# CBSE EXAMINATION PAPER-2025

## BIOLOGY

### (Solved)

Time allowed : 3 hours | Maximum Marks : 83

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**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 3** are case based questions

iv. **Section B** – questions number **4 to 19** are multiple choice questions

v. **Section C** – questions number **20 to 27** are very short answer

vi. **Section D** – questions number **28 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.

The most convincing evidence to trace evolutionary relationships between humans and different groups of animals come from the basic similarities seen at the molecular level. Study the table given

below that depicts the number of amino acid differences between the haemoglobin polypeptide of few animals with that of humans and answer the questions that follow.

| S.No. | Animal | No. of amino acid differences in haemoglobin with that of humans |
|---|---|---|
| 1. | Macaque | 08 |
| 2. | Dog | 32 |
| 3. | Bird | 45 |
| 4. | Frog | 67 |
| 5. | Lamprey | 125 |

**(1)**

**To which category of evolution (Divergent or Convergent) do the following evolutionary relationships belong to :**

**(i) Humans and Macaque**

**(ii) Humans and Frog**

[1 Marks]

**Answer:** The evolutionary relationship between humans and macaques is categorized as divergent evolution. This is because humans and macaques share a common ancestor, with the two species evolving separately over time, leading to the distinct traits seen in each today. In contrast, the relationship between humans and frogs is considered convergent evolution. Although both species may exhibit certain similarities due to adaptations to similar environments, they do not share a close common ancestor, as frogs belong to a different vertebrate lineage. Overall, humans and macaques reflect divergent evolutionary paths from a shared ancestor, while humans and frogs illustrate convergent evolution due to environmental adaptations.

**Key Points: Divergent evolution; common ancestor of humans and macaques; evolutionary path divergence; convergent evolution; adaptations in humans and frogs; no close common ancestor**

**(2)**

**What do the biochemical similarities in haemoglobin suggest about the evolutionary relationship between humans, frog and lamprey ?**

[1 Marks]

**Answer:** The biochemical similarities in haemoglobin between humans, frogs, and lampreys indicate a common evolutionary ancestor among these species. The number of amino acid differences in the haemoglobin polypeptides reflects the degree of genetic divergence that has occurred over time. Humans share a smaller number of differences with frogs compared to lampreys, suggesting that frogs are more closely related to humans than lampreys are. This provides evidence for a branching descent, where humans and frogs diverged more recently from a common ancestor, whereas lampreys, having a higher number of differences, represent an earlier branch in evolution. Such biochemical studies support the notion of shared ancestry and highlight how molecular evidence reflects evolutionary relationships among diverse organisms.

**Key Points: biochemical similarities indicate common ancestry-amino acid differences reflect evolutionary divergence-humans and frogs are more closely related than to lampreys- supports the concept of branching descent**

**(3)**

**Which one of the two lampreys' or macaques' evolution is more closely related to humans and why?**

[2 Marks]

**Answer:** The evolution of macaques is more closely related to humans than that of lampreys. This is primarily due to the fact that macaques, being primates, share a more recent common ancestor with humans compared to lampreys, which are jawless fish. Molecular studies, including the similarities in the structure of haemoglobin proteins, exhibit fewer amino acid differences between humans and macaques than between humans and lampreys, indicating a closer evolutionary relationship. Additionally, both humans and macaques belong to the clade of mammals, whereas lampreys diverged earlier in the evolutionary timeline and belong to a completely different class of vertebrates, further emphasizing the closer relationship between humans and macaques.

**Key Points: Macaques are primates; humans and macaques share a more recent common ancestor; fewer amino acid differences in haemoglobin; both belong to mammals; lampreys are jawless fish and diverged earlier.**

**(4)**

**Which one of the two frogs' or dogs' evolution is more closely related to humans and why?**

[2 Marks]

**Answer:** Dogs' evolution is more closely related to humans compared to frogs. This can be attributed to the shared mammalian ancestry that humans and dogs exhibit. Both belong to the class Mammalia, which indicates that they share a more recent common ancestor compared to amphibians such as frogs. Additionally, molecular similarities, particularly in their genetic material and proteins like haemoglobin, further support this connection. These biochemical similarities point to a common ancestry, as mammals showcase similar functionalities in their proteins compared to those in non-mammalian species like frogs.

**Key Points: Dogs and humans share a more recent common ancestor than frogs; Both belong to the class Mammalia; Molecular similarities in proteins such as haemoglobin; Biochemical similarities indicate common ancestry.**

**Question 3.**

Read the following passage and answer the questions that follow.

Deaths related to the use of drugs were estimated at about 5,00,000 in 2019, 17.5 percent more than in 2009. Liver diseases attributed to Hepatitis B are a major cause of drug-related deaths, according to UNODC, accounting for more than half of the total number of deaths attributed to the use of drugs. Drug overdoses account for a quarter of drug-related deaths.

Opioids contribute to account for the most severe drug-related harm, including fatal overdoses, when used non-medically. At the global level, two-third of direct drug-related deaths are due to opioids, and in some sub-regions the proportion can be as high as three-quarters of such deaths.

**(1)**

**Why are people taking opioids more prone to liver diseases attributed to Hepatitis B ?**

[1 Marks]

**Answer:** People taking opioids are more prone to liver diseases attributed to Hepatitis B primarily due to their method of administration, which is often intravenous. When individuals inject opioids using shared or unsterilized needles and syringes, they significantly increase their risk of contracting Hepatitis B. This virus is transmitted through infected blood, and sharing needles exposes users to blood contaminated with the virus. Additionally, the chronic abuse of drugs, including opioids, can lead to liver damage and conditions such as cirrhosis, further compounding the health risks associated with Hepatitis B. Therefore, the overlap of opioid use and risky injection practices is a major factor contributing to increased susceptibility to liver diseases.

