CBSE 12 Biology (57/2/1) 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. An angiosperm embryo sac is located within the:

(A) Placenta

(B) Megasporangium

(C) Nucellus

(D) Ovary

Correct Answer: (C) Nucellus

Solution: In angiosperms, the embryo sac is located within the nucellus, which is a part of the ovule. The nucellus contains the female gametophyte, the embryo sac, where fertilization takes place.

Quick Tip

The embryo sac in angiosperms is found within the nucellus, which houses the ovule where fertilization occurs.

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

Column I Cross	Column II Phenotypic Ratio
1. Mendelian monohybrid	(i) 1 : 2 : 1 (F2)
2. Mendelian dihybrid	(iv) 9 : 3 : 3 : 1 (F2)
3. Incomplete dominance	(ii) 1 : 1
4. Test cross (monohybrid)	(iii) 3 : 1 (F2)

(A) 1-(ii), 2-(iv), 3-(1), 4-(iii)

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

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

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

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

Solution: - **Mendelian monohybrid cross (1):** This cross results in a phenotypic ratio of 3:1 in the F2 generation.

- **Mendelian dihybrid cross (2):** The phenotypic ratio in the F2 generation is 9:3:3:1.
- **Incomplete dominance (3):** In this case, the phenotypic ratio is 1:2:1 because of the blending of traits in the heterozygote.
- **Test cross (4):** A test cross between a heterozygous and a homozygous recessive plant results in a phenotypic ratio of 1:1 in the F2 generation.

Quick Tip

Mendel's laws of inheritance form the foundation of genetic ratios. Incomplete dominance results in a 1:2:1 ratio, while test crosses give a 1:1 ratio.

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3. 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: In humans, the secondary oocyte completes its second meiotic division only after it is penetrated by a sperm cell during fertilization. This step is critical for the oocyte to proceed to form a mature ovum.

Quick Tip

The completion of the secondary oocyte's meiotic division occurs during fertilization when the sperm enters the egg.

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4. 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 are similar due to shared ancestry, not because of convergent evolution. Convergent evolution leads to analogous structures, which perform similar functions but arise independently.

Quick Tip

Homologous structures result from common ancestry, while analogous structures arise from convergent evolution, leading to similar functions.

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5. 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 Hardy-Weinberg equilibrium, the frequency of heterozygotes (Aa) is given by $2pq$, where: - p is the frequency of allele A ($p = 0.6$) - q is the frequency of allele a ($q = 1 - p = 0.4$)

The frequency of genotype Aa is:

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

Quick Tip

In Hardy-Weinberg equilibrium, the frequency of heterozygotes is calculated by $2pq$, where p is the frequency of the dominant allele and q is the frequency of the recessive allele.

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6. 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: In the double helix structure of DNA, the two strands are complementary, meaning adenine pairs with thymine and cytosine pairs with guanine. The strands run in opposite directions (anti-parallel), with one strand oriented in the 5' to 3' direction and the other in the 3' to 5' direction.

Quick Tip

DNA strands are complementary (A with T, C with G) and anti-parallel, meaning one strand runs in the opposite direction of the other.

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7. 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: In transcription, the 'terminator' sequence is located at the 3' end of the coding strand. This is where the transcription process stops, and the newly synthesized RNA transcript is released.

Quick Tip

The terminator in transcription is located at the 3' end of the coding strand, signaling the end of RNA synthesis.

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8. A woman with normal vision has a colour blind father. She marries a man with normal vision. The percentage chance of their progeny being colour blind is:

(A) 25%

(B) 50%

(C) 75%

(D) 100%

Correct Answer: (A) 25%

Solution: Since the woman has a colour-blind father, she is a carrier ($X^N X^c$). Her husband, having normal vision, has the genotype $X^N Y$. Their offspring will have the following probabilities:

- Sons (XY) will inherit their father's Y chromosome and will not be colour-blind.
- Daughters ($X^N X^c$) will inherit one X chromosome from the mother and will be carriers (not colour-blind).

Thus, there is a 25 percent chance that a daughter could inherit the colour-blind allele, making her a carrier.

