CBSE EXAMINATION PAPER-2026

BIOLOGY

(Solved)

Time allowed : 3 hours | Maximum Marks : 82

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **39 questions.** All questions are **compulsory.**

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

iii. **Section A** – questions number **1 to 2** are case based questions

iv. **Section B** – questions number **3 to 18** are multiple choice questions

v. **Section C** – questions number **19 to 26** are very short answer

vi. **Section D** – questions number **27 to 33** are short answer

vii. **Section E** – questions number **34 to 39** are long answer

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

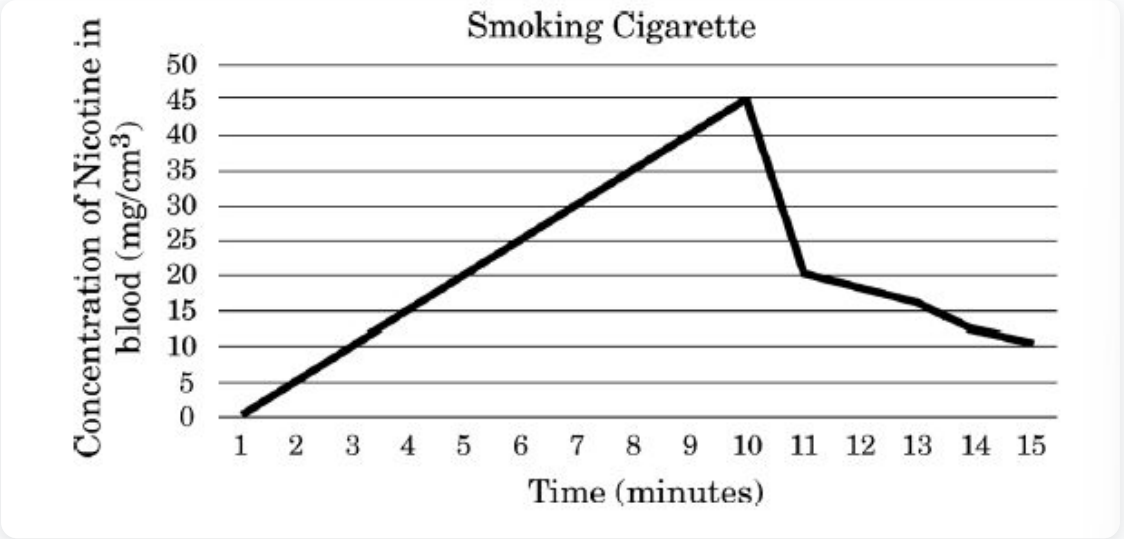
ix. Use of calculator is NOT allowed.

Section A

Question 1.

Read the following passage and answer the question that follow :

The data below shows the concentration of nicotine smoked by a smoker taking 10 puffs/minute



(1) With reference to the above graph, explain the concentration of nicotine in the blood at 10 minutes.

[1 Marks]

Answer: At 10 minutes, the concentration of nicotine in the blood increases significantly as the smoker takes 10 puffs/minute. Nicotine enters the bloodstream quickly through the lungs and accumulates, showing higher levels compared to the initial time. This illustrates how continuous smoking raises nicotine concentration in the blood over time.

Key Points: Nicotine concentration increases over time - Rapid absorption of nicotine into blood - Continuous smoking raises blood nicotine levels

(2) How will this affect the concentration of carbon monoxide and haem-bound oxygen at 10 minutes ?

[1 Marks]

Answer: Smoking increases carbon monoxide concentration in the blood which binds to haemoglobin forming carboxyhaemoglobin, reducing oxygen binding capacity. At 10 minutes, haem-bound oxygen concentration decreases due to competition with carbon monoxide, impairing oxygen delivery to tissues as shown in the passage.

Key Points: Smoking increases carbon monoxide in blood - Carbon monoxide binds strongly with haemoglobin - Decreases haem-bound oxygen concentration at 10 minutes

(3) To which class of compounds does nicotine belong ? Name one other drug from the same class.

[2 Marks]

Answer: Nicotine belongs to the class of compounds called alkaloids, which are nitrogen-containing substances found in plants. According to the passage, nicotine stimulates the adrenal gland affecting the body. Another drug from the same class of alkaloids is Morphine, which is used as a painkiller. Thus, nicotine and morphine both belong to alkaloids, which have strong physiological effects on humans.