**Key Points: Intravenous drug use increases risk of infection-sharing needles leads to virus transmission-opioid abuse can cause liver damage**

**(2)**

**What is the scientific name of the plant from which the opioids are derived and from which part of the plant is it extracted ?**

[2 Marks]

**Answer:** The scientific name of the plant from which opioids are derived is Papaver somniferum, commonly known as the opium poppy. Opioids are primarily extracted from the latex of the unripe seed pods of this plant. The latex contains various alkaloids such as morphine and codeine, which are the main active compounds used in pain management and other medical applications.

**Key Points: Papaver somniferum - opium poppy - extracted from unripe seed pods - latex contains morphine and codeine**

**(3)**

**What is meant by direct drug-related disease ?**

[1 Marks]

**Answer:** Direct drug-related diseases are health complications or illnesses that arise directly from the use of drugs, particularly those substances that can lead to severe physical harm or fatal outcomes. In the context of drug abuse, these diseases may include infections such as Hepatitis B, where individuals who use drugs intravenously are at higher risk due to sharing needles, or other health issues caused by non-medical use of opioids, which can lead to fatal overdoses. This classification highlights the immediate and serious health risks associated with drug use, distinguishing them from diseases that may arise indirectly or from other sources.

**Key Points: Direct drug-related diseases arise directly from drug use; include conditions like Hepatitis B; linked to behaviors like sharing needles; often result in severe health consequences or fatalities.**

**(4)**

**State two common warning signs of drug abuse among the youth.**

[2 Marks]

**Answer:** Two common warning signs of drug abuse among youth include a significant drop in academic performance and a lack of interest in personal hygiene. These signs indicate that the youth may be engaging in behaviors that are detrimental to their health and well-being, suggesting possible substance abuse issues.

**Key Points: drop in academic performance-lack of interest in personal hygiene-withdrawal or isolation**

## Section B

**Question 4.**

In its extended ‘beads-on-string’ form of chromatin, the ‘beads’ in the string represent:

[1 Marks]

(A) Linker DNA

(B) Histone proteins

(C) NHC proteins

**(D) Nucleosomes**

**Explanation:** The correct option is 'Nucleosomes'. In the context provided, nucleosomes are described as the repeating units of chromatin that form the 'beads' in the 'beads-on-string' structure. Each nucleosome consists of a segment of DNA wrapped around histone proteins, and they are visualized under an electron microscope as the beads in this structural model.

**Question 5.**

Given below are a few statements with reference to the accessory ducts of the human male reproductive system :

(i) The seminiferous tubules of the testes open into rete testis then into the vas deferens.

(ii) The vasa efferentia leave the testes and open into the epididymis.

(iii) The epididymis leads to vas deferens that ascends into the abdomen.

(iv) The vas deferens receives a duct from the prostrate gland and opens into the urethra as ejaculatory duct.

(v) The urethra originates from the urinary bladder and extends through the penis to its external opening, urethral meatus.

Choose the option with all true statements from the given options :

[1 Marks]

(A) (ii), (iv), (v)

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

**(C) (ii), (iii), (v)**

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

**Explanation:**

The true statements about the accessory ducts of the human male reproductive system are (ii) and (iii). The correct sequence for sperm transport is: **seminiferous tubules → rete testis → vasa efferentia → epididymis → vas deferens → urethra**. Statement (i) is incorrect because the vasa efferentia, not the vas deferens, directly connect the rete testis to the epididymis. Statement (iv) is

incorrect because the vas deferens receives a duct from the seminal vesicle, not the prostate gland, and opens into the urethra as the ejaculatory duct. Statement (v) is incorrect; the urethra originates from the urinary bladder and extends through the penis to its external opening, but it is not the ejaculatory duct that originates from the urinary bladder.

Therefore **(ii), (iii) and (v)** are correct

**Question 6.**

The substrate used during DNA replication by the enzyme DNA-dependent DNA polymerase is :

[1 Marks]

(A) Ribonucleotide triphosphate

(B) Ribonucleoside triphosphate

**(C) Deoxyribonucleoside triphosphate**

(D) Deoxyribonucleotide triphosphate

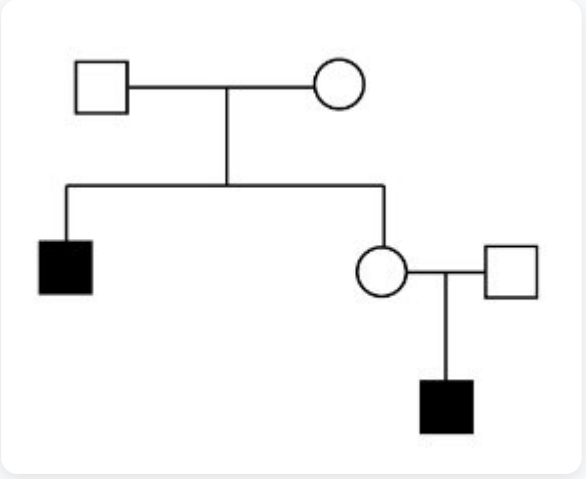
**Explanation:** The correct answer is 'Deoxyribonucleotide triphosphate' because DNA-dependent DNA polymerase requires deoxyribonucleotides (the building blocks of DNA) as substrates for the synthesis of new DNA strands. These deoxyribonucleotides also provide the necessary energy for the polymerization reaction during DNA replication.