Quick Tip

Colour blindness is an X-linked recessive trait. A carrier female has a 50

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9. The vector for dengue fever is:

(A) Female Aedes mosquito

(B) Female Anopheles mosquito

(C) Male Aedes mosquito

(D) Female Culex mosquito

Correct Answer: (A) Female Aedes mosquito

Solution: The primary vector for the transmission of the dengue virus is the *Aedes* mosquito, particularly the female. The mosquito becomes infected by biting a person already infected with the dengue virus, and then it can transmit the virus to other individuals through bites.

Quick Tip

The female *Aedes* mosquito is responsible for the transmission of dengue fever, as it feeds on human blood and carries the virus.

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10. 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** is correctly associated with the production of **Butyric acid**. - **Trichoderma polysporum** is correctly associated with the production of **Cyclosporin A**. - **Monascus purpureus** is not correctly matched with Citric acid. This microorganism produces **Monacolin K**, used in the production of cholesterol-lowering drugs, not citric acid. - **Streptococcus** is correctly associated with **Streptokinase**, an enzyme used to dissolve blood clots.

Quick Tip

Some microorganisms are used in the production of industrial products, like antibiotics, enzymes, and acids. It is important to match the correct organism with its respective product.

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11. Which one of the following is not a feature of plasmids?

(A) Circular

(B) Self-replicating

(C) Single stranded

(D) Extra-chromosomal

Correct Answer: (C) Single stranded

Solution: Plasmids are typically **circular** and **extra-chromosomal**, meaning they are not part of the chromosome and can replicate independently. They are also usually **double-stranded**, not single-stranded.

Quick Tip

Plasmids are circular, double-stranded DNA molecules that replicate independently of chromosomal DNA and can carry genes, such as antibiotic resistance genes.

12. 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 the marine ecosystem, the biomass of fishes (which form the higher trophic levels) can exceed the biomass of phytoplankton (the primary producers) due to the rapid turnover rate of phytoplankton. This results in an inverted pyramid of biomass, where the primary producers have less biomass than the consumers.

Quick Tip

In ecosystems like the sea, the biomass pyramid can be inverted because the rapid turnover of small producers (phytoplankton) supports a large biomass of consumers (fishes).

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13. 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 the Assertion (A).

Solution: - **Assertion (A):** RNA is indeed more unstable compared to DNA due to the 2'-OH group in its sugar molecule, which makes it more prone to hydrolysis and

degradation. - **Reason (R):** The presence of the 2'-OH group in RNA makes it more reactive, contributing to its instability and higher mutation rate.

Quick Tip

The 2'-OH group in RNA makes it more reactive and prone to degradation, which explains its instability and higher mutation rate compared to DNA.

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14. 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: - **Assertion (A):** Virus-infected cells indeed produce interferons as a part of the antiviral defense mechanism to help other cells resist viral infection. - **Reason (R):** While interferons have a role in immune response, they do not directly cause inflammation in virus-infected cells. Instead, they enhance the immune system's ability to combat viruses.

Quick Tip

Interferons are cytokines released by virus-infected cells, but they do not directly cause inflammation. They help protect surrounding cells from viral infections.

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15. Assertion (A): Specific enzymes are used to degrade the cell wall in organisms to isolate the DNA from the cell.

Reason (R): Fungal cell wall is degraded by the enzyme cellulase.

(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: - **Assertion (A):** Specific enzymes like lysozyme and cellulase are indeed used to break down the cell walls to release DNA, particularly in plant and fungal cells. - **Reason (R):** While cellulase breaks down cellulose in plant cell walls, fungal cell walls are primarily made of chitin, not cellulose. Therefore, chitinase is the enzyme that would degrade fungal cell walls, not cellulase.

Quick Tip

For plant cells, cellulase is used to degrade the cell wall, while for fungi, chitinase is the enzyme used to break down the chitin-based cell wall.

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16. 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 the Assertion (A).

