CBSE EXAMINATION PAPER-2025

BIOLOGY

(Solved)

Time allowed : 3 hours | Maximum Marks : 81

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 3** are case based questions

iv. **Section B** – questions number **4 to 17** are multiple choice questions

v. **Section C** – questions number **18 to 25** are very short answer

vi. **Section D** – questions number **26 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.

Study the graphs given below for Case 1 and Case 2 showing different levels of certain hormones and answer the question that follows :

Which hormone is responsible for the peak observed in Case 1 and Case 2 ? Write one function of that hormone.

[1 Marks]

Answer: The hormone responsible for the peak observed in both Case 1 and Case 2 is likely to be insulin, which is a peptide hormone secreted by the pancreas. One primary function of insulin is to regulate blood glucose levels by promoting the uptake of glucose into cells, thereby decreasing blood sugar levels.

Key Points: Identify the hormone responsible for the peaks in both cases - insulin. Mention its primary function - regulating blood glucose levels.

(2)

Write changes that take place in the ovary and uterus during follicular phase.

[1 Marks]

Answer: During the follicular phase of the menstrual cycle, several key changes occur in the ovaries and uterus, driven by the increasing levels of gonadotropins, specifically Luteinizing Hormone (LH) and Follicle Stimulating Hormone (FSH). In the ovary, FSH promotes the growth and maturation of ovarian follicles, leading to the development of primary follicles into growing follicles that produce estrogen. As these follicles grow, they secrete estrogen which plays a crucial role in the proliferation of the endometrial lining of the uterus. Consequently, the endometrium thickens in preparation for the potential implantation of an embryo, should fertilization occur. This period culminates around the 14th day of the cycle when LH levels peak, triggering ovulation. Thus, the follicular phase is characterized by follicle development in the ovaries and the thickening of the uterine lining.

Key Points: Increase in FSH and LH levels- Follicular development in ovaries- Estrogen secretion by growing follicles- Thickening of endometrium in uterus

(3)

Name the hormone Q of Case 2. Write one function of hormone Q.

[2 Marks]

Answer: The hormone Q of Case 2 is likely to be insulin. One important function of insulin is to regulate blood glucose levels by facilitating the uptake of glucose into the tissues, thereby lowering blood sugar levels.

> **Key Points: Hormone Q is insulin-Insulin regulates blood glucose levels-Insulin facilitates glucose uptake**

(4)

Which structure in the ovary will remain functional in Case 2 ? How is it formed ?

[2 Marks]

Answer: In Case 2, the structure in the ovary that will remain functional is the corpus luteum. The corpus luteum is formed from the remnants of the ovarian follicle after ovulation. Once the ovum is released from the follicle during ovulation, the follicle transforms into the corpus luteum under the influence of luteinizing hormone (LH). This structure plays a crucial role in the menstrual cycle by secreting progesterone, which helps maintain the uterine lining for potential implantation of a fertilized egg. If fertilization occurs, the corpus luteum continues to function and produce hormones until the placenta takes over. Otherwise, it degenerates if pregnancy does not occur.

> **Key Points: Corpus luteum formation-Remnants of the ovarian follicle-Ovulation under luteinizing hormone influence-Produces progesterone-Maintains uterine lining**

Question 3.

Read the following passage and answer the questions that follow : In nature, we rarely find isolated, single individuals of any species; majority of them live in groups in a well-defined geographical area, share or compete for similar resources, potentially interbreed and thus constitute a population. The population has certain attributes whereas, an individual organism does not. A population at a given time is composed of individuals of different ages. The size of the population tells us a lot about its status in the habitat. Whatever ecological processes we wish to investigate in a population, be it the outcome of competition with another species, the impact of the predator or the effect of pesticide application, we always evaluate in terms of any change in the population size. The size, in nature, could be low or go into millions. Population size, technically called population density (N) need not necessarily be measured in numbers only. The size of a population

for any species is not a static parameter. It keeps on changing with time depending on various factors including food availability, predation pressure and adverse weather.

(1)

The Monarch butterfly is highly distasteful to its predator because of a special chemical present in its body. How does the butterfly acquire this chemical ?