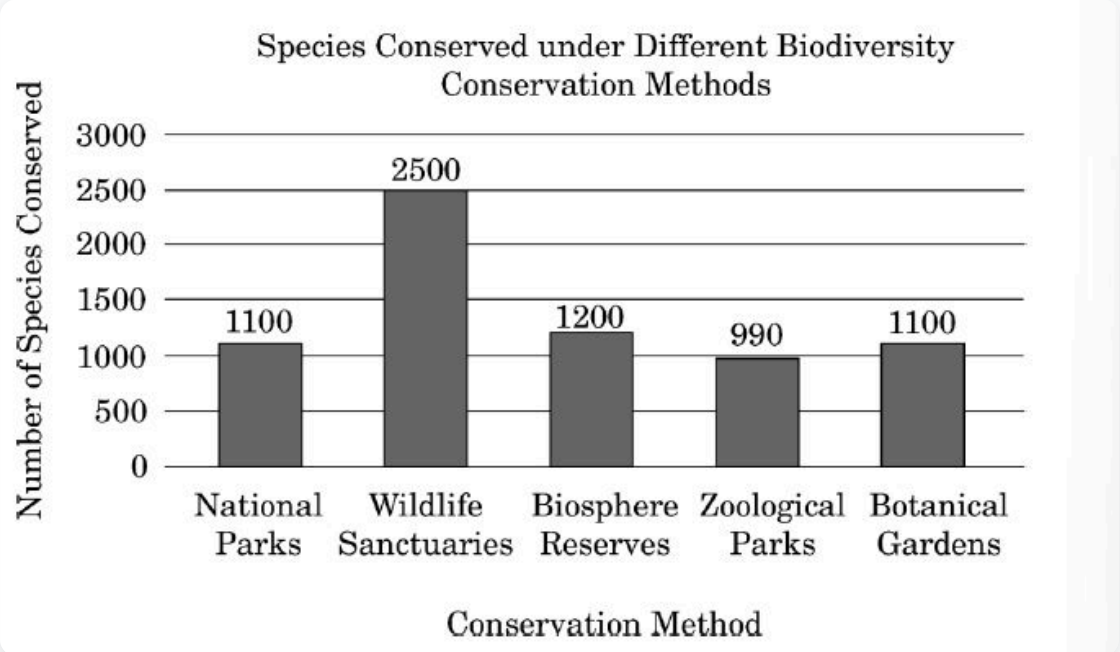
Key Points: Nicotine is an alkaloid - Alkaloids contain nitrogen and affect physiology - Morphine is another alkaloid drug

Question 2.

Read the following passage and answer the questions that follow:

India is one of the megadiverse countries housing around 8·1 per cent of global species diversity, although its land area is only 2·4 per cent of the world's land area. Many of the species are highly threatened due to human activities like deforestation, mining and habitat fragmentation. Laws like Wildlife (Protection) Act, 1972 were enacted by the Government of India to preserve our biological wealth. Various conservation measures are being implemented to save the threatened species.

The following bar graph shows the number of species conserved under different biodiversity conservation methods.



(1) Which method conserves the highest number of species ? Is it ex situ or in situ conservation

[1 Marks]

Answer: In situ conservation conserves the highest number of species. This method protects species in their natural habitat, like national parks and sanctuaries, as seen in India which has 90 national parks and over 450 wildlife sanctuaries. It helps preserve not just the species but the whole ecosystem, unlike ex situ conservation that protects species outside their natural habitat.

Key Points: In situ conservation protects species in natural habitats - India has many national parks and sanctuaries for in situ conservation - In situ conservation conserves more species than ex situ

(2) Which other methods shown in the diagram are opposite to the one identified by you in question (a) ? How are these two conservation approaches different ?

[2 Marks]

Answer: The other methods opposite to in situ conservation are ex situ conservation methods like zoos, botanical gardens and cryopreservation. In situ conservation protects species in their natural habitat preserving the whole ecosystem, while ex situ conservation protects species outside their natural habitat. India uses both methods to save threatened species, as mentioned in the passage, with in situ including national parks and sanctuaries and ex situ including zoological parks and tissue culture.