**Question 7.**

In the given pedigree chart, a cross between a normal couple resulted in a son who was haemophilic and a normal daughter. In course of time, when the daughter was married to a normal man, to their surprise the grandson was also haemophilic.

Choose the option that indicates the correct inheritance of trait in the above pedigree chart :

[1 Marks]



**(A) Sex-linked recessive trait**

(B) Sex-linked dominant trait

(C) Autosome linked dominant trait

(D) Autosomal recessive trait

**Explanation:**

The correct answer is 'Sex-linked recessive trait'. Haemophilia is known to be a sex-linked (or X-linked) recessive disorder, which means that it is carried on the X chromosome and typically affects males more than females. In the context given, the unaffected carrier female (the daughter) passes on the allele for haemophilia to her son, resulting in his haemophilic condition.

**Question 8.**

In which of the following human diseases does mechanism attack self-cells?

[1 Marks]

(A) Phenylketonuria

(B) Thalassemia

**(C) Rheumatoid arthritis**

(D) Filariasis

**Explanation:** The correct option is 'Rheumatoid arthritis' because it is classified as an auto-immune disease, which means the immune system mistakenly attacks the body's own cells, leading to inflammation and damage in the joints. The context specifically mentions that rheumatoid arthritis causes damage to the body and qualifies as an auto-immune disease.

**Question 9.**

Select the statements that are true for a typical dicotyledonous embryo from the given options.

(i) It consists of an embryonal axis and scutellum.

(ii) The portion of embryonal axis above the level of cotyledon is epicotyl.

(iii) The portion of embryonal axis below the level of cotyledon is coleorhiza.

(iv) The lower end of the embryo has radicle covered with a root cap.

Choose the correct answer :

[1 Marks]

(A) (i) and (ii)

(B) (i) and (iii)

**(C) (ii) and (iv)**

(D) (iii) and (iv)

**Explanation:** (ii) and (iv) are correct statements regarding a typical dicotyledonous embryo. The portion of the embryonal axis above the level of cotyledons is indeed the epicotyl, which terminates with the plumule. Additionally, the lower end of the embryo has the radicle, covered with a root cap. Statement (i) is incorrect because dicotyledonous embryos consist of an embryonal axis and two cotyledons, not a scutellum which is characteristic of monocotyledons. Statement (iii) is incorrect as the portion below the level of cotyledons is the hypocotyl, not coleorhiza.

**Question 10.**

About 15 mya during human evolution, the primates which used to walk like gorillas and chimpanzees were :

[1 Marks]

(A) Homo habilis and Homo erectus

(B) Homo erectus and Homo sapiens

**(C) Dryopithecus and Ramapithecus**

(D) Australopithecine and Neanderthal

**Explanation:** The correct option is 'Dryopithecus and Ramapithecus' because the context explains that about 15 million years ago, these primates existed and exhibited walking patterns similar to those of gorillas and chimpanzees, with Ramapithecus being more man-like and Dryopithecus being more ape-like.

**Question 11.**

Use the given information to select the amino acid attached to the 3 end of tRNA during the process of translation, if the coding strand of the structural gene being transcribed has the nucleotide sequence TAC.

[1 Marks]

| Codons for the amino acids : |
| --- |
| AUC – Isoleucine |
| AUG – Methionine |
| UAC – Tyrosine |
| GUA – Valine |

(A) Isoleucine

(B) Tyrosine

**(C) Methionine**

(D) Valine

**Explanation:** The sequence TAC on the coding strand corresponds to the codon AUG on mRNA. According to the context, AUG codes for Methionine, which is also known as the initiator codon in translation. Therefore, the correct option is Methionine.

**Question 12.**

The technique for the early detection of a disease based on the principle of antigen-antibody interaction is :

[1 Marks]

(A) PCR

(B) RNAi

**(C) ELISA**

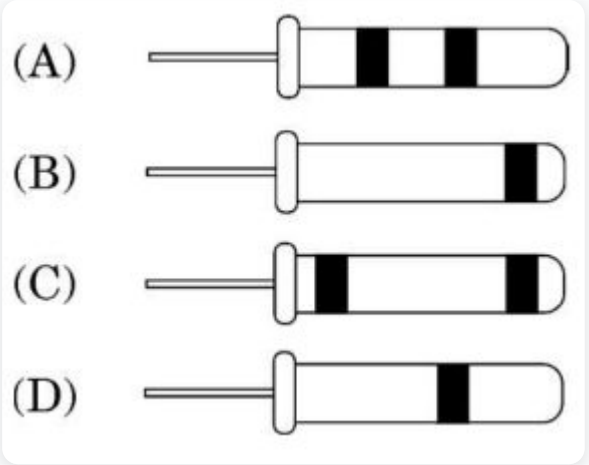
(D) EST

**Explanation:** The correct answer is ELISA. ELISA, or Enzyme Linked Immuno-sorbent Assay, is specifically noted in the context for its basis on antigen-antibody interaction, making it a powerful technique for early detection of pathogens and related diseases.

**Question 13.**

The correct depiction of the experiment performed by Matthew Meselson and Franklin Stahl to prove that DNA replicates semi-conservatively on separation of DNA by centrifugation after 40 minutes is :

[1 Marks]




(A) B

**(B) C**

(C) A

(D) D

**Explanation:**

The correct answer is **C**.which shows two bands, one representing the hybrid DNA and the other represents the light DNA.

