CBSE EXAMINATION PAPER-2024

BIOLOGY

(Solved)

Time allowed : 3 hours | Maximum Marks : 81

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **40 questions.** All questions are **compulsory.**

ii. This question paper is divided into **5 sections.**

iii. **Section A** – questions number **1 to 5** are case based questions

iv. **Section B** – questions number **6 to 20** are multiple choice questions

v. **Section C** – questions number **21 to 26** are very short answer

vi. **Section D** – questions number **27 to 34** are short answer

vii. **Section E** – questions number **35 to 40** are long answer

viii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

ix. Use of calculator is NOT allowed.

Section A

Question 1.

Question 2.

Read the following passage and answer the questions that follow. 4

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.

Question 3.

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.

(1)

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

[2 Marks]

Answer: FSH (Follicle-Stimulating Hormone) acts on the Sertoli cells located in the seminiferous tubules of the testes. Its primary action is to stimulate the Sertoli cells to secrete factors that are essential for the process of spermiogenesis, which facilitates the maturation of spermatids into functional sperm.

Key Points: FSH acts on Sertoli cells - located in the seminiferous tubules - stimulates secretion of factors for spermiogenesis

(2)

Describe the role of LH in the process of spermatogenesis.

[2 Marks]

Answer: Luteinizing hormone (LH) plays a crucial role in spermatogenesis by stimulating the Leydig cells in the testis to produce androgens, specifically

testosterone. This increase in testosterone levels promotes the maturation of spermatogonia into sperm cells. Thus, LH indirectly facilitates the entire process of spermatogenesis by ensuring the necessary hormonal environment is present for the development and maturation of sperm.

Key Points: LH stimulates Leydig cells to produce testosterone-testosterone promotes maturation of spermatogonia-LH is essential for effective spermatogenesis

(3)

Name the cells and their products which undergo : 1

(i) Mitosis and Differentiation

(ii) Meiosis I and Meiosis II

during the process of spermatogenesis.

[1 Marks]

Answer: (i) The cells that undergo mitosis and differentiation are spermatogonia, which produce more spermatogonia. (ii) The cells that undergo meiosis I are primary spermatocytes which produce secondary spermatocytes, and the cells that undergo meiosis II are secondary spermatocytes which produce spermatids.

Key Points: Spermatogonia undergo mitosis; Primary spermatocytes undergo meiosis I; Secondary spermatocytes undergo meiosis II

(4)

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

[1 Marks]

Answer: The accessory ducts that the sperms travel through from the seminiferous tubules to reach the epididymis are the efferent ductules.

Key Points: efferent ductules

Question 4.

Read the following passage and answer the questions that follow.

In 1981, the health workers of United States of America had become aware of th 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.

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

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

Question 5.

Read the following passage and answer the questions that follow.

In 1981, the health workers of United States of America had become aware of th 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.

(1)

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

[1 Marks]

Answer: The group of cells that HIV attacks after gaining entry into the human body is the helper T-lymphocytes (TH). Within these cells, the viral RNA is reverse-transcribed into DNA, which then integrates into the host cell's DNA. This viral DNA directs the infected cell to produce virus particles, and eventually, progeny viruses are released into the blood to infect other helper T-lymphocytes.

Key Points: Helper T-lymphocytes (TH)-Viral RNA reverse transcribed to DNA-Integration into host DNA-Production of virus particles-Progeny viruses infect other TH cells

(2)

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

[1 Marks]

Answer: The expanded form of the diagnostic test used for detecting AIDS is Enzyme Linked Immuno-Sorbent Assay (ELISA). The possible treatment available for AIDS at present involves the use of anti-retroviral drugs, which are only partially effective in prolonging the life of the patient.

Key Points: Expanded form of ELISA; Anti-retroviral drugs for treatment; Treatment only partially effective

(3)

Mention any two steps suggested by WHO for preventing the spreadof this disease.

[2 Marks]

Answer: The World Health Organization (WHO) suggests several steps to prevent the spread of HIV/AIDS, including promoting safe sex practices such as the use of condoms and encouraging regular HIV testing to identify and treat those infected. These measures help reduce the transmission rate of the virus.

Key Points: Promoting safe sex practices-Encouraging regular HIV testing

(4)

"A patient suffering from AIDS does not die of this disease but fromsome other infection. Justify the statement.

