CBSE EXAMINATION PAPER-2023

BIOLOGY

(Solved)

Time allowed : 3 hours | Maximum Marks : 80

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **38 questions.** All questions are **compulsory.**

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

iii. **Section A** – questions number **1 to 4** are case based questions

iv. **Section B** – questions number **5 to 18** are multiple choice questions

v. **Section C** – questions number **19 to 24** are very short answer

vi. **Section D** – questions number **25 to 32** are short answer

vii. **Section E** – questions number **33 to 38** 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.

The following pedigree chart shows the inheritance of a genetic disorder up to three generations of a family. Observe the chart and answer the questions that follow.

If the mother 'B' is a carrier of the disease, what will be the probability of their daughter being a sufferer of this disease?

[1 Marks]

Answer: If the mother 'B' is a carrier of the genetic disorder, the probability of their daughter being a sufferer of the disease is 0% if the disease is an X-linked recessive disorder and she inherits an unaffected X chromosome from her father. If she inherits the affected X chromosome from her mother, her probability would be 50%; thus, the overall probability of the daughter being a sufferer is 0% in cases where she receives the healthy X from her father.

> Key Points: Probability consideration based on X-linked inheritance-Carrier status of mother-Impact of father's contribution to daughter's genotype

(2)

(ii) Is it a recessive or a dominant disorder?

[1 Marks]

Answer: The genetic disorder shown in the pedigree chart is a recessive disorder. This is determined by observing that the trait skips generations and is only expressed when an individual inherits two copies of the mutated gene.

> Key Points: Recessive disorder- trait skips generations- expressed only with two copies of mutated gene

(3)

Write the genotypes of the individuals 'C', 'D' and 'H'.

[1 Marks]

Answer: The genotypes of the individuals are as follows: Individual C: Bb (heterozygous), Individual D: BB (homozygous dominant), Individual H: bb (homozygous recessive).

Key Points: Identify genotypes from pedigree; Use Mendelian principles; Dominance and recessiveness of alleles

(4)

If the female 'D' marries a normal man, what will be the probability of their daughter being a sufferer of this disease?

[1 Marks]

Answer: The probability of their daughter being a sufferer of the disease is 0% if the disorder is inherited in an autosomal recessive manner and 'D' is a carrier. However, if 'D' is affected (i.e., has the disease), then there is a 50% chance that she will pass the affected allele to her daughter.

Key Points: Probability is based on the inheritance pattern; consider whether 'D' is a carrier or affected; daughters receive one X chromosome from each parent.

(5)

Is the disease sex-linked or autosomal as per the chart ? Give reasons in support of your answer.

[1 Marks]

Answer: The disease is sex-linked because it shows a pattern of inheritance where primarily males are affected and it is transmitted from carrier females to their male offspring, which indicates it is likely X-linked.

Key Points: Diseases can be sex-linked or autosomal - Sex-linked traits often show more males affected - Transmission from carrier females to males indicates X-linked inheritance

Question 3.

The diagram shows the life cycle of a pathogenic protozoan

Question 4.

The diagram shows the life cycle of a pathogenic protozoan.

(1)

Name the parasitic stage that is being transfered from host 'X' to host 'Y'.

[1 Marks]

Answer: The parasitic stage being transferred from host 'X' to host 'Y' is the sporozoite stage of the Plasmodium parasite.

Key Points: parasitic stage-sporozoite-host transmission-Plasmodium

(2)

Write the changes the parasite undergoes in the liver.

[1 Marks]

Answer: In the liver, the Plasmodium parasite multiplies within liver cells before targeting red blood cells, leading to their rupture.

Key Points: Multiplication within liver cells-RBC attack-RBC rupture

(3)

Write the changes the parasite undergoes when it enters the RBC.