**Question 14.**

Bioactive molecule Cyclosporin A used for human welfare is derived from :

[1 Marks]

**(A) Trichoderma polysporum**

(B) Monascus purpureus

(C) Aspergillus niger

(D) Propionibacterium sharmanii

**Explanation:** The correct answer is Trichoderma polysporum, as the context states that cyclosporin A, an immunosuppressive agent, is produced by this fungus. The other options do not relate to the production of cyclosporin A.

**Question 15.**

In a pea plant (Pisum sativum) inflated pod shape is dominant over constricted pod shape. The expected ratio of phenotypes of the offspring in a cross between both the parents with heterozygous inflated pod shape will be :

[1 Marks]

**(A) 3 : 1**

(B) 2 : 1

(C) 1 : 0

(D) 1 : 1

**Explanation:** In a cross between two heterozygous pea plants (Ii x Ii), where 'I' represents the dominant allele for inflated pod shape and 'i' represents the recessive allele for constricted pod shape, the expected phenotypic ratio of the offspring will be 3:1 (3 inflated pods to 1 constricted pod). This ratio is based on Mendelian genetics and relates to the concept of dominant and recessive traits.

**Question 16.**

Assertion (A) : Repeat-onstring represents Linker DNA.

Reason (R) : It holds nucleosomes together.

[1 Marks]

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

**(B) Both (A) and (R) are false.**

(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:** Repeat-onstring refers to the Linker DNA, which is the DNA segment connecting one nucleosome to the next. This makes both the assertion and reason true. However, the reason that it holds nucleosomes together is true but is not the correct explanation of the assertion that it represents Linker DNA. The linker DNA is simply the connecting DNA strand, not named due to its role in holding nucleosomes together but because it links nucleosomes.

**Question 17.**

Assertion (A) : A person infected with malaria suffers from chill and high fever, recurring every three or four days.

Reason (R) : The parasite attacks the RBC resulting in their rupture and release of haemozoin.

[1 Marks]

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

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

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

(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). The context explains that malaria symptoms of chills and high fever are directly linked to the rupture of red blood cells caused by the Plasmodium parasite, which releases haemozoin, leading to these recurring fever episodes.

**Question 18.**

Assertion (A) : Immunoglobulin E (IgE) increases phagocytosis of sperms.

Reason (R) : IgE is a non-steroidal preparation.

[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) Both (A) and (R) are false.**

**Explanation:** IgE antibodies are primarily involved in allergic reactions and do not have a role in increasing phagocytosis of sperms. Also, IgE is an antibody (a protein) and not a non-steroidal preparation (which typically refers to drugs like NSAIDs). Thus, both the assertion and reason are false.

**Question 19.**

Assertion (A) : ABO blood grouping in humans is an example of multiple allelism.

Reason (R) : More than two genes in a population govern the same character in ABO blood grouping in humans.

[1 Marks]

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

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

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

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

**Explanation:** Assertion (A) is true because the ABO blood grouping system involves three alleles (IA, IB, i), which is a classic example of multiple allelism. However, Reason (R) is false as it incorrectly states that more than two genes govern the same character; actually, it is the three alleles of the same gene that determine the blood group phenotypes. Therefore, the correct option is that Assertion (A) is true, but Reason (R) is false.

## Section C

**Question 20.** Explain how the immunity of a person is affected if there is atrophy (degeneration) of the thymus gland at an early stage of life.

[2 Marks]

**Answer:** If the thymus gland undergoes atrophy at an early stage, it significantly impairs the immune system. The thymus produces thymosins, which are crucial for T-lymphocyte maturation, responsible for cell-mediated immunity. Consequently, reduced thymosin levels lead to fewer T-lymphocytes, particularly helper T-cells, which are vital for coordinating immune responses. This deficiency results in increased susceptibility to infections, chronic illness, and a weakened immune response overall, making the individual vulnerable to diseases.

> **Key Points: Thymus is vital for T-lymphocyte development-thymosins promote immune response-helper T-cells are crucial-decreased thymosin leads to infections-atrophy weakens immunity.**

**Question 21.**

(i) What are interferons ? Explain their role in providing immunity to a person.

(ii) Which category of innate immunity defence barrier can interferons be classified into ?

[2 Marks]

**Answer:** Interferons are proteins secreted by virus-infected cells. Their primary role is to protect neighboring non-infected cells by interfering with viral replication, thereby enhancing the immune response. They help activate immune cells like macrophages and natural killer cells, which target and

destroy infected cells. Interferons can be classified as a type of cytokine barrier in innate immunity, which is the body's first line of defense against pathogens.

**Key Points: Interferons are proteins; secreted by virus-infected cells; protect non-infected cells; interfere with viral replication; activate immune cells; classified as cytokine barriers in innate immunity**

**Question 22.**

Assume that the given mRNA (start site is not depicted) is theoretically translated in two reading frames.

(a) Translation starting from the first nucleotide (Reading frame 1)

(b) Translation starting from the second nucleotide (Reading frame 2)

Answer the following question :

How many amino acids will be specified in case (a) and case (b) on translation ? Justify your answer.

[2 Marks]

Frame 1

5′ – CUCGCUUGCCGAUCAAGGGUUA – 3′

Frame 2

5′ – GUGGCACUCAGUCCUUAAUGGCG – 3′

**Answer:** In reading frame 1, starting from the first nucleotide, the mRNA is translated into 5 amino acids before a stop codon is reached. In reading frame 2, starting from the second nucleotide, only 4 amino acids are specified as a stop codon appears earlier. The difference is due to the start position of the codons affecting how many complete triplets can be formed until a stop codon is encountered.