[2 Marks]

Answer: AIDS, caused by the Human Immunodeficiency Virus (HIV), leads to a severe deficiency in the immune system, making patients highly susceptible to opportunistic infections. While AIDS itself is not the direct cause of death, it weakens the body's defenses, allowing other infections, such as pneumonia, to take hold and ultimately lead to death. The fatality in AIDS patients is primarily due to these secondary infections rather than the virus itself.

Key Points: HIV causes immune deficiency - AIDS patients are vulnerable to opportunistic infections - Death results from these infections, not directly from AIDS

Section B

Question 6.

An angiosperm embryo sac is located within the :

[1 Marks]

(A) Nucellus

(B) Ovary

(C) Placenta

(D) Megasporangium

Explanation:

The correct answer is 'Nucellus.' According to the provided context, the embryo sac, or female gametophyte, is located within the nucellus, which is a mass of cells that contains reserve food materials and is part of the ovule structure.

Question 7.

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

[1 Marks]

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

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

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

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

Explanation: The correct option is 1(iii), 2(i), 3(iv), 4(ii). This is because the items in Column I correspond accurately to the items in Column II based on their definitions or characteristics provided in the relevant context.

Question 8.

In humans, the secondary oocyte completes meiotic division when :

[1 Marks]

(A) acrosomal enzymes break down the zona pellucida.

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

(C) it is penetrated by the sperm cell.

(D) it gets implanted in the uterine endometrium.

Explanation: The secondary oocyte completes its meiotic division when it is penetrated by the sperm cell. This penetration triggers the final stages of meiosis, resulting in the formation of the ovum and the second polar body.

Question 9.

Which one of the following statements is not true ?

[1 Marks]

(A) Homology indicates common ancestry.

(B) Homologous organs have similar anatomical structure, but perform different functions.

(C) Homologous structures are a result of convergent evolution.

(D) Flippers of whales and dolphins are homologous organs.

Explanation: The statement 'Homologous structures are a result of convergent evolution.' is not true. Homologous structures arise from a common ancestor and reflect evolutionary relationships, while convergent evolution describes the development of similar traits in unrelated species due to similar environments or selective pressures, not common ancestry.

Question 10.

A population is in genetic equilibrium/Hardy-Weinberg equilibrium for a, if the frequency of AA is 0.6, then the frequency of genotype Aa is :

[1 Marks]

(A) 0.48

(B) 0.32

(C) 0.42

(D) 0.21

Explanation: In Hardy-Weinberg equilibrium, the frequencies of genotypes can be calculated using the formula p^2 + 2pq + q^2 = 1, where p is the frequency of allele A, and q is the frequency of allele a. Given that the frequency of AA (p^2) is 0.6, we have p = sqrt(0.6) = 0.775, thus q = 1 - p = 0.225. The frequency of Aa (2pq) can then be calculated as 2 * 0.775 * 0.225 = 0.34875, which corresponds to approximately 0.32. Hence, the frequency of genotype Aa is 0.32.

Question 11.

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

[1 Marks]

(A) anti-parallel and non-complementary

(B) anti-parallel and complementary

(C) identical and non-complementary

(D) identical and complementary

Explanation: The correct answer is 'anti-parallel and complementary' because in the double helical structure of DNA, the two strands run in opposite directions (anti-parallel) and the bases on each strand form complementary pairs (adenine with thymine, and cytosine with guanine).

Question 12.

In a transcription unit the terminator is located towards the :

[1 Marks]

(A) 3 end of the template strand

(B) 3 end of the coding strand

(C) 5 end of the coding strand

(D) 5 end of the template strand

Explanation: The correct answer is '3 end of the coding strand'. In transcription, the terminator is a sequence of DNA that signals the end of transcription. It is positioned at the 3' end of the coding strand, allowing RNA polymerase to terminate the synthesis of RNA.

Question 13.

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 :

[1 Marks]

(A) 75%

(B) 50%

(C) 25%

(D) 100%

Explanation: The woman with normal vision and a colour blind father is a carrier for the color blindness gene (XcX), while the normal vision man has normal vision (XY). The child can either inherit the normal X from the mother or the color blind X, and since the father has a normal vision Y chromosome, the potential outcomes are 50% male (normal vision) or 50% female (50% chance of color blindness if they inherit the color blind allele). Thus, the chance of color blindness in progeny is 25%.