[1 Marks]

Answer: When the Plasmodium parasite enters the red blood cells (RBCs), it undergoes transformations that lead to its multiplication. Initially, it invades the RBCs, where it feeds on hemoglobin. As it multiplies, it causes the RBCs to rupture, releasing the toxic substance haemozoin, which leads to symptoms such as chills and fever in the host.

Key Points: Entering RBCs - Feeding on hemoglobin - Multiplication - Rupturing of RBCs - Release of haemozoin - Symptoms

(4)

Trace the changes parasite undergoes when the host 'X' takes the the blood meal from infected host 'Y'.

[1 Marks]

Answer: When host 'X' takes a blood meal from infected host 'Y', the Plasmodium parasite is transferred into host 'X' along with the blood. Once in the bloodstream, the parasite infects red blood cells, leading to its multiplication and development. This process continues until the mature parasites are released back into the bloodstream, causing the disease symptoms.

Key Points: transfer of Plasmodium to host X - infection of red blood cells - multiplication in host X

(5)

At which stage during the life cycle of the pathogen does the host 'Y' experience the symptoms of the diseas. e ? Name thedisease and the toxic substance responsible for these symptoms.

[1 Marks]

Answer: The host 'Y' experiences symptoms of amoebiasis after the Entamoeba histolytica invades the large intestine. The toxic substance responsible for these symptoms is E. histolytica's secreted enzymes and toxins that cause tissue damage.

Key Points: Entamoeba histolytica - amoebiasis - toxins causing tissue damage

Section B

Question 5.

Choose the set of sex determining chromosomes that indicates the correct sex of the respective organism.

[1 Marks]

(A) Homozygous sex chromosomes (XX) produce male sex in Drosophila

(B) Homozygous sex chromosomes (ZZ) determine female sex in birds

(C) XO type of sex chromosomes determine male sex in grasshoppers

(D) XXY condition in humans, as found in Turner Syndrome, determines male sex

Explanation:

The correct option is 'XO type of sex chromosomes determine male sex in grasshoppers.' In grasshoppers, males have an XO chromosome configuration where they have one X chromosome and no second sex chromosome, whereas females have two X chromosomes. The other options provided are incorrect because: homozygous sex chromosomes (ZZ) determine male sex in birds, not female; homozygous sex chromosomes (XX) produce female, not male, in Drosophila; and the XXY condition in humans corresponds to Klinefelter syndrome, not Turner Syndrome, which is characterized by a single X chromosome (monosomy).

Question 6.

Given below is a list of steps Meselson and Stahl carried out in their experiment to prove that DNA replication is semi-conservative. Select the option that gives the correct sequence of steps followed by them.

(i) Bacteria transferred to a N14 medium and sampled every 20 minutes.

(ii) All bacteria contain hybrid DNA (N14 DNA and N15 DNA).

(iii) Bacteria grown in N15 medium for many generations.

(iv) All bacteria contain N15 DNA.

(v) Bacteria contain either all N14 DNA or all hybrid DNA.

[1 Marks]

(A) (ii) (iv) (iii) (i) (v)

(B) (iii) (iv) (i) (ii) (v)

(C) (iv) (iii) (ii) (v) (i)

(D) (i) (ii) (v) (iv) (iii)

Explanation:

The correct sequence is (iii) (iv) (ii) (i) (v). First, they grew bacteria in N15 medium (iii) until all DNA was N15 (iv). After that, they transferred them to N14 medium, where they observed that the DNA became hybrid (ii) and later concluded that the bacteria contain either all

N14 DNA or all hybrid DNA (v). This progression confirms the semi-conservative nature of DNA replication.

Question 7.

Identify the option that gives the correct type of evolution exhibited by the two animals shown, living in the same habitat in Australia.

[1 Marks]

(A) Disruptive Selection

(B) Convergent Evolution

(C) Divergent Evolution

(D) Homologous Ancestry

Explanation:

The correct answer is Convergent Evolution. This type of evolution occurs when unrelated species develop similar traits due to adapting to similar environments or ecological niches, which is common when two animals live in the same habitat.