**Key Points: Reading frame 1 amino acids: 5; Reading frame 2 amino acids: 4; Stop codon limits translation; Codons are triplets.**

**Question 23.**

Explain what is meant by the term MTP. What was the main reason to legalize MTP by the Government of India ?

[2 Marks]

**Answer:** MTP stands for Medical Termination of Pregnancy, which refers to the intentional and voluntary termination of a pregnancy before the full term. The Government of India legalized MTP in 1971 primarily to address issues of unwanted pregnancies resulting from factors like unprotected intercourse, contraceptive failure, or rape. Legalizing MTP aimed to prevent unsafe, illegal abortions and address the serious social concern of female foeticide in the country.

> **Key Points: Definition of MTP; Legalization in India; Address unwanted pregnancies; Prevent unsafe abortions; Combat female foeticide**

**Question 24.**

Name any two STIs which might occur in a human female. State its two early symptoms.

[2 Marks]

**Answer:** Two STIs that might occur in a human female are gonorrhoea and chlamydiasis. Early symptoms of gonorrhoea include painful urination and abnormal vaginal discharge. For chlamydiasis, early symptoms can include a burning sensation during urination and lower abdominal pain. Detecting these symptoms early can help facilitate better treatment outcomes.

> **Key Points: Gonorrhoea-Chlamydiasis-Painful urination-Abnormal vaginal discharge**

**Question 25.**

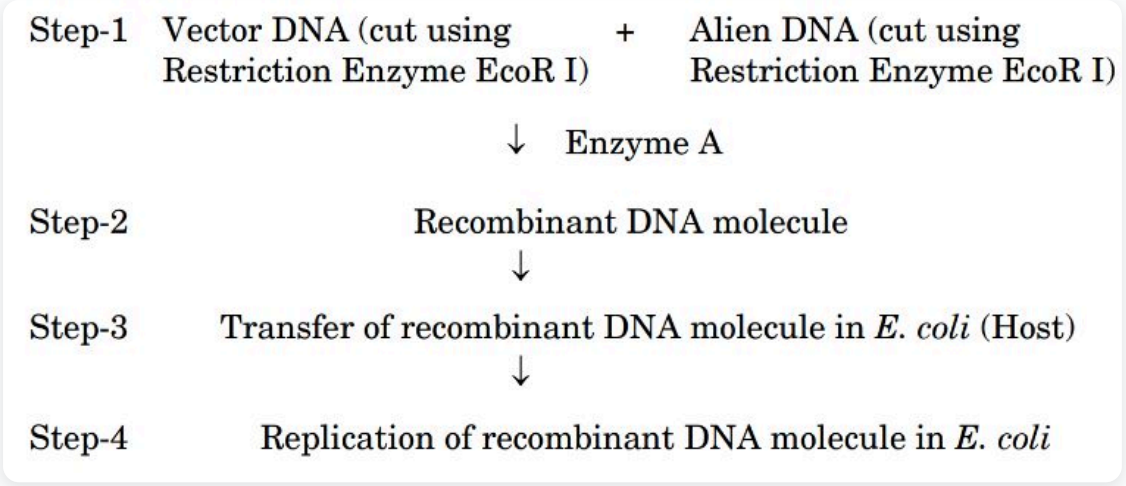
The basic scheme of the essential steps involved in the process of recombinant DNA technology is summarized below in the form of a flow diagram. Study the given flow diagram and answer the questions that follow.

(a) Name the enzyme used in Step-1 to join the cut plasmid and alien DNA.

(b) State the technical term used for Step-3.

(c) Justify the use of same Restriction Enzyme EcoR I to cut both the vector DNA and the alien DNA.

[2 Marks]




**Answer:** The enzyme used in Step-1 to join the cut plasmid and alien DNA is DNA ligase. The technical term used for Step-3 is ligation, which refers to the process of joining DNA fragments together. The use of the same restriction enzyme, EcoR I, is crucial because it ensures that both the vector DNA and the alien DNA have compatible ends. This allows for effective ligation, creating a stable recombinant DNA molecule.

**Key Points: DNA ligase-EcoR I-ligation-same restriction enzyme-compatible ends**

**Question 26.**

Explain how the interaction between sea anemone and clownfish is one of the best examples of commensalism in nature.

[2 Marks]

**Answer:** The interaction between the sea anemone and clownfish exemplifies commensalism as the clownfish benefits by receiving protection from predators due to the anemone's stinging tentacles, which deter would-be attackers. In this relationship, the clownfish finds a safe habitat among the anemone’s tentacles, while the anemone itself does not gain any significant benefit or experience harm from the presence of the clownfish, illustrating the core principle of commensalism.

**Key Points: clownfish gains protection from predators-sea anemone's tentacles deter predators-no significant benefit or harm to anemone-example of commensalism**

**Question 27.**

Correctly depict (also indicate the trophic level) and describe the ecological pyramid of biomass in sea with 40 standing crop of phytoplankton supporting 90 standing crop of zooplankton which further supports 120 small fishes.

[2 Marks]

**Answer:** The ecological pyramid of biomass in the sea typically shows an inverted structure. At the base, phytoplankton, the primary producers, have a standing crop of 40 units, constituting the first

trophic level. Zooplankton, the herbivores, occupy the second trophic level, with a standing crop of 90 units. Finally, small fishes, the primary carnivores, form the third trophic level with a biomass of 120 units. This inversion occurs because the biomass of fish, although lower in number, exceeds that of phytoplankton.

**Key Points: Pyramid of biomass; Inversion due to higher weight of fish; Trophic levels: producers (phytoplankton), primary consumers (zooplankton), secondary consumers (small fishes); Ecological significance**

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## Section D

**Question 28.**

Explain the process of formation of placenta in a human female after the implantation of the blastocyst in the endometrium of the uterus.