Key Points: In situ conservation - Ex situ conservation - Difference in habitat preservation

(3)

Write two features of Biodiversity hotspots

[1 Marks]

Answer: Features of Biodiversity hotspots:

1. Biodiversity hotspots are regions with very high numbers of plant and animal species, much higher than other areas.
2. These areas face accelerated habitat loss and need strict protection to conserve their rich biodiversity, as mentioned in the case passage about India's hotspots like the Western Ghats and Himalaya.

Key Points: High species diversity in small area - Regions face rapid habitat loss - Need for strict protection

Section B

Question 3.

Foetal ejection reflex in human female triggers the release of which hormone ?

[1 Marks]

(A) hCG from placenta

(B) Oxytocin from foetal pituitary gland

(C) Progesterone from corpus luteum

(D) Oxytocin from maternal pituitary gland

Explanation:

The foetal ejection reflex initiates mild uterine contractions which triggers the release of oxytocin from the maternal pituitary gland. Oxytocin then acts on the uterine muscles to cause stronger contractions, facilitating childbirth. This mechanism forms a positive feedback loop between uterine contractions and oxytocin secretion.

Question 4.

Which of the following is not a functional unit of an ecosystem ?

[1 Marks]

(A) Decomposition

(B) Energy flow

(C) Productivity

(D) Stratification

Explanation:

Stratification is a structural feature of an ecosystem, referring to the arrangement of species in layers. Functional units of an ecosystem involve processes such as productivity, decomposition, and energy flow, which represent the functions or activities within the ecosystem. Therefore, stratification is not a functional unit but a structural component.

Question 5.

Match Column I with Column II and select the correct option

[1 Marks]

	Column I		*Column II*
a.	Primers	i.	β-galactosidase
b.	Insertional inactivation	ii.	To separate and purify products
c.	Bioreactor	iii.	Chemically synthesized oligonucleotides
d.	Downstream processing	iv.	Large scale production of specific product of activity of microbes

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

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

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

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

Explanation:

Based on the context, the alleles I^A, I^B, and i correspond to blood groups A, B, and O respectively with i being recessive. Matching accordingly, option a-i, b-iii, c-iv, d-ii correctly pairs the alleles and their traits as described. This option reflects the correct genotypes and phenotypes according to the provided information about blood group inheritance.

Question 6.

Golden rice is a promising transgenic crop. When released for cultivation, it will help in

[1 Marks]

(A) Herbicide tolerance

(B) Pest resistance

(C) Reduction of Vitamin A deficiency in humans

(D) Producing petrol-like fuel

Explanation:

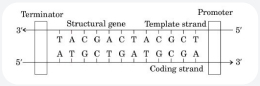
Golden rice is genetically modified to be enriched with Vitamin A. It is designed to help reduce Vitamin A deficiency in humans, which is a major nutritional issue in many countries. This is supported by the context stating that golden rice is Vitamin 'A' enriched rice, thus enhancing the nutritional value of food.

Question 7.

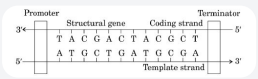
Four different transcription units are shown below. Choose the option with the correct image

[1 Marks]

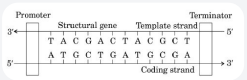
(A) Option C



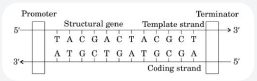
(B) Option D



(C) Option B



(D) Option A



Explanation:

A transcription unit in DNA consists of three main regions: the promoter, the coding region, and the terminator. The correct image should clearly show these regions in the proper order along the DNA strand. Option 3 correctly depicts these elements in sequence, illustrating the promoter region at the

start, followed by the coding sequence, and ending with the terminator. This matches the schematic structure of a transcription unit as explained in the given context.

Question 8.

Appearance of antibiotic-resistant bacteria is an example of evolution due to

[1 Marks]

(A) Anthropogenic action

(B) Artificial selection

(C) Divergent evolution

(D) Adaptive radiation

Explanation:

The appearance of antibiotic-resistant bacteria results from the use of antibiotics by humans, which acts as a selection pressure leading to the survival of resistant varieties. This process occurs on a much shorter time scale due to human influence and is an example of evolution caused by anthropogenic action (human activities), rather than natural evolutionary processes like adaptive radiation or divergent evolution.

Question 9.

Identify the statements that correctly describe Darwin's Theory of Evolution

(i) Overproduction of organisms leads to competition.

(ii) Variation is inherited and causes evolution.

