube.

Diagram of pollen grain with 4 labeled parts:

Generative Cell	Vegetative Cell
Pollen Tube	Nucleus

Quick Tip

In oogenesis, meiosis is incomplete until fertilization. This ensures that the female gamete (ovum) is haploid, ready to merge with the male gamete during fertilization. In pollination, the main aim is to transfer pollen efficiently between flowers to ensure genetic diversity.

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32. Student to attempt either option (A) or (B).

(A)

(i) Explain how is a bacterial cell made 'competent' to take up recombinant DNA from the medium.

(ii) Explain the steps of amplification of gene of interest using PCR technique.

OR

(B)

(i) What are transgenic animals?

(ii) Why are these animals being produced? Explain any four reasons.

Solution:

(A) (i) Explain how is a bacterial cell made 'competent' to take up recombinant DNA from the medium.

- Bacterial cells are made competent to take up recombinant DNA through a process called chemical transformation or electroporation.
- In chemical transformation, bacteria are treated with calcium chloride ($CaCl_2$), which makes the cell membrane more permeable. This allows the recombinant DNA to enter the bacterial cell.
- In electroporation, an electrical shock is applied to the bacterial cells, which creates temporary pores in the cell membrane, allowing the DNA to enter.
- After this process, the bacterial cells are incubated, and only the cells that have successfully taken up the recombinant DNA will grow on selective media.

(ii) Explain the steps of amplification of gene of interest using PCR technique.

The Polymerase Chain Reaction (PCR) technique is used to amplify a specific gene of interest. The steps are as follows:

1. Denaturation: The DNA sample is heated to about 94-98°C to denature the DNA, causing the double-stranded DNA to separate into two single strands.
2. Annealing: The temperature is lowered to about 50-65°C to allow short DNA primers to bind (anneal) to the complementary sequences on the single-stranded DNA.
3. Extension: The temperature is raised to around 75-80°C, which is the optimal temperature for the enzyme Taq polymerase to extend the primers and synthesize the new DNA strand.
4. Amplification: These steps are repeated for 20-40 cycles, leading to exponential amplification of the target gene.

OR

(B) (i) What are transgenic animals?

- Transgenic animals are those that have been genetically modified by inserting a foreign gene into their genome. This gene can be from the same species or a different species.
- These animals express the foreign gene, which may impart a new trait, such as resistance to disease or the ability to produce a specific protein.

(ii) Why are these animals being produced? Explain any four reasons.

Transgenic animals are produced for various purposes, including:

1. Production of therapeutic proteins: Some transgenic animals are engineered to produce proteins like insulin, growth hormones, or antibodies in their milk, blood, or other bodily fluids.
2. Disease research: Transgenic animals are used to study human diseases by introducing specific genes associated with these diseases into the animals, allowing researchers to understand the progression and treatment.
3. Improved agricultural traits: Transgenic animals may be created to have better growth rates, disease resistance, or enhanced production of meat, milk, or eggs.
4. Pharmaceutical production: Transgenic animals are used in the production of biopharmaceuticals, such as in the case of ”pharming,” where animals are genetically modified to

produce medically useful proteins.

Quick Tip

In PCR, each cycle doubles the amount of DNA, leading to exponential amplification. The key to success in PCR is using a heat-stable polymerase enzyme like Taq polymerase.

33.

Student to attempt either option (A) or (B).

(A)

(i) Explain giving three reasons why tropics show greatest levels of species diversity.

(ii) Draw a graph showing species-area relationship. Name the naturalist who studied such relationship. Write the observation made by him.

OR

(B)

(i) The world is facing the accelerated rate of species extinctions due to human activities. Explain any three major causes of biodiversity losses.

(ii) Describe 'Ex situ' approach for conserving biodiversity. Give any two examples.

Solution:

(A) (i) Three reasons why tropics show greatest levels of species diversity:

1. Stable climate: The tropics have a warm, stable climate with little seasonal variation. This consistency allows for the evolution and survival of a wide range of species.

2. High primary productivity: The tropical regions, especially rainforests, have high primary productivity due to abundant sunlight, rainfall, and warm temperatures, supporting a wide range of organisms.

3. Ecological niches: The tropics have a diverse range of habitats, creating multiple ecological niches where different species can evolve and coexist.

(ii) Species-area relationship and the naturalist who studied it:

- The species-area relationship suggests that the number of species increases with the area of the habitat, but at a decreasing rate. This relationship is expressed mathematically as:

$$S = cA^z$$

where S is the number of species, A is the area of the habitat, and c and z are constants.
- The naturalist who studied this relationship is Robert H. MacArthur and E.O. Wilson. They are known for their work on the theory of island biogeography.
- Observation by them: They observed that larger islands tend to have more species than smaller islands, but the rate of increase of species number diminishes with increasing area. They concluded that the species diversity is also influenced by factors like immigration and extinction rates.

OR

(B) (i) Three major causes of biodiversity losses:

1. Habitat destruction: Destruction of natural habitats, like deforestation and urbanization, leads to the loss of biodiversity by reducing the area available for species to live and reproduce.
2. Pollution: Pollution of air, water, and soil adversely affects many species, disrupting ecosystems and causing species to either migrate or go extinct.
3. Climate change: Global warming alters habitats and climate patterns, forcing species to adapt, migrate, or face extinction due to unsuitable environmental conditions.

(ii) 'Ex situ' approach for conserving biodiversity:

- Ex situ conservation refers to the conservation of species outside their natural habitats. This method is used when in situ conservation is not possible. The main goal is to preserve species by maintaining them in controlled environments.

Examples:

1. Botanical gardens: These are places where plants are grown and conserved outside their natural habitat. They help protect endangered plant species and provide research opportunities.
2. Zoos and aquariums: These institutions house endangered animals in artificial environments and play a crucial role in breeding programs for species at risk of extinction.

Quick Tip

Tropical regions support a higher level of biodiversity due to stable environmental conditions and abundant resources, making them hotspots for various species. Ex situ conservation plays a critical role in preserving species that cannot be saved in the wild.