[3 Marks]

**Answer:** After the implantation of the blastocyst in the endometrium, the trophoblast layer of the blastocyst adheres to the uterine lining. This triggers rapid division of uterine cells, enveloping the blastocyst and embedding it firmly into the endometrium. Subsequently, the chorionic villi, which are projections from the trophoblast, extend into the uterine tissue. These villi interdigitate with maternal blood vessels, forming the placenta, a crucial organ for nutrient and gas exchange. The placenta also acts as an endocrine tissue, producing essential hormones such as human chorionic gonadotropin (hCG) and human placental lactogen (hPL). Furthermore, it connects to the developing embryo via the umbilical cord, facilitating transport of oxygen, nutrients, and waste products. This complex interconnection establishes a vital interface between the mother and the embryo, supporting its growth and development throughout pregnancy.

**Key Points: Trophoblast layer attachment- Rapid division of uterine cells- Formation of chorionic villi- Interdigitation with maternal tissue- Establishment of placenta- Endocrine functions of placenta- Connection via umbilical cord**

**Question 29.**

Gregor Mendel conducted hybridisation experiments in garden pea for seven years and proposed the law of inheritance.

(a) Why was he successful in his hybridisation experiments ? Give two reasons.

(b) State the law of independent assortment as proposed by Mendel after his dihybrid crosses.

[3 Marks]

**Answer:** Gregor Mendel's success in his hybridisation experiments can be attributed to two key reasons: firstly, he carefully selected garden peas, which exhibit distinct and easily observable traits, allowing him to accurately record inheritance patterns. Secondly, Mendel employed a systematic approach, focusing on simple, controllable crosses and analyzing multiple generations to draw consistent conclusions. Regarding the law of independent assortment, Mendel proposed that during gamete formation, alleles for different traits segregate independently of one another, meaning the inheritance of one trait does not influence the inheritance of another. This principle was derived from his dihybrid crosses, particularly when examining traits like seed shape and color.

**Key Points: Mendel's choice of garden peas for distinct traits; systematic breeding methods and multiple generations; law of independent assortment states alleles segregate independently.**

**Question 30.**

Study the given below single strand of deoxyribonucleic acid depicted in the form of a “stick” diagram with 5′ – 3′ end directionality, sugars as vertical lines and bases as single letter abbreviations and answer the questions that follow.

(a) Name the covalent bonds depicted as (a) and (b) in the form of slanting lines in the diagram.

(b) How many purines are present in the given "stick" diagram?

(c) Draw the chemical structure of the given polynucleotide chain of DNA.

[3 Marks]

**Answer:** In the DNA stick diagram, the covalent bonds represented by (a) and (b) are phosphodiester bonds. These bonds link the phosphate group of one nucleotide to the deoxyribose sugar of the next, establishing the backbone of the DNA strand. The total number of purines in the given stick diagram is dependent on the specific bases depicted. Typically, in DNA, the purines are adenine (A) and guanine (G). The structural recognition of these components is vital for understanding DNA's function.

**Key Points: Covalent bonds in DNA are phosphodiester bonds-Identify purines (A and G)-Understanding structure aids function**

**Question 31.**

Explain the biological treatment of primary effluent when passed into the large aeration tanks in a sewage treatment plant (STP).

[3 Marks]

**Answer:** The biological treatment of primary effluent in sewage treatment plants occurs in large aeration tanks where the effluent is mechanically agitated and oxygen is introduced. This process utilizes heterotrophic microbes present in the sewage to break down organic matter. The microbes consume a significant portion of this organic material, leading to a notable reduction in the biochemical oxygen demand (BOD) of the effluent. The reduction of BOD is essential as high BOD indicates greater pollution potential. After the microbial activity, the treated effluent is moved to a settling tank, allowing the formed bacterial flocs, referred to as activated sludge, to sediment. Some of this activated sludge is recirculated back into the aeration tank to maintain the microbial population, ensuring efficient treatment. The overall process not only cleans the effluent but also produces biogas, which can be utilized as a source of energy.

**Key Points: Aeration tanks; Heterotrophic microbes; Reduction of BOD; Settling tank; Activated sludge; Recirculation; Biogas production**

**Question 32.**

Given below is a flower with its characteristic features specialised for the most common type of abiotic pollination.

Answer the following questions based on the above diagram :

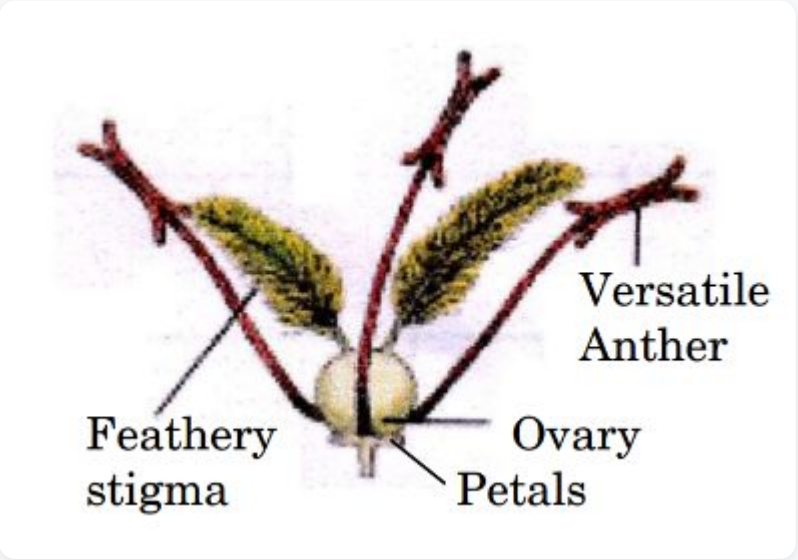
(a) Name the mode of abiotic pollination that will be adopted by the given plant species in the above picture.