(iii) Acquired characters are inherited

(iv) Survival depends on favourable traits

(v) New species arise due to accumulation of favourable variations

[1 Marks]

(A) (i), (ii), (iv) and (v) are correct

(B) (ii), (iii) and (iv) are correct

(C) All are correct

(D) Only (i) and (iv) are correct

Explanation:

Darwin's Theory of Evolution is based on natural selection where overproduction of organisms leads to competition for limited resources (statement i). Variation among individuals is inherited and is crucial for evolution (statement ii). Survival depends on favourable traits that help organisms adapt better to their environment (statement iv). New species arise due to the accumulation of favourable variations over generations (statement v). However, acquired characters are not inherited according to Darwin's theory, so statement (iii) is incorrect.

Question 10.

Which of the following is not a symptom of Ascariasis ?

[1 Marks]

(A) Intestinal blockage

(B) Anaemia

(C) Skin ulcers

(D) Muscular pain and fever

Explanation:

According to the given context, symptoms of Ascariasis caused by Ascaris include intestinal blockage, anemia, muscular pain, and fever. Skin ulcers are not mentioned as a symptom of Ascariasis. Therefore, 'Skin ulcers' is the correct answer as it is not a symptom of this disease.

Question 11. Every trophic level has a certain mass of living material at a particular time. What is it called

[1 Marks]

(A) Standing crop

(B) Ecological efficiency

(C) Primary productivity

(D) Standing state

Explanation: The mass of living material at a particular time in each trophic level is called the standing crop. It is measured as the biomass or the number of organisms in a unit area. This term specifically refers to the living mass present at a given time, distinguishing it from other terms like ecological efficiency or primary productivity.

Question 12.

The smallest part of DNA molecule that can be changed by point mutation is :

[1 Marks]

(A) Codon

(B) Nucleotide

(C) Gene

(D) Oligonucleotide

Explanation:

A point mutation is a change in a single nucleotide of the DNA sequence. According to the context, each nucleotide is represented by letters {U, C, A, G}, and a codon consists of three nucleotides. A point mutation involves alteration of one nucleotide, making 'Nucleotide' the smallest part of DNA that can be changed by point mutation.

Question 13.

Some statements regarding drugs and alcohol are given below: (i) Adolescents are more vulnerable to peer pressure. (ii) Drug addiction leads to increased tolerance level of the receptors present in our body. (iii) Alcohol affects the central nervous system. (iv) Excessive use of drugs helps to increase energy. (v) Anabolic steroids decrease aggressiveness Choose the option with correct statement(s).

[1 Marks]

(A) Statements (i), (ii) and (iii) are correct

(B) Statements (i), (iv) and (v) are correct

(C) Only statement (iii) is correct

(D) Only statements (i) and (v) are correct

Explanation:

Statement (i) is correct because adolescents are indeed more vulnerable to peer pressure, which can lead to drug and alcohol use. Statement (ii) is correct as repeated use of drugs increases the tolerance levels of receptors, making them respond only to higher doses, leading to addiction. Statement (iii) is correct; alcohol affects the central nervous system. Statements (iv) and (v) are incorrect; excessive use of drugs typically does not increase energy, and anabolic steroids usually increase aggressiveness, not decrease it.

Question 14. Select the correct option for the pair of plants pollinated by water

[1 Marks]

(A) Vallisneria and Hydrilla

(B) Water lily and Parthenium

(C) Zostera and Water lily

(D) Water hyacinth and Water lily

Explanation: Water pollination is rare in flowering plants and occurs mainly in some aquatic plants where pollination happens through water. Vallisneria and Hydrilla are examples of plants that are pollinated by water because their pollen is transported through water to reach the female flowers. On the other hand, water lily and water hyacinth have flowers that emerge above the water surface and are pollinated by insects or wind, not by water.

Question 15.

Assertion (A) : Activated sludge contains large population of bacteria. Reason (R) : These bacteria help in anaerobic digestion of human waste in biogas plant

[1 Marks]

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

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

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

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

Explanation:

Activated sludge does contain a large population of bacteria, but these bacteria perform aerobic digestion (require oxygen) in the aeration tank. The anaerobic digestion of human waste in biogas plants is carried out by different bacteria called methanogens, which grow in the absence of oxygen. Therefore, the reason is false as it incorrectly attributes anaerobic digestion to the bacteria in activated sludge.

Question 16.