[1 Marks]

Answer: The Monarch butterfly acquires its distasteful chemical, called cardenolides or cardiac glycosides, primarily through its diet. When the larvae feed on milkweed plants, they ingest these toxic compounds. The ability to store these compounds in their bodies enables the adult butterflies to become unpalatable to predators. This dietary acquisition not only protects them from predation but also plays a crucial role in their survival and reproduction.

Key Points: Monarch butterfly diets on milkweed- acquires toxic glycosides- gains distastefulness to predators- enhances survival and reproduction

(2)

If population density at a time t + 1 is 800, Emigration = 100, Immigration = 200, Natality = 200 and Mortality = 150, calculate the population density at time t and comment upon the type of age pyramid that will be formed in this case.

[1 Marks]

Answer: To calculate the population density at time t (Nt), we use the formula Nt+1 = Nt + [(B + I) – (D + E)], where Nt+1 is the population density at time t + 1, B is the Natality, I is Immigration, D is Mortality, and E is Emigration.\n\nSubstituting the values:\n800 = Nt + [(200 + 200) – (150 + 100)]\n800 = Nt + [400 - 250]\n800 = Nt + 150\nNow, solving for Nt:\nNt = 800 - 150 = 650.\nThus, the population density at time t (Nt) is 650.\n\nRegarding the type of age pyramid, since natality is higher than mortality and there is net immigration, this suggests a growing population. Therefore, the age pyramid is likely to be broad at the base and narrow at the top, indicating a population that is expanding with a higher proportion of younger individuals. This shape reflects potential for continued growth and a youthful demographic structure.

Key Points: Calculate population density using Nt+1 formula - Population density at time t is 650 - Comment on the age pyramid shape indicating growth status

(3)

What is the difference in a method of measuring population density in an area if there are 200 carrot grass plants to only single huge banyan tree ?

[2 Marks]

Answer: When measuring population density in an area with 200 carrot grass plants compared to a single huge banyan tree, the methods used differ significantly due to the characteristics of the species involved. For the carrot grass, we can directly count the number of individual plants, which provides a clear numerical density (200 plants). In contrast, with the single banyan tree, simply counting it as one would not accurately reflect its ecological significance. Instead, we must consider alternative methods such as measuring the percent cover it provides or its biomass, which indicates its role in the ecosystem. While individual count is effective for numerous small plants, more complex metrics such as cover or biomass are essential for larger, more influential species like the banyan tree, demonstrating that population density encompasses more than just numerical counts.

Key Points: 200 carrot grass plants are a direct count for population density, single banyan tree is significant but not represented by numerical count, alternative measures like percent cover or biomass are needed for trees.

(4)

Name two methods to measure the population density of tigers.

[2 Marks]

Answer: Two methods to measure the population density of tigers include assessing pug marks and analyzing fecal pellets. Pug marks are the footprints left by tigers, which can help estimate their numbers based on the frequency of these tracks in a given area. Fecal pellets provide additional information on the presence of tigers, and by analyzing their distribution and quantity, researchers can estimate population density effectively.

Key Points: Pug marks-Fecal pellets

Section B

Question 4.

A man whose father was colour-blind marries a woman who had a colour-blind mother and normal father. What percentage of male children of this couple will be colour-blind?

[1 Marks]

(A) 25%

(B) 0%

(C) 50%

(D) 75%

Explanation: The father is colour-blind, which means he has the defective X chromosome associated with colour blindness (XcY). The mother, having a colour-blind mother and a normal father, is a carrier (XcX) since she does not exhibit colour blindness herself. The potential male offspring can inherit the Y chromosome from the father and either the normal X chromosome or the X chromosome carrying the colour blindness gene from the mother. Therefore, there is a 50% chance that a son will inherit the Xc chromosome from the mother, resulting in 50% of their male children being colour-blind.

Question 5.

GEAC stands for

[1 Marks]

(A) Ground Environment Action Committee

(B) Genetic and Environment Approval Committee

(C) Genome Engineering Action Committee

(D) Genetic Engineering Approval Committee

Explanation: The correct answer is 'Genetic Engineering Approval Committee' as stated in the context provided, which indicates that the Indian Government has established this

committee to oversee the validity and safety of GM research and the introduction of genetically modified organisms.

Question 6.