(b) State the need of exposed large feathery stigmas for the flower.

(c) What will be the two important adaptations in the pollen grains of the flowers pollinated by the above mode of pollination ?

(d) What could be the probable reason for the petals being small and non-green ?

[3 Marks]



**Answer:** The mode of abiotic pollination depicted in the diagram is wind pollination. Exposed large feathery stigmas are essential for capturing pollen grains carried by the wind, thereby increasing the chances of successful fertilization. Pollen grains in wind-pollinated flowers exhibit adaptations such as reduced size and lightweight structures, enabling them to be easily carried by air currents. Additionally, pollen grains may have a sticky outer coating to enhance adherence to stigmas. The petals being small and non-green suggests that they are less involved in attracting pollinators, thereby optimizing energy for pollen production as these flowers rely on wind rather than biotic agents.

**Key Points: Mode of pollination: wind pollination; Exposed stigmas: capture wind-borne pollen; Pollen adaptations: lightweight and sticky; Petals: small and non-green for energy optimization.**

**Question 33.**

According to a recent wildlife report, the biggest threat to the tiger's survival in Mudumalai Tiger Reserve (MTR) was found to be a small, beautiful flower, Lantana camara, a tropical American shrub, that invaded 40% of India's tiger range. Tamil Nadu department's Lantana weed eradication drive helped to restore the dying MTR thereby also reducing human-wildlife conflicts. MTR is home to 25 species of grasses and legumes.

Answer the given questions based on the information given above.

(a) Explain how did the removal of Lantana help in restoring the dying Mudumalai Tiger Reserve.

(b) Why is the invasion of Lantana camara a cause of concern in MTR.

[3 Marks]

**Answer:** The removal of Lantana camara is crucial for restoring the Mudumalai Tiger Reserve (MTR) because this invasive species was choking out native vegetation essential for the ecosystem's health. By eradicating Lantana, the department facilitated the recovery of native grasses and legumes, providing better habitat for tigers and their prey. This restoration helps maintain the balance within the ecosystem and reduces human-wildlife conflicts, as healthy forests can better support wildlife without encroaching on human settlements.

**Key Points: Lantana camara is invasive, competes with native plants, its removal restores native vegetation, improves tiger habitat, enhances prey availability, reduces human-wildlife conflict.**

**Question 34.**

Enlist one advantage and two disadvantages of green revolution.

[3 Marks]

**Answer:** The Green Revolution significantly increased food production, with one of its primary advantages being the tripling of food supply, which helped in improving food security for a growing population. However, it also posed challenges. Firstly, one major disadvantage is the heavy reliance on chemical fertilizers and pesticides, which can lead to soil degradation and health hazards due to chemical exposure. Secondly, the use of high-yielding varieties often reduces the genetic diversity of crops, making them more susceptible to diseases and pests, creating long-term vulnerabilities in agricultural systems.

**Key Points: tripling of food supply; reliance on chemical fertilizers and pesticides; soil degradation and health hazards; reduced genetic diversity of crops; vulnerability to diseases and pests**

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## Section E

**Question 35.**

(i) Explain how does double fertilisation take place in a flowering plant.

(ii) Write the fate of the products of double fertilization in these plants.

[5 Marks]

**Answer:** Double fertilisation in flowering plants involves two key fusion events: syngamy and triple fusion. After pollination, the pollen grain germinates on the stigma, forming a pollen tube that travels down the style to the ovule. The tube discharges two male gametes into the embryo sac. One male gamete fuses with the egg cell, resulting in the formation of a diploid zygote (syngamy), while the second gamete fuses with two polar nuclei to form the triploid endosperm. This endosperm serves as the nutritive tissue for the developing embryo. Following fertilisation, the ovule develops into a seed, and the ovary matures into a fruit. Thus, double fertilisation not only secures the formation of a new plant but also ensures proper nourishment through the endosperm, reflecting a remarkable evolutionary adaptation in angiosperms.

**Key Points: Pollination initiation-Pollen tube germination and growth-Fusion of male gametes with egg cell (syngamy)-Fusion of second male gamete with polar nuclei (triple fusion)-Formation of diploid zygote and triploid endosperm-Development of seeds and fruits**

**Question 36.**

(i) Explain the structure of testicular lobules in human male reproductive system. Name the two types of cells present in the seminiferous tubules and state their role.

(ii) Describe the role of hypothalamic hormone GnRH in spermatogenesis.

[5 Marks]

**Answer:** The male reproductive system includes a pair of testes, which are vital for sperm production. Each testis contains approximately 250 compartments known as testicular lobules. Within each lobule, there are one to three coiled seminiferous tubules. The inner lining of these tubules comprises two primary cell types: male germ cells, known as spermatogonia, and Sertoli cells. Spermatogonia are responsible for undergoing meiotic division, ultimately leading to sperm formation. Sertoli cells play a crucial supportive role by providing nutrition and structural support to the developing germ cells. Furthermore, the process of spermatogenesis is initiated at puberty due to increased levels of gonadotropin-releasing hormone (GnRH), which is secreted by the hypothalamus. GnRH stimulates the anterior pituitary gland to release FSH and LH, promoting the production of sperms and testosterone, respectively, thus facilitating the entire process of spermatogenesis.