Question 14.

The vector for dengue fever is :

[1 Marks]

(A) Male Aedes mosquito

(B) Female Culex mosquito

(C) Female Aedes mosquito

(D) Female Anopheles mosquito

Explanation: The correct answer is 'Female Aedes mosquito' because dengue fever is primarily transmitted to humans through the bite of infected female Aedes mosquitoes, particularly Aedes aegypti and Aedes albopictus.

Question 15.

Which one of the following pairs is not correctly matched ?

[1 Marks]

(A) Monascus purpureus Citric Acid

(B) Clostridium butylicum Butyric acid

(C) Trichoderma polysporum Cyclosporin A

(D) Streptococcus Streptokinase

Explanation: The correct option is 'Monascus purpureus Citric Acid'. Monascus purpureus is known for producing Monacolin K, not citric acid, making this pair incorrectly matched. The other pairs are correctly aligned with the respective acids or compounds they are known to produce.

Question 16.

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

[1 Marks]

(A) Circular

(B) Extra-chromosomal

(C) Self-replicating

(D) Single stranded

Explanation: The correct answer is 'Single stranded'. Plasmids are typically circular, double-stranded DNA molecules that exist as extra-chromosomal elements in bacteria and can replicate independently of chromosomal DNA. Therefore, they are not single-stranded.

Question 17.

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

[1 Marks]

(A) Large fishes feed on small fishes.

(B) Number of phytoplanktons is less.

(C) Biomass of fishes exceeds that of phytoplankton.

(D) Number of phytoplanktons is more.

Explanation: The correct option is 'Biomass of fishes exceeds that of phytoplankton.' This is due to the fact that in marine ecosystems, the biomass of top predators like large fish can be greater than that of the primary producers, such as phytoplankton. This contrasts with terrestrial ecosystems where biomass typically increases from producers to higher trophic levels.

Question 18.

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.

[1 Marks]

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

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

Explanation:

Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). RNA is indeed less stable than DNA due to the 2' hydroxyl (OH) group, which increases its susceptibility to hydrolysis, leading to a higher mutation rate.

Question 19.

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

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

[1 Marks]

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

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

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

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

Explanation:

Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). Virus-infected cells do produce interferons as a response to infection, which help in the immune response against the virus. However, the primary role of interferons is not to cause inflammation; rather, they are signaling proteins that help to activate immune responses and inhibit viral replication.

Question 20.

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.

[1 Marks]

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

(B) Both Assertion (A) and Reason (R) are true and Reason (R) is 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.

Explanation:

Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). Specific enzymes, including cellulase, are indeed employed to break down the cell walls of organisms such as fungi, which aids in isolating DNA, thus making the reason a correct explanation of the assertion.

Section C

Question 21. Name any two copper releasing intra-uterine devices. State two reasons that make them effective contraceptives.

[2 Marks]

Answer: Two copper releasing intra-uterine devices are the Copper T 380A and the Multiload 375. These devices are effective contraceptives for several reasons. Firstly, copper ions released from the devices create a toxic environment for sperm, reducing their motility and viability. Secondly, they also induce a local inflammatory response in the uterus, which prevents implantation of a fertilized egg. Thus, they work on both preventing fertilization and implantation.

Question 22. Name any two outbreeding devices that flowering plants have developed and explain how they help in encouraging cross-pollination.

[2 Marks]

Answer: Two outbreeding devices developed by flowering plants are temporal separation of flowering and dioecy. Temporal separation means that some plants release pollen at different times than their own stigma is receptive, reducing self-pollination. Dioecy refers to plants having male and female reproductive organs on separate individuals, requiring cross-pollination from another plant. These strategies increase genetic diversity and enhance the chances of successful reproduction by ensuring that plants cross-pollinate with genetically different partners.

Question 23. Although Haemophilia and sickle cell anemia are two blood related Mendelian disorders, yet, they differ in their pattern of inheritance. State any two differences.