Question 8.

Which of the following options correctly matches the name of the hormone to its site of production in the human body?

[1 Marks]

(A) P-i, Q-iv, R-iii, S-ii

(B) P-iii, Q-iv, R-i, S-ii

(C) P-ii, Q-iii, R-i, S-iv

(D) P-i, Q-iii, R-ii, S-iv

Explanation: According to the context, (i) refers to peptide, polypeptide, protein hormones produced by organs like gastrointestinal tract, kidney, heart, etc. (ii) indicates steroids such as cortisol and other steroid hormones. (iii) refers to iodothyronines (thyroid hormones). (iv) includes amino-acid derivatives such as insulin and glucagon. Therefore, the correct matching of hormone names to their sites/types of production would be P-i (peptide hormones), Q-iv (amino-acid derivatives like insulin), R-iii (iodothyronines or thyroid hormones), and S-ii (steroids such as cortisol).

Question 9.

Which of the following seeds have remained alive for the longest period?

[1 Marks]

(A) Yucca gigantea

(B) Mangifera indica

(C) Striga asiatica

(D) Phoenix dactylifera

Explanation:

Phoenix dactylifera, commonly known as date palm seeds, have been reported to remain viable for over 2,000 years, making them the seeds that have remained alive for the longest period compared to the other options.

Question 10.

Select the options which is/are incorrect statement(s) with respect to T-lymphocytes in the human body.

(i) They are a type of white blood cells.

(ii) They are produced in bone marrow.

(iii) They remain active at all times in the body.

(iv) They mature in the bone marrow.

[1 Marks]

(A) (i) and (iv) only

(B) (iii) only

(C) (iv) only

(D) (iii) and (iv) only

Explanation:

The incorrect statements are (iii) and (iv) only. T-lymphocytes do not remain active at all times in the body; they are activated in response to specific antigens. Additionally, while T-lymphocytes originate in the bone marrow, they mature in the thymus gland, not in the bone marrow.

Question 11.

Human settlement often leads to habitat loss which leads to fragmentation, forming smaller patches of habitats. Select the statements that describe how a small patch differs from a large patch of the same habitat.

(i) Invasive species will never be seen here.

(ii) Population of large animals decreases.

(iii) Biodiversity decreases.

(iv) Competition from surrounding habitats increases.

[1 Marks]

(A) (ii), (iii) and (iv) only

(B) (ii) and (iv) only

(C) (i) and (iii) only

(D) (i), (ii) and (iii) only

Explanation:

The correct option is (ii), (iii) and (iv) only. In smaller patches, the population of large animals declines due to insufficient space and resources. Biodiversity is lower in smaller habitats because they can support fewer species. Additionally, competition with surrounding habitats increases, as species are forced into a smaller area and compete for limited resources.

Question 12.

Identify the option that does not exhibit a parasitic relationship.

[1 Marks]

(A) Ticks on dogs

(B) Head lice in humans

(C) Female Anopheles

(D) Cuscuta on a mango tree

Explanation:

The correct answer is 'Female Anopheles' because while it is a blood-feeding mosquito, it is not a parasite in the same way the other options are. Head lice, Cuscuta, and ticks are all true parasites that depend on their hosts for survival, whereas Female Anopheles primarily seek blood meals for reproduction but do not necessarily harm the host in a parasitic sense.

Question 13.

Which of the following is commonly known as baker's yeast?

[1 Marks]

(A) Penicillium notatum

(B) Monascus purpureus

(C) Propionibacterium sharmanii

(D) Saccharomyces cerevisiae

Explanation:

The correct answer is Saccharomyces cerevisiae, as this species of yeast is widely used in baking due to its ability to ferment sugars, producing carbon dioxide and alcohol, which helps in the rising of dough.

Question 14.

The given schematic illustration shows three steps 'P', 'Q' and 'R' of the I polymerase chain reaction.

Which of the following statements are correct with reference to the illustration given above?