Match the items in Column-A with that of Column-B:

[1 Marks]

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

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

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

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

Explanation: The correct answer is (i) - (c), (ii) - (d), (iii) - (b), (iv) - (a) based on the details in the provided context regarding blood groups and donor compatibility. This indicates the relationships between different blood types and their corresponding compatibility for transfusions.

Question 7.

The process of mineralization by microorganisms help in the release of:

[1 Marks]

(A) inorganic nutrients from humus.

(B) both organic and inorganic nutrients from detritus.

(C) organic nutrients from humus.

(D) inorganic nutrients from detritus and formation of humus.

Explanation: The correct option is 'inorganic nutrients from humus.' Mineralization is the process in which microorganisms break down organic matter, such as humus, to release inorganic nutrients, providing essential minerals back to the soil.

Question 8.

Transplantation of tissues/organs to some patients often fails due to rejection of such tissues/organs by the body of the patient. Which type of immune response is responsible for such rejections?

[1 Marks]

(A) Autoimmune response

(B) Humoral immune response

(C) Cell mediated immune response

(D) Physiological immune response

Explanation: The correct answer is 'Cell mediated immune response' because this type of immune response involves T-lymphocytes that identify and reject foreign tissues or organs, which is the mechanism responsible for graft rejection in transplantation.

Question 9.

Match the following items of Column-I with that of Column-II:

[1 Marks]

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

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

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

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

Explanation: Lenders require collateral to mitigate the risk of loan default, as it provides them with a form of security. If the borrower fails to repay the loan, the lender can claim the collateral to recover some or all of the lost funds.

Question 10.

The diagram given below shows labelling of four parts of a dicot embryo during its development as P, Q, R and S.

Choose the option that indicates correct labelling of 'P', 'Q', 'R' and 'S' of embryo in different stages of its development:

[1 Marks]

(A) P: Zygote, Q: Suspensor, R: Cotyledon, S: Radicle

(B) P: Egg, Q: Radicle, R: Suspensor, S: Cotyledon

(C) P: Zygote, Q: Suspensor, R: Cotyledon, S: Plumule

(D) P: Egg, Q: Suspensor, R: Radicle, S: Cotyledon

Explanation: The correct option is P: Zygote, Q: Suspensor, R: Cotyledon, S: Plumule. In a typical dicot embryo, the zygote is the initial fertilized cell, the suspensor supports the embryo, cotyledons are the seed leaves that help in nourishment, and the plumule is the part that develops into the shoot. This aligns with the development stages described for dicot embryos.

Question 11.

Amplification of gene of interest by using DNA polymerase may go upto:

[1 Marks]

(A) 1 million times

(B) 1 billion times

(C) 0.1 million times

(D) 1 trillion times

Explanation: The correct answer is '1 billion times' as indicated in the provided context, which states that the process of DNA replication can amplify the DNA segment to approximately 1 billion copies through the repetitive cycles of PCR using thermostable DNA polymerase.

Question 12.

The sequence of nitrogenous bases in a segment of a coding strand of DNA is 5′ — AATGCTAGGCAC — 3′. Choose the option that shows the correct sequence of nitrogenous bases in the mRNA transcribed by the DNA.

[1 Marks]

(A) 5′-UUACGAACCGAG— 3′

(B) 5′-AAUGCUAGGCAC — 3′

(C) 5′-UUACGUACCGUG-— 3′

(D) 5′-AACGUAGGCAGC — 3′

Explanation: The mRNA is transcribed from the coding strand of DNA by replacing thymine (T) with uracil (U) and keeping the sequence same. The coding strand sequence is 5′ — AATGCTAGGCAC — 3′, so the transcribed mRNA will be 5′ — AAUGCUAGGCAC — 3′. This option corresponds directly with the original DNA sequence, making it the correct answer.

Question 13.

How many pollen grains and ovules are likely to be formed in the anther and the ovary of an angiosperm bearing 50 microspore mother cells and 50 megaspore mother cells respectively?

[1 Marks]

(A) 100, 25

(B) 50, 50

(C) 200, 100

(D) 200, 50

Explanation: Each microspore mother cell (PMC) undergoes meiosis to produce four microspores, so for 50 PMCs, this results in 50 x 4 = 200 pollen grains. Each megaspore mother cell (MMC) typically results in one functional megaspore (ovule), so 50 MMCs result in 50 ovules. Therefore, the total is 200 pollen grains and 50 ovules.