Solution: - Assertion (A): ”Loss of biodiversity can occur due to overexploitation of resources.” This is true. Overexploitation of natural resources, such as overfishing, deforestation, and excessive hunting, can lead to the loss of biodiversity. When species are exploited faster than they can reproduce, their populations decline, leading to a decrease in

biodiversity. Therefore, the assertion is correct.
- Reason (R): ”Introduction of *Clarias gariepinus* in Indian rivers has led to a decline in native Indian fishes.” This is also true. *Clarias gariepinus*, also known as the African catfish, was introduced into Indian rivers for aquaculture purposes. However, it became an invasive species and outcompeted native fish species for food and space, leading to a decline in the populations of native Indian fishes. While this is true, it does not directly explain the assertion about the overexploitation of resources leading to biodiversity loss. The introduction of an invasive species is a different factor that contributes to biodiversity loss, but it is not a direct consequence of overexploitation of resources.
Thus, both the assertion and reason are true, but the reason is not a direct explanation of the assertion. The correct answer is (B).

Quick Tip

Biodiversity loss can result from multiple factors, including overexploitation of resources and the introduction of invasive species. The introduction of *Clarias gariepinus* is an example of an invasive species that led to the decline of native fish populations in India.

SECTION B

17. (a) Name any two copper releasing intra-uterine devices. State two reasons that make them effective contraceptives.

Solution: Two copper-releasing intra-uterine devices (IUDs) are: 1. **Copper-T** 2. **Multiload Cu375**

These IUDs are effective contraceptives because: 1. They release copper ions, which create a hostile environment in the uterus, preventing sperm from fertilizing the egg.
2. They cause changes in the cervical mucus, making it thicker and less penetrable by sperm.

Quick Tip

Copper-releasing IUDs are highly effective as they not only prevent fertilization but also alter the uterine environment to reduce sperm mobility.

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

Solution: Two outbreeding devices developed by flowering plants to encourage cross-pollination are: 1. **Brightly colored flowers:** The bright colors attract pollinators like bees, birds, and butterflies, encouraging the transfer of pollen from one flower to another.
2. **Different flowering times:** Plants may have different flowering periods to ensure that they do not self-pollinate, thus promoting cross-pollination when different species or individuals flower at different times.

Quick Tip

Outbreeding devices like bright flowers and varying flowering times ensure cross-pollination, which increases genetic diversity in plants.

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

Solution: The two differences in inheritance patterns between Hemophilia and Sickle Cell Anemia are:
1. Hemophilia is X-linked recessive, meaning it is carried on the X chromosome and primarily affects males, while Sickle Cell Anemia is autosomal recessive, meaning it is inherited through non-sex chromosomes.
2. In Hemophilia, a single X chromosome carrying the defective gene is enough to express the disorder in males, but in Sickle Cell Anemia, both alleles must be defective (homozygous) for the disorder to be expressed in an individual.

Quick Tip

Hemophilia is X-linked, while Sickle Cell Anemia is autosomal. This difference affects the inheritance patterns, especially with regard to sex-linked transmission.

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

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

Quick Tip

These plants produce drugs that affect the nervous system in different ways: morphine (pain relief), THC (altered perception), and cocaine (stimulation and addiction).

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20. Write the role of 'ori' and restriction site in the cloning vector pBR322.

Solution: - ori (Origin of replication): The ori site in pBR322 allows the plasmid to replicate inside the host cell, ensuring that the vector is maintained and multiplied. - Restriction site: The restriction sites in pBR322 are where specific restriction enzymes can cut the plasmid to insert foreign DNA for cloning purposes.

Quick Tip

The ori site is essential for plasmid replication, and the restriction sites allow for the insertion of foreign DNA for genetic manipulation.

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

Solution: - Nature of detritus: Decomposition is faster when detritus (dead organic matter) is rich in easily degradable materials like proteins and sugars. Lignin and cellulose-rich materials decompose more slowly.

- Temperature: Higher temperatures generally increase the rate of decomposition by accelerating the activity of decomposers (bacteria and fungi), while lower temperatures slow down the process.

Quick Tip

Decomposition is influenced by both the chemical composition of detritus and environmental factors like temperature. Warmer temperatures and nutrient-rich materials promote faster decay.

SECTION C

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

Solution: IVF is so named because it involves fertilization that occurs outside the body (in vitro), meaning in a laboratory dish. The sperm and egg are combined in a petri dish for fertilization, and the resulting zygote is then implanted into the woman's uterus.

Importance: IVF helps in overcoming infertility in cases where other treatments have failed. It is particularly useful for women with blocked fallopian tubes, male infertility, or unexplained infertility.