(i) Step 'P' is showing denaturation at low temperature.

(ii) Step 'Q' is a denaturation of DNA strand at high temperature, followed by annealing.

(iii) Step 'R' is an extension of DNA in presence of thermostable DNA polymerase.

(iv) Step 'Q' is extension with two sets of primers.

[1 Marks]

(A) (ii) only

(B) (i) and (iii) only

(C) (ii) and (iii) only

(D) (i) only

Explanation:

The correct statements are (ii) and (iii) only. In the polymerase chain reaction, step 'Q' involves the denaturation of DNA strands which occurs at a high temperature (around 94-98°C), while step 'R' is correctly identified as the extension phase where DNA polymerase synthesizes a new DNA strand. Statement (i) is incorrect because denaturation occurs at high temperature, not low. Statement (iv) is also incorrect because the extension does not involve two sets of primers.

Question 15.

Assertion (A): In humans the genotype with all the dominant alleles (AABBCC) will have the darkest skin color.

Reason (R): In a polygenic trait, phenotype reflects the contribution of each allele.

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

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

Explanation:

Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). While the genotype AABBCC is associated with darker skin color due to having all dominant alleles, the reason provided explains the nature of polygenic inheritance, which does not specifically justify why this particular genotype results in the darkest skin color.

Question 16.

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

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

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

Explanation:

Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). The decrease in the number of white-winged moths was primarily due to pollution caused by industrialisation, such as soot from factories, rather than being directly linked to the effects of industrialisation being more prominent in rural areas.

Question 17.

Assertion (A): More and more children in metro cities of India suffer from allergies and asthma due to sensitivity to the environment.

Reason (R): Modern day lifestyle and a protected environment in early life has resulted in lowering the immunity.

[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) because the protective environment often limits exposure to common allergens and pathogens, which can lead to a weaker immune system, making children more susceptible to allergies and asthma.

Question 18.

Assertion (A): The Mediterranean orchid Ophrys uses sexual deceit to get pollinated by a species of bee. Reason (R): The female bee changes its colour depending on the temperature of the area.

[1 Marks]

(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.

Explanation:

Assertion (A) is true because the Ophrys orchid mimics the appearance and scent of female bees to attract male bees for pollination. Reason (R) is false because the female bee's coloration does not depend on the temperature of the area. Therefore, the correct answer is: Assertion (A) is true, but Reason (R) is false.

Section C

Question 19.

(a) Explain the process of the development of a male gametophyte in an angiosperm.

(b) Why is it called a male gametophyte ?

[2 Marks]

Answer: The male gametophyte in angiosperms develops from microspores, which are formed through meiosis in the anthers. Each microspore undergoes mitosis to form a pollen grain, consisting of two cells: the generative cell and the tube cell. The pollen grain is then released from the anther during pollination. The male gametophyte is called so because it produces male gametes, specifically sperm cells, necessary for fertilization with the female gametophyte.

Question 20.

(a) Write the first step the primary effluent undergoes when it enters the secondary treatment plant and state the purpose.

(b) What is the level of B.O.D indicative of in the secondary treatment plant ? Mention its significance.

[2 Marks]

Answer: The first step that primary effluent undergoes when it enters the secondary treatment plant is aeration. During aeration, air is introduced to the effluent, which promotes the growth of aerobic microorganisms. The purpose of this step is to enhance the microbial breakdown of organic matter present in the effluent, improving its quality before further treatment. The Biochemical Oxygen Demand (B.O.D) level indicates the amount of organic material that can be biologically degraded, reflecting the efficiency of the treatment process. A lower B.O.D signifies better treatment and less pollution potential.

Question 21.

Given below is a food web that involves nine organisms.

(a) Identify two producers and two carnivores shown in the food web.

(b) Is it possible to make an ecological pyramid depicting this food web ? Give reason in support of your answer.