Question 14.

Evolution of modern man involves the following man-like primates. Choose the correct series of human evolution.

[1 Marks]

(A) Australopithecines → Ramapithecus → Dryopithecus → Homo sapiens

(B) Dryopithecus → Homo erectus → Australopithecines → Homo sapiens

(C) Australopithecines → Homo erectus → Neanderthal → Homo sapiens

(D) Homo erectus → Australopithecines → Homo sapiens → Neanderthal

Explanation: The correct series is 'Australopithecines → Homo erectus → Neanderthal → Homo sapiens'. This sequence reflects the evolutionary lineage where Australopithecines are considered one of the earliest human ancestors, followed by Homo erectus which displayed more advanced traits, then Neanderthals who coexisted with early Homo sapiens, ultimately leading to the emergence of modern humans (Homo sapiens). This progression is supported by fossil evidence and the study of comparative anatomy.

Question 15.

RNA interference (RNAi) helps in making tobacco-plant resistant to a nematode (Meloidegyne incognitia). Choose the correct option that shows how RNAi is achieved:

[1 Marks]

(A) Preventing the process of replication of DNA of the nematode.

(B) Preventing the process of translation of mRNA of the nematode.

(C) Preventing the process of transcription of DNA of the plant.

(D) Preventing the process of replication of DNA of the plant.

Explanation: The correct option is 'Preventing the process of translation of mRNA of the nematode.' RNA interference (RNAi) involves the introduction of complementary RNA that forms double-stranded RNA (dsRNA) with the specific mRNA of the nematode, leading to its silencing and preventing its translation. This mechanism specifically targets and inhibits the expression of the nematode's genes, allowing the tobacco plant to resist the infestation.

Question 16.

Assertion (A): One of the property of genetic code is degeneracy.

Reason (R): Some amino acids can be coded by more than one codon.

[1 Marks]

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

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

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

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

Explanation: Both (A) and (R) are true and (R) is the correct explanation of (A). The degeneracy of the genetic code means that multiple codons can code for the same amino acid, which supports the statement in the assertion that degeneracy is a property of the genetic code.

Question 17.

Assertion (A): When the two genes in a dihybrid cross are situated on the same chromosome, the proportion of parental gene combinations is much higher than non-parental type.

Reason (R): Higher parental gene combinations can be attributed to crossing over between two genes.

[1 Marks]

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

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

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

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

Explanation:

(A) is true, but (R) is false. The assertion (A) is correct because genes on the same chromosome tend to be inherited together, resulting in more parental types. However, (R) is incorrect because while crossing over does lead to recombinant types, it doesn't explain why parental combinations are more abundant; it rather suggests the opposite with increased genetic variation.

Section C

Question 18. How are morphine and heroin related? Mention their effect on the human body.

[2 Marks]

Answer: Morphine and heroin are chemically related; heroin is derived from morphine through a process called acetylation. Morphine acts as a potent painkiller and sedative, while heroin, being a depressant, slows down bodyfunctions. Both compounds interact with opioid receptors in the body, resulting in pain relief and euphoria. However, heroin's effects are more intense, leading to higher potential for abuse and addiction compared to morphine, which is used medically under controlled conditions.

Question 19.

(i) Name an alcoholic drink which is produced by the help of microbes:

(1) With distillation

(2) Without distillation

(ii) Explain how cyanobacteria can be used as bio-fertilizer.

[2 Marks]

Answer: 1. With distillation: Whisky, brandy, or rum. 2. Without distillation: Wine or beer. Cyanobacteria, or blue-green algae, serve as bio-fertilizers in paddy fields. They help in enriching the soil by fixing atmospheric nitrogen, which is beneficial for plant growth. Additionally, they improve soil fertility by adding organic matter, thereby reducing the need for chemical fertilizers. Their use promotes sustainable agriculture practices.

Question 20. Analyse the following ecosystems and discuss, which will be more productive in terms of primary productivity: A young forest, a natural old forest, a shallow polluted lake.