Assertion (A) : Ecosystems require a constant supply of energy to synthesize the molecules they require. Reason (R) : This is to counteract the universal tendency towards increasing disorderliness as per Second Law of Thermodynamics.

[1 Marks]

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

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

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

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

Explanation:

Ecosystems require a constant supply of energy to build complex molecules because, according to the Second Law of Thermodynamics, natural processes tend towards increasing disorder or entropy. To maintain order and synthesize necessary molecules, energy must be continuously supplied. This is why ecosystems receive energy mainly from the sun, allowing producers to perform photosynthesis and support the rest of the food chain. Thus, both the Assertion and the Reason are true, and the Reason correctly explains the Assertion.

Question 17. Assertion (A) : DNA cannot pass through cell membrane of a bacterial cell. Reason (R) : DNA is a hydrophilic molecule

[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: The Reason (R) is correct since DNA is a hydrophilic molecule because of its charged phosphate groups. However, the Assertion (A) is false because DNA can pass through bacterial cell membranes under certain conditions, such as during bacterial transformation where bacteria take up DNA from their surroundings. The context mentions that DNA entered the bacterial cells, so DNA can indeed pass through the cell membrane.

Question 18. Assertion (A) : Repetitive sequences are stretches of DNA sequences that are thought to have no direct coding functions. Reason (R) : They shed light on chromosome structure, dynamics and evolution.

[1 Marks]

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

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

(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: Repetitive sequences are indeed stretches of DNA that are repeated many times and generally do not code for proteins, which makes the assertion true. These sequences contribute significantly to the genome and are known to play important roles in understanding chromosome structure, their dynamics, and evolution, making the reason true as well. Therefore, the reason correctly explains why repetitive sequences are important despite not coding for proteins.

Section C

Question 19.

A person complains of persistent itching in the groin region and scalp. The person also shows dry and scaly lesions on skin, nails, etc.

(i) Identify the disease.

(ii) Name its two causative agents.

(iii) Mention its mode of transmission.

[2 Marks]

Answer: (i) The disease is Ringworm (Tinea).
(ii) Two causative agents are Microsporum and Trichophyton.
(iii) The mode of transmission is through direct contact with an infected person, animal, or by sharing contaminated items like towels and clothing.

Key Points: Disease is Ringworm - Causative agents are Microsporum and Trichophyton - Transmission occurs by direct contact or sharing contaminated items

Question 20.

A girl develops sneezing, watery eyes and difficulty in breathing every time she visits a flower garden.

(i) Identify the condition.

(ii) Name the immune component responsible for this condition.

(iii) Name the chemical released.

(iv) State one medicine used to treat such a condition

[2 Marks]

Answer: (a) The condition is Allergy.
(b) The immune component responsible is Immunoglobulin E (IgE) antibodies.
(c) The chemical released during this condition is Histamine.
(d) One medicine used to treat allergy is Antihistamine.

Key Points: Condition is Allergy - Immune component is IgE antibodies - Chemical released is Histamine - Treatment includes Antihistamine medicine

Question 21.

(i) Mention any two characteristics of Neanderthal man that lived near East and Central Asia.

(ii) Identify the following hominids with respect to human evolution :

(I) Brain capacity 900 cc, probably ate meat.

(II) First human-like with brain capacity 650 – 800 cc

[2 Marks]

Answer: (i) Two characteristics of Neanderthal man are: They had a brain size of about 1400 cc and lived between 100,000-40,000 years ago near East and Central Asia.
They used hides to protect their body and buried their dead.
(ii) (I) Homo erectus had a brain capacity of about 900 cc and probably ate meat.
(II) Homo habilis was the first human-like being with a brain capacity of 650-800 cc and probably did not eat meat.

Key Points: Neanderthal man had 1400 cc brain-Neanderthal man lived near East and Central Asia-Neanderthal man used hides and buried dead-Homo erectus brain capacity 900 cc-Homo erectus probably ate meat-Homo habilis brain capacity 650-800 cc-Homo habilis was first human-like

Question 22.

The allele for brown eyes (B) is dominant over blue eyes (b). In a population, 36% of individuals have blue eyes.