[2 Marks]

Answer: Two producers from the food web are grass and shrubs, as they generate energy through photosynthesis. Two carnivores are rabbits and snakes, which consume other organisms for energy. An ecological pyramid can be created for this food web, as it illustrates the hierarchical structure of energy flow, with producers at the base, followed by herbivores and then carnivores at higher levels. This visual representation helps understand the energy transfer.

Question 22.

Illustrate with the help of an example how introduction of an alien species turns invasive and causes decline of an indigenous species.

[2 Marks]

Answer: The introduction of the predatory brown tree snake (Boiga irregularis) to Guam is a notable example of an alien species causing the decline of indigenous species. The snake was accidentally brought to the island and quickly overpopulated due to the absence of natural predators. Its invasion led to the decline and extinction of several native bird species that were not adapted to deal with such a predator, significantly altering Guam's ecosystem.

Question 23.

Explain how recombinant DNA technology is used to detect a disease even before any clinical symptom appears.

[2 Marks]

Answer: Recombinant DNA technology enables early disease detection through techniques like PCR (polymerase chain reaction) and genetic sequencing. By isolating specific DNA sequences associated with a disease-causing pathogen, scientists can identify its presence in an individual even before symptoms manifest. This allows for prompt intervention or treatment, enhancing the chances of successful outcomes. Early detection is crucial for managing conditions like genetic disorders or infections, improving patient prognosis.

Question 24.

'Insertion inactivation' is metjod to detect recombinant DNA . Explain the method?

[2 Marks]

Answer: Insertion inactivation is a technique used to detect recombinant DNA by inserting it within the coding sequence of the β-galactosidase enzyme. This insertion inactivates the enzyme production. When bacteria containing the plasmid are cultured on a chromogenic substrate, colonies with no insert produce blue color, indicating non-recombinant DNA. In contrast, colonies with the insert remain colorless, marking them as recombinant. This method aids in identifying successful genetic engineering.

Section D

Question 25.

(i) How many types of RNA polymerases are there in a eukaryote cell ? Mention which one of them transcribes hnRNA.

(ii) Write the changes that hnRNA undergoes before it leaves the nucleus as mRNA.

[3 Marks]

Answer: In eukaryotic cells, there are three main types of RNA polymerases: RNA polymerase I, RNA polymerase II, and RNA polymerase III. RNA polymerase II is responsible for transcribing heterogeneous nuclear RNA (hnRNA), which is the precursor to mRNA. Before hnRNA exits the nucleus, it undergoes several important modifications to become mature mRNA. These changes include the addition of a 5' cap, which protects the RNA and aids in ribosome binding, followed by splicing where introns are removed and exons are joined together. Lastly, a poly-A tail is added to the 3' end, enhancing stability and export of the mRNA from the nucleus.

Question 26.

The length of DNA in any cell is far greater than the dimension of its nucleus. Explain how this enormous DNA is packaged in a eukaryotic cell.

[3 Marks]

Answer: In eukaryotic cells, DNA is packaged into a compact structure called chromatin. This process involves the wrapping of DNA around histone proteins, forming nucleosomes, which resemble 'beads on a string.' Each nucleosome consists of a segment of DNA wound around a core of histone proteins, aiding in the organization and reduction of DNA length. The nucleosomes further coil and stack together to form higher-order structures, such as solenoids and loops, that eventually compacts into chromosomes during cell division. This efficient organization allows the enormous DNA to fit within the nucleus while still being accessible for processes like transcription and replication. Additionally, regulation of chromatin structure plays a crucial role in gene expression.

Question 27.