[2 Marks]

Answer: In terms of primary productivity, a young forest typically shows higher productivity compared to a natural old forest and a shallow polluted lake. Young forests have abundant sunlight, water, and nutrients, promoting rapid biomass production. In contrast, old forests have slower growth rates due to maturity but maintain biodiversity. A shallow polluted lake often struggles with low primary productivity due to toxic substances impacting aquatic plants. Therefore, the young forest emerges as the most productive ecosystem.

Question 21. Differentiate between Net primary productivity and Gross primary productivity in an ecosystem.

[2 Marks]

Answer: Gross primary productivity (GPP) refers to the total amount of organic matter produced by photosynthesis in an ecosystem, representing the overall energy captured from sunlight. In contrast, net primary productivity (NPP) is the portion of GPP that remains after accounting for the energy used by producers for respiration. Therefore, NPP indicates the available biomass for consumption by heterotrophs, including herbivores and decomposers.

Question 22.

Study the cross given below :

Identify the abnormalities '1' and '2' in the offsprings of a cross done between a couple and distinguish between them.

[2 Marks]

Answer: Abnormality '1' in the offspring typically represents a dominant phenotype resulting from a homozygous dominant or heterozygous genotype, whereas '2' indicates a recessive phenotype resulting from a homozygous recessive genotype. This distinction helps in understanding inheritance patterns. For example, in a test cross, the dominant phenotype can obscure the genetic contributions from both parents, revealing the hidden recessive traits solely through crossbreeding with a recessive parent.

Question 23.

Study the pedigree chart given below, showing the inheritance pattern of blood group in a family :

Answer the following questions :

(a) Give the possible genotypes of individual 1 and 2.

(b) Which antigen or antigens will be present on the plasma membranes of the R.B.Cs of individuals '5' and '8' ?

[2 Marks]

Answer: The possible genotypes of individuals 1 and 2 can be A or AO for individual 1 and B or BO for individual 2, considering the ABO blood group system. The antigens present on the R.B.Cs membranes of individuals '5' and '8' should be determined by their blood type. If individual 5 is AB, both A and B antigens will be present, while if individual 8 is type O, no antigens will be present.

Question 24.

A patient with ADA deficiency requires periodic infusion of genetically engineered lymphocytes. Explain why such periodic infusion is required and also suggest a permanent cure for such ADA deficiency.

[2 Marks]

Answer: Periodic infusions of genetically engineered lymphocytes are necessary for ADA deficiency patients because these lymphocytes, which produce the crucial enzyme adenosine deaminase (ADA), are not immortal and eventually die off. This leads to a continuous need for fresh supplies of these cells. A permanent cure for ADA deficiency could be achieved through gene therapy, specifically by introducing the ADA gene into the patient's stem cells at the embryonic stage, producing a lasting corrective effect.

Question 25.

Describe in brief any two techniques that can be utilised to transfer recombinant DNA into the host cell directly without using any vector.

[2 Marks]

Answer: Two techniques to transfer recombinant DNA directly into host cells without vectors include micro-injection and biolistics. Micro-injection involves the direct injection of recombinant DNA into the nucleus of a host cell using a fine needle. This method allows for precise delivery of DNA. Biolistics, or the gene gun method, entails bombarding plant cells with microscopic gold or tungsten particles coated with DNA. This technique effectively penetrates cell walls and delivers DNA into plant cells.

Section D

Question 26.

(a) Write the palindromic nucleotide sequence for following sequence of DNA segment : 5'- GAATTC - 3'

(b) Name the restriction endonuclease that recognizes this sequence.

(c) How are sticky ends produced ? Mention their role.

[3 Marks]

Answer: (a) The palindromic nucleotide sequence for the DNA segment 5'- GAATTC - 3' is 5'- GAATTC - 3' on one strand and 3'- CTTAAG - 5' on the complementary strand. This means that the sequence is read the same forwards and backward on both strands. (b) The restriction endonuclease that recognizes this sequence is EcoRI. (c) Sticky ends are produced when restriction endonucleases cut the DNA at specific sites to leave overhanging ends, enabling the fragments to easily bind with complementary sequences. This 'stickiness' facilitates the joining of fragments through hydrogen bonds, enhancing the efficiency of DNA ligase in recombinant DNA technology.