Quick Tip

In vitro fertilization (IVF) is a groundbreaking technique in reproductive medicine, allowing fertilization to happen outside the body before implantation.

(b) Distinguish between GIFT and ZIFT.

Solution: - GIFT (Gamete Intra-Fallopian Transfer): In GIFT, eggs and sperm are placed directly into the fallopian tubes, where fertilization occurs naturally inside the body. - ZIFT (Zygote Intra-Fallopian Transfer): In ZIFT, fertilization occurs outside the body (in vitro), and the resulting zygote is transferred into the fallopian tube.

Quick Tip

While both GIFT and ZIFT involve transferring gametes or embryos into the fallopian tubes, GIFT places the gametes, and ZIFT places the zygote after fertilization.

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23. (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 egg provides the X chromosome and the sperm provides the Y chromosome.

- **Genetic Disorder:** The individual may have **Klinefelter syndrome**, a disorder caused by the presence of an extra X chromosome (XXY), leading to male infertility and other physical and developmental features.

Quick Tip

Klinefelter syndrome occurs when a male has an extra X chromosome. The typical karyotype is XXY instead of XY.

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

Solution: Two common symptoms of Klinefelter syndrome are:

1. Infertility: Due to underdeveloped testes and reduced sperm production.

2. Tall stature and long limbs: Affected individuals are typically taller than average, with longer arms and legs.

Quick Tip

Klinefelter syndrome leads to infertility and distinctive physical features, such as tall stature and longer limbs, due to an extra X chromosome.

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

Solution: The formation of an XX egg can occur due to a failure in meiosis, specifically during oogenesis. This error, known as non-disjunction, leads to an egg with two X

chromosomes instead of just one.

Quick Tip

Non-disjunction during meiosis can result in gametes with an abnormal number of chromosomes, leading to genetic disorders like Klinefelter syndrome.

OR

(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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24. (a) Explain the process by which amino acid gets attached to the tRNA molecule during translation process.

Solution: The amino acid is attached to the tRNA molecule by the enzyme aminoacyl-tRNA synthetase. The enzyme binds the appropriate amino acid to the corresponding tRNA molecule, ensuring that the tRNA carries the correct amino acid for protein synthesis. This process requires ATP.

Quick Tip

Aminoacyl-tRNA synthetase ensures that each tRNA molecule is charged with the correct amino acid before protein synthesis begins.

(b) How does the translation process get terminated?

Solution: Translation terminates when a stop codon (UAA, UAG, or UGA) is encountered in the mRNA sequence. Release factors bind to the stop codon, causing the ribosome to release the newly synthesized polypeptide and dissociate from the mRNA.

Quick Tip

The presence of a stop codon signals the end of translation, leading to the release of the polypeptide and termination of protein synthesis.

(c) Expand 'UTR'. Where are they located?

Solution: UTR stands for Untranslated Region. UTRs are regions in the mRNA that are transcribed but not translated into proteins. There are two types:

1. 5' UTR: Located before the start codon.
2. 3' UTR: Located after the stop codon.

Quick Tip

The UTRs play a role in regulating translation efficiency and mRNA stability, but they are not translated into proteins.

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25. (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.

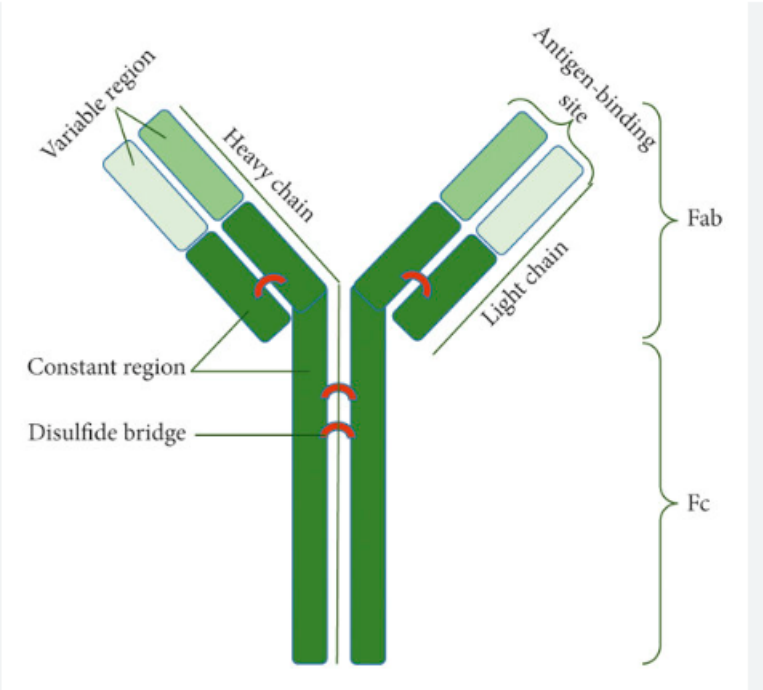
- Cell-mediated immune response: This response is carried out by T cells, particularly cytotoxic T cells, which target and destroy infected cells or cancerous cells. It does not involve antibodies.