**Key Points: Testicular lobules contain seminiferous tubules; Two types of cells: spermatogonia and Sertoli cells; Spermatogonia undergo meiosis, Sertoli cells provide nutrition; GnRH triggers spermatogenesis by stimulating anterior pituitary; Leads to secretion of FSH and LH, promoting sperm and testosterone production.**

**Question 37.**

Name and explain the biotechnological strategy wherein the infection by the nematode Meloidegyne incognitia can be prevented using Agrobacterium vectors in the roots of tobacco plant by RNA interference.

[5 Marks]

**Answer:** The biotechnological strategy to prevent infection by the nematode Meloidegyne incognitia involves the use of RNA interference (RNAi) mediated by Agrobacterium vectors. This approach requires the introduction of specific nematode genes into the tobacco plant through Agrobacterium tumefaciens, which delivers a segment of DNA known as T-DNA. This inserted DNA is engineered to express both sense and anti-sense RNA, which are complementary to each other. When these RNAs are produced within the plant cells, they form double-stranded RNA (dsRNA). This dsRNA triggers the RNAi pathway, silencing the specific messenger RNA (mRNA) of the nematode. The silenced mRNA results in the inability of the nematode to produce essential proteins for its survival, ultimately leading to its death. By implementing this strategy, transgenic tobacco plants can effectively resist nematode infestations, thus maintaining plant health and improving crop yields. This technique highlights the potential of genetic engineering to provide sustainable solutions to agricultural problems caused by pests.

**Key Points: 1. Use of RNA interference (RNAi) to prevent nematode infection; 2. Insertion of nematode-specific genes into tobacco using Agrobacterium tumefaciens; 3. Production of sense and anti-sense RNA forming dsRNA; 4. Silencing of nematode**

**mRNA through RNAi; 5. Resulting in resistance against Meloidegyne incognitia and improved crop yields.**

**Question 38.**

Explain the amplification of gene of interest using the technique of Polymerase chain reaction (PCR).

[5 Marks]

**Answer:** The Polymerase Chain Reaction (PCR) is a revolutionary technique used to amplify specific segments of DNA, allowing for the generation of millions of copies of a gene of interest. The process consists of three main steps: denaturation, where the double-stranded DNA is heated to separate it into two single strands; primer annealing, where short sequences of RNA or DNA primers bind to the single-stranded templates; and extension, where DNA polymerase synthesizes new DNA strands from the primers. This polymerase, often derived from the thermophilic bacterium Thermus aquaticus, is heat-stable, enabling it to withstand the high temperatures necessary for denaturation. Through repeated cycles of these steps, typically 20-40 times, the target DNA can be amplified to a billion copies. This high level of amplification makes PCR incredibly useful for various applications, including cloning, genetic testing, forensics, and medical diagnostics, such as detecting HIV or identifying genetic mutations associated with cancer. The amplified DNA can then be used for further analysis or ligation into vectors for cloning purposes. PCR's sensitivity allows for the detection and analysis of even trace amounts of DNA, making it an essential tool in molecular biology.

**Key Points: Definition and importance of PCR - Process: denaturation, primer annealing, extension - Role of DNA polymerase - Amplification to a billion copies - Applications: cloning, diagnostics, forensics - Sensitivity for trace DNA detection**

**Question 39.**

(i) Describe the population growth curve applicable in a population of any species in nature that has limited resources at its disposal.

(ii) Give the equation of this growth curve.

(iii) Name the growth curve and depict a graphical plot for this type of population growth.

[5 Marks]

**Answer:** In nature, populations often exhibit logistic growth due to limited resources. Such populations experience an initial period of exponential growth when resources are abundant. However, as resources become limited, competition increases, eventually slowing down growth until it reaches a plateau known as the carrying capacity (K). The logistic growth equation is represented as $dN/dt = rN(K-N)/K$, where N is the population size, r is the intrinsic growth rate, and K is the carrying capacity. This curve depicts a sigmoidal shape, illustrating the transition from exponential growth to

stabilization at K. Graphically, the curve starts steep, then flattens as it approaches the carrying capacity, indicating that population growth is constrained by resource availability.

**Key Points: 1. Definition of logistic growth; 2. Equation: dN/dt = rN(K-N)/K; 3. Carrying capacity (K); 4. Graphical representation: sigmoidal curve; 5. Transition from exponential to stable population growth.**

**Question 40.**

(i) Explain the Species-Area relationship within a natural forest and also predict the nature of graph when species richness is plotted against the area for a wide variety of taxa.

(ii) Depict the graphical relationship between species richness and area.

(iii) Give the equation of the Species-Area relationship for a wide variety of taxa on a logarithmic scale.

[5 Marks]

**Answer:** The Species-Area relationship posits that species richness increases with the area of the habitat, forming a commonly observed rectangular hyperbolic curve. As proposed by Alexander von Humboldt, this relationship indicates that larger areas support more species diversity, though it plateaus after reaching a certain limit. When plotted, this relationship shows a curve that eventually levels off. On a logarithmic scale, this relationship can be expressed with the equation log S = log C + Z log A, where S is species richness, A is area, C is the Y-intercept, and Z is the slope. The value of Z typically ranges from 0.1 to 0.3, depicting the dependency of biodiversity on the extent of habitat available.

**Key Points: Species richness increases with area; Graph forms a rectangular hyperbola; Plateauing effect; Logarithmic representation linear; Equation log S = log C + Z log A; Variables: S = species richness, A = area, C = Y-intercept, Z = slope; Z value range is 0.1 to 0.3.**