Question 27.

Study a part of life cycle of Plasmodium given below :

Answer the following questions :

(a) Name the infective stage of Plasmodium that is stored in the female Anopheles mosquito.

(b) Where does fertilization and development of parasite take place ?

(c) Identify labels P and Q in the given diagram.

(d) Asexual and sexual phase of the life cycle of the Plasmodium takes place in two different hosts. Write their names.

[3 Marks]

Answer: The infective stage of Plasmodium stored in the female Anopheles mosquito is called sporozoites. Fertilization and development of the parasite take place in the female Anopheles mosquito itself. In typical diagrams illustrating the life cycle, label P usually refers to sporozoites while label Q typically represents oocysts. The asexual phase of the Plasmodium life cycle occurs in humans, while the sexual phase occurs in the female Anopheles mosquito.

Question 28.

(a) Indiscriminate human activities such as alien species invasion, fragmentation and habitat loss have accelerated the loss of biodiversity. Justify by taking one example for each.

(b) State the importance of the following :

(i) IUCN Red data list

(ii) Hot spots in conservation of biodiversity

[3 Marks]

Answer: Human activities have significantly accelerated biodiversity loss through various means. For instance, habitat loss, primarily due to deforestation for agriculture, undermines ecosystems, exemplified by the Amazon rainforest destruction, leading to the extinction of numerous native species. Alien species invasion can be illustrated through the introduction of the zebra mussel in North America, disrupting local aquatic ecosystems. The IUCN Red Data List is crucial as it assesses species' conservation status and highlights those at risk, guiding conservation efforts. Biodiversity hotspots are regions of significant biological wealth under threat; conserving these areas is vital for protecting a large number of species and maintaining ecological balance.

Question 29.

Study the diagram given below and answer the questions that follows :

(a) Identify the structure shown in the above figure. (b) Identify the labels P and Q.

(c) Write the nature of histone proteins.

(d) Distinguish between Euchromatin and Heterochromatin.

[3 Marks]

Answer: The structure depicted in the diagram is chromatin, which is composed of DNA and histone proteins. Label P refers to euchromatin, which is the less condensed form of chromatin that is transcriptionally active, thus allowing gene expression. Label Q corresponds to heterochromatin, the more tightly packed chromatin that is transcriptionally inactive. Histone proteins are basic proteins that package and manage DNA within the nucleus, allowing it to fit into the cell. On the other hand, euchromatin is loosely packed and active during transcription, while heterochromatin is densely packed and not actively involved in gene expression.

Question 30.

Shyam and Radha are expecting their first child with Radha being in her second month of pregnancy with no complications. Shyam's family has a history of cystic fibrosis while Radha's family has a history of Down's syndrome, leading to a concern that the baby may have one of these conditions.

(a) Suggest and explain a way of testing if their baby is at risk for any genetic disorders.

(b) In case of presence of one or both of the abnormalities and posing a risk to the mother's health, mention one possible option for them to consider. Is that option safe for Radha at the current gestational age ? Justify.

(c) Under what conditions is the process mentioned in (b) illegal ?

[3 Marks]

Answer: To determine the risk of genetic disorders, Shyam and Radha can opt for non-invasive prenatal testing (NIPT). This test analyzes cell-free fetal DNA circulating in Radha's blood, gauging the risk of conditions like Down's syndrome and cystic fibrosis without the need for invasive procedures. If abnormalities are found and pose risks, one option could be amniocentesis, which safely offers definitive results. However, this procedure carries risks, especially in the early second trimester. It's generally safe after 15 weeks of gestation. The procedure is illegal if performed solely for sex determination, which is prohibited under the Prenatal Diagnostic Techniques Act. The law aims to prevent female foeticide by banning such practices. Couples must follow legal guidelines to ensure ethical standards in prenatal care.

Question 31.

Explain the basis on which gel electrophoresis technique works. Write any two ways the products obtained through this technique can be utilised.

[3 Marks]

Answer: Gel electrophoresis is a technique that exploits the negative charge of DNA to separate its fragments. When an electric current is applied, DNA fragments migrate towards the positive electrode, with smaller fragments moving faster through the agarose gel matrix due to a sieving effect. This allows for the resolution of DNA fragments based on size, enabling the visualization of bands after staining with ethidium bromide and exposure to UV light. The purified DNA products obtained from this process can be utilized in constructing recombinant DNA by joining them with cloning vectors, and they can also be used for genetic fingerprinting or analyzing genetic variations in organisms.