Assuming Hardy-Weinberg equilibrium, calculate

(i) Frequency of allele B

(ii) Percentage of heterozygous individuals

(iii) Percentage of individuals that are homozygous dominant

(working to be shown)

[2 Marks]

Answer: (i) Frequency of allele b = sqrt(0.36) = 0.6
Frequency of allele B = 1 - 0.6 = 0.4
(ii) Percentage of heterozygous individuals (Bb) = 2pq = 2 * 0.4 * 0.6 = 0.48 or 48%
(iii) Percentage of homozygous dominant individuals (BB) = p2 = 0.4 * 0.4 = 0.16 or 16%
This calculation is based on Hardy-Weinberg principle where p + q = 1 and p2 + 2pq + q2 = 1, where p is frequency of dominant allele and q is frequency of recessive allele.

Key Points: Frequency of recessive homozygous q2 = 0.36 - Frequency of recessive allele q = 0.6 - Frequency of dominant allele p = 0.4 - Use of p + q = 1 - Calculation of heterozygous frequency 2pq - Calculation of homozygous dominant frequency p2

Question 23.

What did Henking observe in his experiments on insects that led to the discovery of sex chromosome ? How did his observation contribute to our understanding of sex determination

[2 Marks]

Answer: (a) Henking observed a special "X-element" or chromosome in the nuclei of sperm cells during spermatogenesis in certain insects. He found that about 50 percent of sperm had this structure while the other 50 percent did not.
(b) This observation indicated that the presence or absence of this chromosome determined the sex of the offspring, leading to the concept of sex chromosomes controlling sex determination.
(c) Thus, Henking's discovery helped establish that sex is genetically determined by chromosomes, which was a major advance in genetics.

Key Points: Henking observed a special "X-element" in sperm - 50% sperm had the X-element, 50% did not - This led to discovery of sex chromosomes - Sex is determined by presence or absence of the sex chromosome

Question 24.

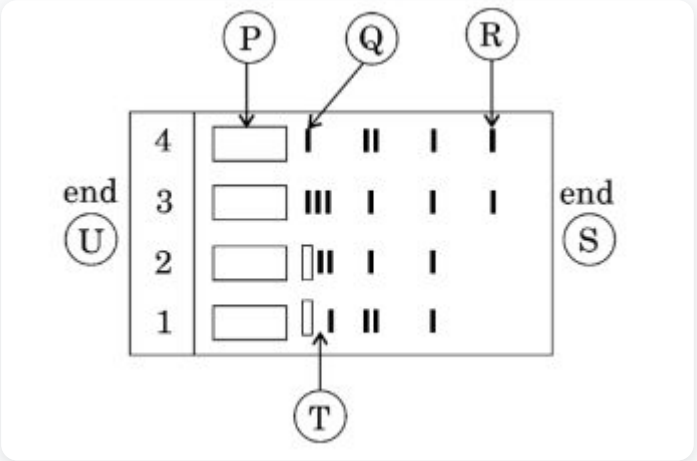
Given below is the schematic representation of the process of electrophoresis. Identify the alphabets representing the

(I) Anode end, and

(II) Lightest/Smallest DNA in matrix

(ii) What is Agarose gel and why is it used in this process ?

[2 Marks]



Answer: (a) The anode end is the positive electrode towards which DNA moves during electrophoresis.
(b) The lightest or smallest DNA fragments travel farthest in the gel matrix.
(ii) Agarose gel is a natural polymer extracted from seaweed that forms a porous matrix. It is used in electrophoresis because it acts like a sieve allowing DNA fragments to separate according to size; smaller fragments move faster and farther through the gel than larger ones.

Key Points: Anode is positive end - Smallest DNA moves farthest in gel - Agarose gel acts as a porous matrix for size-based DNA separation

Question 25.

After performing gel electrophoresis, a student observes that DNA fragments are not visible.

(i) Suggest a reason for this and explain how fragments can be made visible.

(ii) Also explain how a specific DNA fragment can be collected from the gel for further use.

[2 Marks]

Answer: (i) DNA fragments are not visible because DNA is colorless and requires staining to be seen. To make fragments visible, stain the gel with ethidium bromide or another suitable dye and then view it under UV light; the dye binds to DNA and fluoresces.

(ii) To collect a specific DNA fragment, cut the band carefully from the gel using a clean blade after visualization. Then, extract the DNA from the gel slice using a gel extraction kit for further experiments.

Key Points: DNA is colorless - Stain gel with ethidium bromide - Visualize under UV light - Cut specific DNA band from gel - Extract DNA using gel extraction method

Question 26.