Expand and explain the following techniques used in the Test Tube Baby' programme:

(a) GIFT

(b) ZIFT

(c) IUI

[3 Marks]

Answer: GIFT (Gamete Intrafallopian Transfer) involves placing both sperm and eggs directly into the fallopian tubes, allowing fertilization to occur naturally. This technique helps in cases of unexplained infertility or when traditional IVF is not suitable. ZIFT (Zygote Intrafallopian Transfer) is similar, but it involves transferring a fertilized zygote into the fallopian tube. This method is often used when there are issues with the uterus or if the couple seeks a more natural conception process. IUI (Intrauterine Insemination) involves placing sperm directly into the uterus around the time of ovulation, increasing the chances of fertilization. This less invasive technique is commonly used for couples with mild infertility issues. Each method aligns with the specific needs and medical conditions of the intending parents, enhancing the likelihood of conception.

Question 28.

Given below is a diagrammatic sectional view of a seminiferous tubule. State the developmental process of :

(a)(i) b' from 'a'.

(ii) 'e' from 'd'.

(iii) 'd' from 'b'.

(b) Identify 'a', 'b' and 'c'.

[3 Marks]

Answer: (a) (i) 'b' represents spermatogonia, which are formed from 'a', where spermatogenesis initiates. These are diploid stem cells that undergo mitosis to produce primary spermatocytes. (ii) 'e' is the spermatozoa, developed from 'd', the spermatid, after a process called spermiogenesis. Here, round spermatids differentiate into elongated spermatozoa with a tail for mobility. (iii) 'd' is the spermatid formed from a secondary spermatocyte 'b' through the process of meiosis II, leading to the formation of haploid spermatids. (b) 'a' is the basal layer, 'b' is the primary spermatocyte, and 'c' is the Leydig cell responsible for testosterone production.

Question 29.

(a) Darwin's theory of Natural Selection is widely accepted but some limitations have been identified by modern biologists. Mention the limitations identified.

(b) Name and state the most accepted theory of evolution in modern times.

(c) Mention any two ways the limitations identified in Darwin's theory of evolution are explained in modern biology.

[3 Marks]

Answer: Darwin's theory of Natural Selection has several limitations identified by modern biologists. One limitation is the lack of understanding of the genetic basis of inheritance during Darwin's time, as he did not know about genes or DNA. Additionally, Darwin's theory does not adequately explain the role of genetic drift and gene flow in evolution. The most accepted theory of evolution today is the Modern Synthesis, which integrates genetics with natural selection. It highlights that evolutionary change is driven by the interplay of genetic variation, mutation, and environmental pressures. Two ways the limitations of Darwin's theory are addressed in modern biology include the emphasis on population genetics, which considers genetic variation within populations, and the role of epigenetics, which shows how environmental factors can influence gene expression and lead to evolutionary changes.

Question 30.

(a) Name the category of drugs represented by the chemical structure given above.

(b) If the methyl group is substituted by acetyl group we get a bitter crystalline compound. Name the compound.

(c) Name the natural source of these compounds.

(d) State the harmful effects of this class of drugs on the human body.

[3 Marks]

Answer: The category of drugs represented by the given chemical structure is opiates. When the methyl group is substituted by an acetyl group, the compound obtained is morphine. Opiates are primarily derived from the opium poppy plant, Papaver somniferum, which provides latex that can be processed into these drugs. The harmful effects of opiates on the human body include addiction, respiratory depression, mental clouding, and increased tolerance, leading to potential overdose. Long-term use can also result in severe withdrawal symptoms upon cessation.

Question 31.

(a) Write the scientific name of the nematode that infests the tobacco plants and the part that it infests.

(b) How is Agrobacterium used to protect tobacco plant from this attack ?

[3 Marks]

Answer: The scientific name of the nematode that infests tobacco plants is Meloidogyne incognita, commonly known as root-knot nematode. This nematode primarily infests the roots of tobacco plants, leading to significant damage and reduced yield. To protect tobacco plants from such infestations, Agrobacterium tumefaciens plays a crucial role. This bacterium is used in genetic engineering to introduce specific genes into tobacco plants, which can enhance their resistance to nematode attacks. By incorporating genes that confer resistance, such as those that trigger plant defense mechanisms, the overall health of tobacco plants can be improved, thereby mitigating the damaging impacts of nematodes.