Question 32.

Compare and contrast convergent and divergent evolution.

[3 Marks]

Answer: Convergent evolution occurs when unrelated species develop similar traits as they adapt to similar environments, despite having different ancestral origins. A prime example is the evolution of wings in bats (marsupials) and birds (placental mammals), showcasing similar functional traits despite differing lineage. In contrast, divergent evolution involves two or more related species developing different traits as they adapt to varied environments, reflecting their common ancestry. For instance, the variety of beak shapes in Darwin's finches exemplifies this, where species evolved from a common ancestor yet adapted differently based on their dietary needs. Both processes highlight the adaptability of organisms but underscore different evolutionary paths: convergence illustrates similar adaptations from diverse ancestors, while divergence shows diversification from a shared lineage.

Section E

Question 33.

Answer the following questions :

(i) State what do you understand by "MALT" ? Where it is located inside our body ?

(ii) Explain cytokine barriers.

(iii) Name the diagnostic test for AIDS. On what principle does it work ?

(iv) Bone marrow and thymus play an important role in human immune system. Explain how are they able to achieve this.

[5 Marks]

Answer: MALT, or Mucosa-Associated Lymphoid Tissue, refers to a collection of lymphoid tissue associated with mucosal surfaces in the body, playing a crucial role in the immune system by identifying and responding to pathogens that enter through these surfaces. MALT is primarily located in the gastrointestinal tract (GALT), including the Peyer's patches, as well as in the respiratory tract (BALT) and the urogenital tract. It acts as a first line of defense, contributing to the body's local immunity. Cytokine barriers refer to the mechanism by which virus-infected cells secrete interferons, which are vital proteins that help protect nearby uninfected cells from viral infection, thereby enhancing the body's innate immune response. In terms of AIDS diagnosis, the enzyme-linked immunosorbent assay (ELISA) is a common test that detects antibodies against HIV in the blood, indicating a potential infection. This principle operates on the ability of the test to identify specific antibodies produced in response to HIV. Bone marrow is responsible for producing various blood cells, including lymphocytes, while the thymus is crucial for the maturation of T-

cells, both essential components of the adaptive immune response. Together, they ensure that the immune system can effectively respond to infections and maintain immunity.

Question 34.

(i) Study the following table & fill 'H', 'T, 'J', 'K, 'L' and 'M' in following table with suitable words :

(ii) Why are baculoviruses used as biological control agents ?

[5 Marks]

Answer: Baculoviruses, primarily those belonging to the genus Nucleopolyhedrovirus, are effective biocontrol agents targeting specific insect pests and are utilized in agricultural practices. Their specificity allows for narrow-spectrum insecticidal applications, meaning they can control only certain pest species without harming beneficial insects. This selectivity is crucial as it helps in maintaining biodiversity and eco-balance within the ecosystem. Moreover, their viral nature ensures that the pests do not develop significant resistance, making baculoviruses a sustainable choice for pest management in agriculture.

Question 35.

(a) Distinguish between the two cells enclosed in a mature male gametophyte of an angiosperm.

(b) Study the diagram given below showing the modes of pollination. Answer the questions that follow.

(i) The given diagram shows three methods of pollen transfer in plants. Examine them carefully and write the technical terms used for pollen transfer methods '1', '2' and '3'.

(ii) How do the following plants achieve pollination successfully ?

(a) Water lily

(b) Vallisneria

(iii) Write advantages of pollen transfer in method '3'.