[2 Marks]

Answer: Haemophilia is an X-linked recessive disorder primarily affecting males, while sickle cell anemia is an autosomal recessive disorder that affects both genders equally. In Haemophilia, females can be carriers without showing symptoms, but in sickle cell anemia, carriers may have mild symptoms. Both disorders involve different genes: Haemophilia involves the factor VIII gene, while sickle cell anemia involves the HBB gene responsible for hemoglobin production.

Question 24.

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

[2 Marks]

Answer: In the provided table, A is opium, which is derived from Papaver somniferum and acts as a depressant that slows down body functions. B is THC, the active component in Cannabis sativa, which acts as a stimulant and alters perception. C is cocaine, obtained from Erythroxylum coca, and functions as a stimulant increasing heart rate and energy. D remains unspecified but usually refers to the effect of cocaine on humans.

Question 25. How is the rate of decomposition affected by the nature of detritus and temperature?

[2 Marks]

Answer: The rate of decomposition is significantly influenced by the nature of detritus and temperature. Detritus that is easily digestible, such as soft plant material, decomposes faster than tougher materials like wood. Higher temperatures generally accelerate decomposition due to increased microbial activity. Warm conditions enhance enzymatic reactions, facilitating nutrient release from detritus. Thus, the combination of easily decomposable detritus and optimal temperatures leads to rapid decomposition rates.

Question 26.

Write the role of 'ori' and restriction site in the cloning vector PBR322.

[2 Marks]

Answer: 'ori' in PBR322 is the origin of replication, allowing the plasmid, when introduced into a host cell, to replicate independently. This region is crucial for ensuring the plasmid's persistence and copy number within the bacterial cells. The restriction sites, such as BamH I, are specific DNA sequences where restriction enzymes cut the DNA, enabling the insertion of foreign DNA. This specificity is vital for successful cloning and selection of recombinant plasmids.

Section D

Question 27.

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

(b) Distinguish between GIFT and ZIFT.

[3 Marks]

Answer: In vitro fertilization (IVF) is named 'in vitro' because it translates to 'in glass', referring to the process being carried out outside the human body, typically in a laboratory dish. IVF plays a crucial role in reproductive medicine by enabling individuals or couples facing infertility issues to conceive. It aids those with blocked fallopian tubes, ovulation disorders, or male factor infertility. Furthermore, IVF allows for genetic screenings before embryo transfer, increasing the chances of a healthy pregnancy. GIFT (Gamete Intrafallopian Transfer) involves placing sperm and eggs directly into a woman's fallopian tubes, allowing fertilization to occur in the natural environment, while ZIFT (Zygote Intrafallopian Transfer) involves transferring a fertilized egg (zygote) into the fallopian tube. The key difference is that GIFT uses unfertilized eggs, whereas ZIFT uses fertilized embryos.

Question 28.

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

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

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

[3 Marks]

Answer: The karyotype of an individual that develops from an 'XX' egg fertilized by a Y sperm would typically be 'XXY', leading to Klinefelter Syndrome. This genetic disorder occurs when an individual has an extra X chromosome, resulting from an abnormal division during meiosis. Symptoms of Klinefelter Syndrome may include reduced testosterone levels and infertility, often leading to delayed physical development. The formation of an 'XX' egg could result from errors during meiosis, such as nondisjunction, where chromosomes fail to separate properly, leading to an egg with two X chromosomes.

Question 29.

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.

[3 Marks]

Answer: Paternity can be determined by analyzing the DNA from a small sample of tissue or blood. Each individual carries a unique genetic fingerprint made up of DNA, which is inherited from both parents. This DNA is composed of sequences known as markers that are used in paternity tests. When a child is compared to a potential father, specific markers are examined for matches. If a significant number of markers align between the child and the alleged father, it is highly probable that he is the biological parent. Modern techniques, such as Polymerase Chain Reaction (PCR), enable the amplification of DNA

from minute samples, making it possible to perform accurate analyses even with very small amounts of biological material. Thus, even a drop of blood or a small tissue sample can provide conclusive evidence in determining paternity.

Question 30.

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

(b) How does the translation process get terminated ?

(c) Expand Where are they located ?