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.

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

Solution:

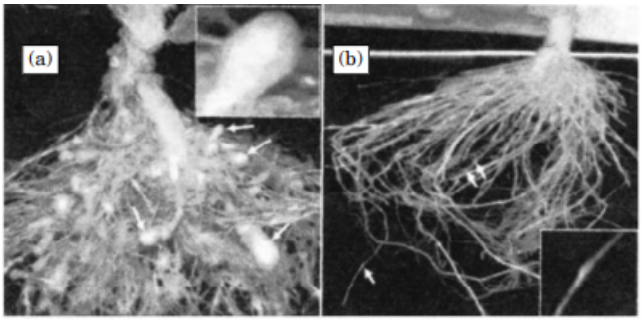


- An antibody molecule has a ”Y” shaped structure with two heavy chains and two light chains.
- Variable region: Located at the tips of the Y, it binds to the antigen.
- Constant region: The stem of the Y, which determines the class of antibody (IgG, IgM, etc.).
- Hinge region: Located between the arms of the Y, allows flexibility.
- Disulfide bonds: Hold the heavy and light chains together.

Quick Tip

The antibody’s variable region binds to antigens, and its constant region helps in immune cell recognition and activation.

26. The picture given below shows:



(a) Roots of a typical control tobacco crop plant (infected).

(b) Transgenic tobacco plant showing healthy roots even after deliberate infection by nematode.

Explain how this transformation was achieved in the tobacco plant.

Solution: The transformation in the tobacco plant was likely achieved by genetic modification using the bacterium *Agrobacterium tumefaciens*. This bacterium transfers a part of its DNA (T-DNA) into the plant's genome, conferring resistance to nematode infection. The transgenic plants were engineered to express genes that provide resistance to nematode damage, allowing them to grow healthy roots even after infection.

Quick Tip

Genetic engineering using *Agrobacterium tumefaciens* is commonly used to introduce resistance genes into plants, providing resistance to various pests and diseases.

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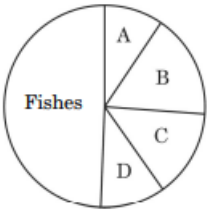
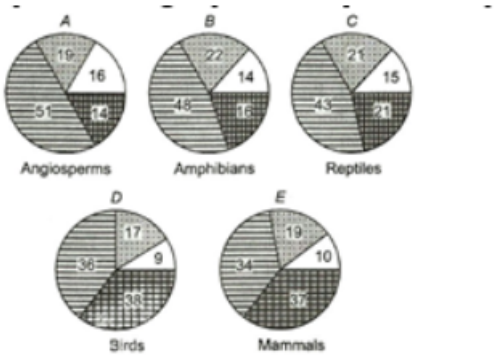
27. Given below is a pie chart representing global diversity of vertebrates.



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



(b) Mention two examples of recently extinct animals.

Solution: (a) The pie chart represents the global diversity of vertebrates. Based on the typical representation: - **A: Amphibians** - **B: Reptiles** - **C: Birds** - **D: Mammals** - The largest section corresponds to **Fishes**, as they represent the most diverse group among vertebrates.

Redrawn Pie Chart: (Diagram description or reference to external tools can be used for drawing the chart.)

(b) Two examples of recently extinct animals: 1. **Passenger Pigeon** (Ectopistes migratorius): Went extinct in 1914 due to overhunting and habitat destruction. 2. **Western Black Rhinoceros** (Diceros bicornis longipes): Declared extinct in 2011 due to poaching.