Question 32.

Explain the following population interactions with the help of one example each :

(a) Brood Parasitism

(b) Co-evolution of mutualists

[3 Marks]

Answer: Brood parasitism is a behavior where one species relies on another to raise its offspring. A classic example is the cuckoo bird, which lays its eggs in the nests of other birds, such as the reed warbler. The unsuspecting host then incubates and rears the cuckoo chick, often at the expense of its own young. In contrast, co-evolution of mutualists

refers to the simultaneous evolution of two or more species that interact closely, leading to mutual benefits. An example of this is the relationship between flowering plants and their pollinators, such as bees. Over time, bees have evolved to recognize specific flowers, while plants have developed adaptations to attract these pollinators, ensuring efficient pollination. Both species benefit from this interaction, enhancing reproductive success.

Section E

Question 33.

Answer the following questions with respect to recombinant DNA technology:

(i) Why is plasmid considered to be an important tool in rDNA technology? From where can plasmids be isolated ? (Any two sources)

(ii) Explain the role of 'ori' and selectable marker in a cloning vector.

(iii) "r-DNA technology cannot proceed without restriction endonuclease." Justify.

[5 Marks]

Answer: Plasmids are crucial in recombinant DNA (rDNA) technology due to their ability to independently replicate within a host cell. They serve as vectors to transfer foreign genes into host cells, enabling the production of genetically modified organisms. Plasmids can be isolated from various sources, including bacterial cells, notably E. coli, and some yeast cells. In a cloning vector, the origin of replication ('ori') ensures the plasmid is replicated within the host cell, while a selectable marker, such as an antibiotic resistance gene, allows for the identification of successfully transformed cells. Without restriction endonucleases, which cut DNA at specific sequences, isolating and inserting genes into plasmids would be impossible, making them integral to the rDNA process.

Question 34.

Answer the following questions based on Bt-crops :

(i) Why do farmers prefer to grow Bt cotton crop than genetically unmodified cotton crops ?

(ii) Name any two insects that are killed by Bt toxin.

(iii) Explain the mechanism by which Bt toxin kills the insects but not the bacterium which possesses the toxin.

[5 Marks]

Answer: Farmers prefer to grow Bt cotton because it offers significant advantages over genetically unmodified cotton. Primarily, Bt cotton is genetically engineered to express a

protein from the bacterium Bacillus thuringiensis, which provides built-in pest resistance. This leads to reduced reliance on chemical insecticides, lower production costs, and higher yields due to decreased crop loss from pests. Two insects targeted by Bt toxin are the cotton bollworm and the tobacco budworm. The mechanism by which Bt toxin kills insects involves the activation of the toxin in the insect's alkaline gut environment, where it binds to specific receptors on the gut cells. This binding creates pores in the gut lining, leading to cell lysis and ultimately death of the insect. The toxin does not harm the bacterium itself because it is present in a dormant form and only becomes activated in the specific gut conditions of the insects, thus ensuring the bacterium's survival while effectively controlling pests.

Question 35.

Protein synthesis requires the services of all three types of RNAs, namely t-RNA, m-RNA and r-RNA. Explain the role of each of them during the process of protein synthesis in prokaryotes.

[5 Marks]

Answer: In prokaryotes, protein synthesis is a crucial process that relies on three types of RNAs: mRNA, tRNA, and rRNA. mRNA, or messenger RNA, is transcribed from DNA and serves as the template for protein synthesis, carrying the genetic code from the nucleus to the ribosome. tRNA, or transfer RNA, plays a pivotal role in decoding the mRNA. Each tRNA molecule carries a specific amino acid and has an anticodon that pairs with the corresponding codon on the mRNA. This ensures the correct amino acids are added in the right order during translation. Lastly, rRNA, or ribosomal RNA, is a structural component of ribosomes. It facilitates the binding of mRNA and tRNA, ensuring the proper assembly of amino acids into polypeptide chains. Overall, these three types of RNA work together to translate the genetic information into functional proteins, maintaining vital cellular functions.