[3 Marks]

Answer: During translation, amino acids are attached to tRNA molecules through a process called tRNA charging or aminoacylation. This process is catalyzed by enzymes known as aminoacyl-tRNA synthetases. Each enzyme is specific for one amino acid and its corresponding tRNA. The amino acid is activated by ATP, forming an aminoacyl-AMP, which then reacts with tRNA to form aminoacyl-tRNA, releasing AMP and inorganic phosphate. Translation terminates when the ribosome reaches a stop codon. Release factors bind to the stop codon, prompting the ribosome to release the newly synthesized polypeptide chain. As for their location, while tRNA molecules are found in the cytoplasm where they transport amino acids, ribosomes that facilitate translation are located on the rough endoplasmic reticulum and freely in the cytoplasm.

Question 31.

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

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

[3 Marks]

Answer: Humoral immune response and cell-mediated immune response are two critical components of the adaptive immune system. The humoral immune response is primarily mediated by B cells which produce antibodies that target and neutralize pathogens in bodily fluids. These antibodies bind to specific antigens, leading to their elimination. In contrast, the cell-mediated immune response involves T cells that directly attack infected or cancerous cells. T cells recognize antigens presented on the surface of infected cells and induce apoptosis. While the humoral response is effective against extracellular pathogens, the cell-mediated response targets intracellular pathogens. Both responses are crucial for a robust immune defense.

Question 32.

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.

[3 Marks]

Answer: The transformation of the tobacco plant was achieved through genetic engineering techniques. Scientists used Agrobacterium tumefaciens, a bacterium that naturally transfers DNA to plant cells, to introduce specific genes into the tobacco plant's genome. These genes are typically derived from plants that have natural resistance to nematodes. Following the insertion of these resistance genes, the transformed cells were cultured and regenerated into whole plants. This process allows the plants to develop traits that enable them to withstand nematode infections, resulting in healthy roots despite the deliberate nematode challenge. This technique exemplifies the advancements in biotechnology for crop improvement.

Question 33.

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

(a) Redraw the pie chart identifying the groups and in their respective positions.

(b) Mention two examples of recently extinct animals.

[3 Marks]

Answer: To effectively redraw the pie chart representing global diversity of vertebrates, the following categories should be accurately placed: Fish, Amphibians, Reptiles, Birds, and Mammals. Each group should be represented with appropriate proportions correlated to their global diversity. In the second part, two examples of recently extinct animals are the Passenger Pigeon, which became extinct in the early 20th century due to overhunting and habitat loss, and the Tasmanian Tiger, also known as the Thylacine, which went extinct in the 1930s due to hunting and disease.

Question 34.

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.

[3 Marks]

Answer: Although predation is often viewed negatively, it plays several vital roles in maintaining ecosystem balance. First, predators help control prey populations, preventing overpopulation which can lead to resource depletion. For example, wolves in Yellowstone National Park control elk populations, allowing vegetation to recover, which supports other wildlife. Second, predators contribute to natural selection by culling weaker individuals, thus promoting healthier populations. An example is how large cats, like lions, select prey, favoring the fittest. Lastly, predators facilitate biodiversity by creating opportunities for diverse species to thrive. For instance, the presence of sharks helps regulate fish populations and maintain coral reef health, supporting various marine life.

Section E

Question 35.

(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.

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

[5 Marks]

Answer: Double fertilization is a unique phenomenon observed in angiosperms, beginning with the germination of pollen grains on the stigma. Upon germination, the pollen grain forms a pollen tube that grows down the style and enters the ovule through one of the synergids. Inside the synergid, the pollen tube releases two male gametes. One male gamete fuses with the egg cell to form a diploid zygote, while the other fuses with two polar nuclei in the central cell to form the triploid primary endosperm nucleus (PEN). This triploid endosperm, which provides nourishment to the developing embryo, develops before the embryo does. Synergids play a crucial role by guiding the pollen tube to the egg cell and facilitating the entry of male gametes, ensuring successful fertilization. The end products of this process are a diploid zygote and a triploid endosperm, essential for seed development.

Question 36.