Quick Tip

Fishes are the most diverse group of vertebrates globally. Recent extinctions often result from human activities like habitat destruction and poaching.

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28. 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: Although predation is considered a detrimental interaction for prey, predators play several positive roles in an ecosystem, such as: 1. Maintaining Population Control: Predators prevent overpopulation of prey species, ensuring a balance in the ecosystem. **Example:** Wolves in Yellowstone National Park control the population of deer, preventing overgrazing of vegetation.

2. Promoting Biodiversity: Predators help maintain species diversity by preventing the dominance of any single prey species. **Example:** Starfish predation on mussels allows other

species to thrive in intertidal zones.

3. Regulating Food Web Dynamics: Predators play a key role in regulating food web dynamics, preventing the collapse of ecosystems. **Example:** Tigers regulate the populations of herbivores like deer in forests, ensuring the sustainability of vegetation.

Quick Tip

Predators maintain ecosystem balance by controlling prey populations, promoting biodiversity, and ensuring the stability of food webs.

SECTION D

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

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

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

OR

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

Solution: - Site of action of FSH: FSH (Follicle-Stimulating Hormone) acts on the **Sertoli cells** in the seminiferous tubules of the testes.

Action of FSH: It stimulates Sertoli cells to secrete **androgen-binding protein (ABP)**.

ABP maintains a high concentration of testosterone in the seminiferous tubules, which is essential for the progression of spermatogenesis.

OR

Role of LH in spermatogenesis: LH (Luteinizing Hormone) acts on the **Leydig cells** located in the interstitial space of the testes. It stimulates the Leydig cells to secrete **testos-**

terone, which plays a crucial role in the initiation and maintenance of spermatogenesis.

Quick Tip

FSH acts on Sertoli cells to enhance testosterone concentration in the seminiferous tubules, while LH acts on Leydig cells to produce testosterone.

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

(i) Mitosis and Differentiation: - Cells: **Spermatogonia** - Product: Primary Spermatocytes

(ii) Meiosis I and Meiosis II: - Meiosis I: - Cells: **Primary Spermatocytes** - Product: Secondary Spermatocytes - Meiosis II: - Cells: **Secondary Spermatocytes** - Product: Spermatids

Quick Tip

Mitosis leads to the formation of primary spermatocytes, while meiosis results in secondary spermatocytes and spermatids.

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

Solution: The sperms travel through the following accessory ducts:

1. **Rete testis**
2. **Vasa efferentia**
3. **Epididymis**

Quick Tip

Sperms travel through rete testis, vasa efferentia, and epididymis before reaching the vas deferens.

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

In 1981, the health workers of United States of America had become aware of the increased frequency of Kaposi's sarcoma, cancer of the skin. and blood vessels and another disease pneumocystis pneumonia, a respiratory infection caused by a protozoan. Both these diseases were very rare in the general population, but occurred frequently in more. severely "immunosuppressed" individuals. This led to the recognition of the immune system disorder that was named Acquired Immune Deficiency Syndrome (AIDS). In 1983, virologists working in the USA and France had identified a causative agent for 'AIDS', now known as Human Immunodeficiency Virus (HIV). "HIV" follows a set path to attack the human body to cause the disease.

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

Solution: - HIV primarily targets **CD4+ T-helper cells**.

- After entering the cell:

1. The viral RNA is converted into DNA by **reverse transcriptase**.
2. The viral DNA integrates into the host cell's genome using the enzyme **integrase**.
3. The host cell machinery is hijacked to produce viral particles, leading to the destruction of CD4+ cells.

Quick Tip

HIV attacks CD4+ T-cells, weakening the immune system and making the body vulnerable to opportunistic infections.

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

Solution: - The expanded form of the diagnostic test is **Enzyme-Linked Immunosorbent Assay (ELISA)**.

- Possible treatments: - The current treatment involves **Antiretroviral Therapy (ART)**. This therapy uses a combination of antiretroviral drugs to suppress viral replication, improve immune function, and prevent progression to AIDS.

Quick Tip

ART does not cure HIV but helps manage the infection and prolong the patient's life by suppressing the virus.