Question 36.

A homozygous tall pea plant with green seeds is crossed with a homozygous dwarf pea plant with yellow seeds.

(i) Write the possible phenotype and genotype of F1 generation.

(ii) State the laws of Mendel that are proved true by the F1 generation.

(iii) Mention the F2 phenotypic ratio along with their possible phenotypes.

(iv) Write the genotypes of the male and female gametes produced by F1 progeny.

[5 Marks]

Answer: In this genetic cross, a homozygous tall pea plant (TTGG, where T = tall, G = green) is crossed with a homozygous dwarf pea plant (ttgg, where t = dwarf, g = yellow). The F1 generation will exhibit the phenotype of tallness with green seeds (TtGg) as the dominant traits prevail. The laws of Mendel that apply here include the Law of Dominance, indicating that dominant alleles will express themselves in phenotype, and Law of Segregation, suggesting that alleles segregate into gametes. In the F2 generation, the phenotypic ratio will be 9:3:3:1, producing phenotypes of tall green, tall yellow, dwarf green, and dwarf yellow plants. The male and female gametes from the F1 progeny will be TG and tg, respectively.

Question 37.

Given below is a diagrammatic representation of a human ovum.

(i)Identify the parts 'a', 'b' and 'c'.

(ii) This ovum is released from the ovary with incomplete meiotic division. When, where and how is the meiotic division completed?

(iii) How does an ovum ensure the entry of a single sperm during fertilisation?

[5 Marks]

Answer: The diagram of the human ovum shows three critical parts: (i) Part 'a' is the Zona Pellucida, a glycoprotein layer that surrounds the ovum, providing protection and playing a key role in fertilization. Part 'b' is the Cytoplasm (ooplasm), containing organelles and nutrients essential for early developmental processes after fertilization. Part 'c' is the Nucleus, which holds the genetic material of the ovum. (ii) The ovum is released from the ovary during ovulation, typically in the middle of the menstrual cycle, under the influence of luteinizing hormone (LH). This ovum undergoes a process called oogenesis where it remains in a state of meiotic arrest at metaphase II until fertilization occurs. The second meiotic division is completed only after fertilization by the sperm, which triggers the maturation of the ovum and the expulsion of the second polar body. (iii) To ensure that only one sperm successfully enters the ovum, the ovum employs several mechanisms. Initially, the Zona Pellucida plays a critical role in sperm recognition and binding. After the first sperm penetrates and fertilizes the ovum, a biochemical change occurs in the Zona Pellucida that renders it impenetrable to additional sperm, thus preventing polyspermy. This ensures that the genetic material from only one sperm is used to create the zygote, maintaining the correct number of chromosomes for development.

Question 38.

(i) Double fertilisation is an event unique to all flowering plants. Explain the process.

(ii) Give a reason for the following :

(1) A seed of an orange has many embryos.

(2) Cashew is a false fruit but Guava is a true fruit.

[5 Marks]

Answer: Double fertilisation is a distinctive process in flowering plants (angiosperms) where two fertilisation events occur within the embryo sac. After pollination, a pollen grain lands on the stigma, germinates, and produces a pollen tube that extends through the style to reach the ovule. One sperm cell from the pollen tube fertilises the egg cell, forming a diploid zygote, while the other sperm fuses with two polar nuclei, creating a triploid cell that develops into the endosperm, providing nourishment to the zygote as it develops into an embryo. This dual fertilisation ensures the successful formation of seeds with nutritional support. As for the orange seed, it contains many embryos because oranges are formed from flowers that can undergo polyembryony, where multiple zygotes may develop from a single fertilized ovule. In the case of cashew, it is considered a false fruit because the fleshy part of the cashew is derived from the receptacle of the flower rather than from the ovary, while guava is termed a true fruit as it develops from the ovary after fertilisation and contains seeds.