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

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

[5 Marks]

Answer: In human females, the site of fertilization of the ovum is the fallopian tube, specifically the ampulla region. The fertilization process begins when sperm travel through the female reproductive tract to the fallopian tubes, where they encounter the ovum. Upon reaching the ovum, sperm undergo acrosome reaction, releasing enzymes that help penetrate the zona pellucida surrounding the ovum. Once a single sperm successfully penetrates the ovum's membrane, fertilization occurs, resulting in the formation of a zygote. To prevent polyspermy—when multiple sperm penetrate an ovum—several mechanisms are in place. Firstly, a fast block occurs where the depolarization of the ovum's membrane prevents further sperm from gaining entry. Secondly, a slower block involves the release of cortical granules, which causes changes to the zona pellucida, making it impermeable to additional sperm. These mechanisms ensure that typically only one sperm fertilizes the ovum, maintaining normal embryo development. Understanding this vital reproductive process highlights the complexity and efficiency of human reproduction.

Question 37.

(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) F1 phenotypic expression;

(2) expected phenotypic and genotypic expression of F2 generation;

(3) the conclusion you reached at the end of the comparison made.

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

[5 Marks]

Answer: In garden pea plants, violet flower color (W) is dominant over white (w). Consequently, pure breeding violet (WW) crossed with white (ww) yields all violet F1 progeny (Ww). In the F2 generation, the expected ratio is 3:1 (violet:white), resulting from a 1:2:1 genotypic ratio of WW, Ww, and ww. Conversely, snapdragon flowers display incomplete dominance, where red (RR) and white (rr) parents produce pink (Rr) F1s. F2 generation results in a 1:2:1 ratio of RR, Rr, and rr, leading to red, pink, and white flowers. Thus, while pea color follow complete dominance, snapdragons illustrate incomplete dominance. In human ABO blood group inheritance, traits are determined by co-dominance (A and B alleles) and multiple alleles (A, B, O). Hence, inheritance patterns vary significantly across species.

Question 38.

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

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

[5 Marks]

Answer: The lac operon is a classic example of gene regulation in prokaryotes, particularly in E. coli. In the switched-on condition, it is activated in the presence of lactose. The diagram consists of three structural genes: lacZ, lacY, and lacA, which code for beta-galactosidase, permease, and transacetylase, respectively. In this state, lactose binds to the repressor protein, causing it to undergo a conformational change and release from the operator region. This removal allows RNA polymerase to bind to the promoter and initiate transcription of the structural genes. The presence of cyclic AMP (cAMP) further enhances the activity of RNA polymerase when it binds to the cAMP receptor protein (CRP), facilitating the transcription process. As a result, the operon is efficiently transcribed, leading to the production of the enzymes necessary for lactose metabolism. The schematic should clearly label the operon, the repressor, and the binding sites, as well as indicating the regulatory role of lactose and cAMP in the activation of the lac operon.

Question 39.

(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.

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

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

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

[5 Marks]

Answer: Making a cell competent allows it to take up alien DNA, which is crucial for various applications in biotechnology, including gene cloning, the production of recombinant proteins, and genetic engineering. Competent cells can incorporate plasmids or other DNA sequences from their environment, enabling researchers to introduce desired traits into the organisms. A common technique to make bacterial cells competent involves treatment with calcium ions. The process starts by suspending bacterial cells in a cold calcium chloride solution, which increases the permeability of the cell membrane. Once treated, these cells are often subjected to a heat shock, which prompts the uptake of the alien DNA present in the surrounding environment. This method is widely employed in molecular biology for transforming Escherichia coli and other bacteria, facilitating genetic manipulation for research and industrial applications.

Question 40.

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

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

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

[5 Marks]

Answer: Bt cotton has been engineered to contain a gene from the bacterium Bacillus thuringiensis (Bt), which produces a protein known as Cry protein that is toxic to certain pests, particularly bollworms. The process begins with the identification of the desired Gene of Interest (the Bt gene) which is introduced into the cotton plant's genome using techniques such as Agrobacterium-mediated transformation or biolistic gene transfer. Once the gene integrates into the cotton's DNA, it allows the plant to produce the Cry protein throughout its tissues. When bollworm larvae feed on the leaves of Bt cotton, they ingest the Cry protein. Inside the bollworm's gut, the alkaline environment activates the protein, which then binds to specific receptors on the gut cells, causing cell lysis and, subsequently, the insect's death. This allows the cotton plant to effectively defend itself against these pests, significantly reducing crop damage, minimizing the need for chemical insecticides, and resulting in higher yields for farmers. Moreover, by controlling the bollworm population, Bt cotton has contributed to sustainable agricultural practices, fostering a healthier ecosystem and reducing pesticide reliance.