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

Solution: Two steps suggested by WHO for preventing the spread of HIV are: 1. **Safe sexual practices:** Use of condoms to prevent transmission through sexual contact. 2. **Screening of blood:** Ensuring all blood and blood products are screened for HIV before transfusion.

Quick Tip

Preventive measures like safe sexual practices and proper blood screening significantly reduce the risk of HIV transmission.

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

Solution: - AIDS weakens the immune system by destroying CD4+ T-cells, making the body unable to fight opportunistic infections. - Common infections include: - **Pneumonia (caused by Pneumocystis jirovecii)**. - **Tuberculosis (caused by Mycobacterium tuberculosis)**. - These infections, rather than HIV itself, lead to the death of the patient.

Quick Tip

AIDS compromises the immune system, allowing opportunistic infections to thrive, which ultimately leads to the patient's death.

SECTION E

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

Solution: - **Process of Double Fertilization:** 1. Pollen germination: Pollen grain germinates on the stigma, forming a pollen tube that grows through the style and enters the ovule via the micropyle. 2. Synergids: One synergid guides the pollen tube into the embryo sac. 3. Fertilization I (Syngamy): One male gamete fuses with the egg cell, forming a diploid zygote ($2n$). 4. Fertilization II (Triple Fusion): The second male gamete fuses with two polar nuclei in the central cell to form a triploid primary endosperm nucleus ($3n$). - **Ploidy of end products:** - Zygote: Diploid ($2n$). - Endosperm: Triploid ($3n$).

Quick Tip

Double fertilization is unique to angiosperms and ensures the formation of both the zygote and nutritive endosperm in the same reproductive cycle.

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

Solution: The endosperm develops before the embryo because it provides essential nutrients for the developing embryo, supporting its early growth and establishment.

Quick Tip

The endosperm acts as a nutritive tissue, ensuring that the embryo has sufficient resources during its development.

OR

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

Solution: - **Site of fertilisation:** The ampullary region of the fallopian tube. - **Process of fertilisation:**

1. The sperm reaches the ovum in the fallopian tube.

2. The sperm penetrates the zona pellucida layer of the ovum using acrosomal enzymes.

3. The sperm nucleus fuses with the egg nucleus, forming a diploid zygote. - **Prevention of polyspermy:**

- Cortical reaction: Once the sperm enters the ovum, cortical granules are released, altering the zona pellucida structure and preventing other sperms from entering.

Quick Tip

Polyspermy is prevented by changes in the zona pellucida after the entry of one sperm, ensuring a single fertilisation event.

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

Solution: - **Embryonic stage:** The blastocyst.

- **Process of implantation:**

1. The blastocyst reaches the uterus and attaches to the endometrial lining.
2. The trophoblast cells of the blastocyst invade the endometrium.
3. The endometrium grows around the blastocyst, anchoring it securely.

Quick Tip

Implantation ensures the embryo is securely attached to the uterus, allowing it to receive nutrients from the maternal blood supply.

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32. (a) (i) Compare the pattern of inheritance of flower colour in garden pea plant (violet/white) with snapdragon plant (red/white) on the basis of the following:

1. F_1 phenotypic expression.

2. Expected phenotypic and genotypic expression of F_2 generation.

3. Conclusion you reached at the end of the comparison.

Solution: 1. **F_1 phenotypic expression:**

- Garden pea: All F_1 plants are violet (dominant trait).

- Snapdragon: All F_1 plants are pink (incomplete dominance).

2. **F_2 generation:** - Garden pea:

- Phenotypic ratio: 3:1 (violet: white).

- Genotypic ratio: 1:2:1 (VV:Vv:vv).

- Snapdragon: - Phenotypic ratio: 1:2:1 (red: pink: white).

- Genotypic ratio: 1:2:1 (RR:Rr:rr).

3. **Conclusion:** - In garden pea, flower colour inheritance follows complete dominance.

- In snapdragon, flower colour inheritance follows incomplete dominance.

Quick Tip

Inheritance patterns can vary between traits, with some showing complete dominance (pea plant) and others incomplete dominance (snapdragon).

(a) (ii) List any two characteristics of pattern of inheritance of human blood group ABO.