[5 Marks]

Answer: In a mature male gametophyte of an angiosperm, there are typically two types of cells: the generative cell and the tube cell. The generative cell is responsible for producing the two male gametes, which will later participate in the double fertilization process. It divides to form the sperms that are essential for fertilization. On the other hand, the tube

cell develops into the pollen tube upon germination, facilitating the transport of the male gametes to the ovule. The formation of these two cells ensures successful reproduction in flowering plants through the mechanisms of pollination and fertilization. \n\n(i) The technical terms for the pollen transfer methods are: \n1. Anemophily (wind pollination) \n2. Entomophily (insect pollination) \n3. Hydrophily (water pollination). \n\n(ii) Water lilies achieve pollination via the method of floating flowers that are accessible to pollinators, while Vallisneria utilizes water currents to aid in the transfer of pollen to stigmas submerged beneath the water's surface. \n\n(iii) The advantages of method '3' (Hydrophily) include the ability to pollinate even in aquatic environments and the potential for large-scale pollen dispersal through water currents, ensuring genetic diversity and successful reproduction in various habitats.

Question 36.

Given below is the diagram of human ovum surrounded by a few sperms. Observe the diagram and answer the questions that follows :

(i) Compare the fate of sperms 'P', 'Q' and 'R' shown in the diagram.

(ii) Write the role of Zona pellucida in this process.

(iii) Analyse the changes occurring in the ovum after the entry of sperm.

(iv) How acrosome and middle piece of a human sperm are able to play an important role in human fertilization ?

[5 Marks]

Answer: In the reproductive process, only one sperm successfully fertilizes the ovum, while the others (sperms P and Q) are unable to penetrate the zona pellucida and contribute genetically, ultimately dying. Sperm R, however, penetrates the zona pellucida, aided by enzymes released from its acrosome, facilitating fusion with the ovum. Once fertilization occurs, the ovum completes its second meiotic division, leading to the formation of a haploid ovum and a polar body. The zona pellucida undergoes changes that prevent additional sperm from entering. The middle piece of the sperm provides energy for motility, crucial for reaching the ovum during fertilization.

Question 37.

(i) Perform a cross between two sickle cell carriers. What ratio is obtained between carrier, disease free and diseased individuals in F_1 progeny? Name the nitrogenous base substituted, in the haemoglobin molecule in this disease.

(ii) Explain the difference in inheritance pattern of flower colour in garden pea plant and snap-dragon plant with the help of monohybrid crosses.

[5 Marks]

Answer: (i) When two sickle cell carriers (heterozygous) are crossed, the genotypic ratio of their progeny is 1:2:1. Here, 1 is disease free (AA), 2 are carriers (AS), and 1 is diseased (SS - sickle cell anemia). The substitution of the nitrogenous base is from adenine (A) to thymine (T) in the sixth codon of the beta-globin gene, which changes glutamic acid to valine in the haemoglobin molecule, causing sickle cell disease.

(ii) In garden pea plants, the inheritance of flower colour shows complete dominance where purple flower colour (P) is dominant over white (p). In monohybrid crosses, F_1 generation shows all purple flowers and F_2 generation shows a 3:1 ratio of purple to white flowers.
In contrast, snap-dragon plants display incomplete dominance in flower colour. A cross between red (RR) and white (WW) flowers produces pink (RW) flowers in F_1 generation. In F_2 generation, the phenotypic ratio is 1 red : 2 pink : 1 white. This shows that neither allele is completely dominant and the heterozygous condition results in an intermediate phenotype.

Question 38.

Explain with the help of well-labelled diagrams how lac operon operates in E. coli:

(i) In presence of an inducer.

(ii) In absence of an inducer.

[5 Marks]

Answer: The lac operon in E. coli is a group of genes involved in the metabolism of lactose. It consists of structural genes (z, y, a), an operator (o), a promoter (p), and a regulatory gene (i) that codes for the repressor protein.
(i) In absence of inducer: When no inducer (lactose or its analog) is present, the repressor protein produced by the i gene binds to the operator region. This binding prevents RNA polymerase from attaching to the promoter and transcribing the structural genes. As a result, the enzymes needed to metabolize lactose are not produced. This is because the cell does not need to metabolize lactose when it is absent.
(ii) In presence of inducer: When lactose or an inducer is present, it binds to the repressor protein and changes its shape, rendering it inactive. This inactivation releases the

repressor from the operator. RNA polymerase can now bind to the promoter and transcribe the structural genes. The resulting enzymes beta-galactosidase, permease, and transacetylase help in the uptake and breakdown of lactose to glucose and galactose, providing energy to the cell. Thus, gene expression is induced only when the substrate (lactose) is present, demonstrating an example of inducible operon regulation.