Solution: 1. The ABO blood group exhibits **codominance**, where both A and B alleles are expressed equally in the AB blood group.

2. The blood group also shows **multiple allelism**, as there are three alleles (I^A, I^B, i) for a single gene.

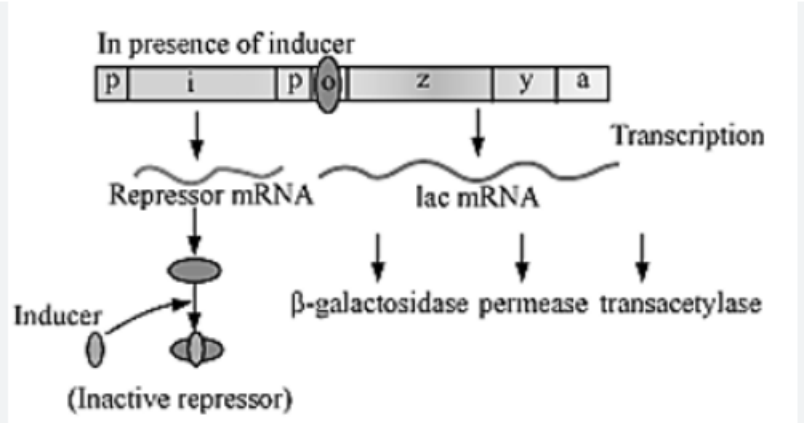
Quick Tip

The ABO blood group system is an example of codominance and multiple allelism, unique among genetic traits.

OR

(b) (i) Draw a schematic, self-explanatory labelled diagram of lac operon in a 'switched on' condition.

Solution:



(Provide a diagram description for lac operon in 'switched on' condition.)

Quick Tip

The lac operon is switched on in the presence of lactose, enabling the expression of genes involved in lactose metabolism.

(b) (ii) Why is regulation of lac operon referred to as negative regulation?

Solution: The lac operon is referred to as negative regulation because the operon is switched off by the binding of a repressor protein to the operator region in the absence of lactose. Lactose acts as an inducer by removing the repressor.

Quick Tip

Negative regulation involves the prevention of gene expression by a repressor protein in the absence of an inducer.

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

Solution: - Why should a cell be made competent? A cell needs to be made competent to allow the uptake of foreign DNA into its cytoplasm during genetic transformation.
- Competence using calcium ions: - Bacterial cells are treated with a solution of **calcium chloride ($CaCl_2$)**.
- Calcium ions create pores in the bacterial cell wall, allowing DNA to enter. - A heat-shock step (at $42^{\circ}C$) further facilitates DNA uptake by the bacterial cells.

Quick Tip

Competent cells are crucial in biotechnology to introduce plasmids or foreign DNA for genetic manipulation.

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

Solution: Gel electrophoresis is used to **separate DNA fragments** based on their size, allowing analysis, purification, or further genetic manipulations.

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

- DNA fragments are negatively charged due to their phosphate backbone. - When an electric current is applied, DNA fragments move towards the positive electrode.
- Smaller fragments move faster, while larger fragments move slower through the gel matrix.

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

Ethidium bromide is an intercalating dye that binds to DNA, fluorescing under UV light, which helps visualize DNA bands.

Quick Tip

Gel electrophoresis is a fundamental technique for DNA analysis, with ethidium bromide aiding in DNA visualization.

OR

(b) (i) How was Bt cotton the genetically modified crop, has greatly helped the cotton framers to increase their crop yield

Solution: Bt cotton was genetically modified by introducing a gene from the bacterium **Bacillus thuringiensis (Bt)**.

The Bt gene produces a protein toxic to bollworms but safe for other organisms.

When expressed in cotton plants, this protein provides resistance to bollworms.

Quick Tip

Bt cotton is an example of genetic engineering used in agriculture to combat pests without using excessive chemical pesticides.

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

Solution: 1. Bollworms ingest the Bt toxin while feeding on cotton plants.

2. In the insect's alkaline gut, the toxin is activated and binds to specific receptors in the gut lining.

3. This binding creates pores in the gut wall, leading to leakage of gut contents and eventual death of the insect.

Quick Tip

The Bt toxin is highly specific to certain insects, ensuring minimal harm to non-target organisms and the environment.