GEAC is a regulatory body under the Ministry of Environment, Forest and Climate Change in India.

(a) Write the full form of GEAC.

(b) Mention two of its important functions related to biotechnology

[2 Marks]

Answer: (a) The full form of GEAC is Genetic Engineering Approval Committee.
(b) Two important functions of GEAC related to biotechnology are:
1. It evaluates and approves the release of genetically modified organisms (GMOs) into the environment.
2. It ensures the safety of biotechnology research and products before they are allowed for commercial use or public release.

Key Points: Full form of GEAC - Approval of GMOs release into environment - Ensuring safety of biotechnology research

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Section D

Question 27.

Answer the following questions:

(a) Explain the different ways by which apomictic seeds can be developed.

(b) Mention one advantage of apomictic seeds for farmers

[3 Marks]

Answer: (a) Apomictic seeds are developed without fertilisation. There are mainly three ways in which apomictic seeds can form: i) Diplospory: The embryo sac develops from the diploid megaspore mother cell without undergoing meiosis, leading to the formation of an embryo without fertilisation. ii) Apospory: The embryo sac develops from somatic cells of the ovule rather than from the megaspore mother cell. iii) Adventitious embryony: Embryos arise directly from the cells of the ovule, such as

nucellus or integuments, without formation of an embryo sac or fertilisation. (b) One advantage of apomictic seeds for farmers is that they produce offspring genetically identical to the parent plant, ensuring uniformity and stability in crop characteristics. Farmers can save seeds from apomictic plants and get the same high-yielding crop every year without buying hybrid seeds repeatedly.

Key Points: Apomictic seed formation methods - Diplospory - Apospory - Adventitious embryony - Advantage: genetic uniformity - Farmers can reuse seeds - No need to buy hybrid seeds annually

Question 28.

(a) What is meant by translation in protein synthesis ?

(b) Explain charging of tRNA (aminoacylation of tRNA) and mention its importance in the process of translation.

[3 Marks]

Answer: (a) Translation in protein synthesis is the process where the genetic code carried by mRNA is decoded by the ribosome to produce a specific sequence of amino acids, forming a polypeptide chain that folds into a functional protein.
(b) Charging of tRNA or aminoacylation of tRNA is the process in which an amino acid is attached to its specific tRNA molecule by the enzyme aminoacyl-tRNA synthetase using energy from ATP. This charged tRNA then carries the amino acid to the ribosome during translation. The importance of charging is that it activates amino acids for peptide bond formation and ensures the correct amino acid is added according to the mRNA codon, enabling accurate protein synthesis.

Key Points: Translation is the process of decoding mRNA to form polypeptides - Charging of tRNA involves attaching amino acid to tRNA using ATP and aminoacyl-tRNA synthetase - Charged tRNA brings correct amino acids to ribosome for protein synthesis

Question 29.

(a) What is the carrying capacity of a species in a habitat ?

(b) Explain the growth curve that takes this capacity into account

[3 Marks]

Answer: (a) The carrying capacity of a species in a habitat is the maximum number of individuals of that species which the habitat can support due to limited resources like food, space and water. It is denoted by K.
(b) The growth curve taking carrying capacity into account is the sigmoid or S-shaped curve. Initially, the population grows slowly during the lag phase, then rapidly during acceleration phase. As resources become limited, growth slows down during deceleration phase and finally stabilizes at

carrying capacity, forming an asymptote. The fraction (K - N) / K shows how much room is left for growth where N is current population size. This curve represents realistic population growth under resource limitations.

Key Points: Carrying capacity is maximum individuals supported - Limited resources determine carrying capacity - Sigmoid growth curve shows phases and stabilizes at carrying capacity

Question 30.

In vitro fertilization (IVF) is a popular method these days that is helping childless couples to bear a child.

(a) Write the different steps that are carried out in this technique.

(b) Would you consider gamete intra fallopian transfer as a type of IVF ? Justify your answer.

[3 Marks]

Answer: (a) The steps of IVF include: first, the female is given hormonal treatment to stimulate the production of multiple eggs. Then, mature eggs are collected from her ovaries. At the same time, sperm is collected from the male partner. Fertilisation occurs outside the body in a laboratory by mixing the eggs and sperms in a suitable culture medium. The fertilised eggs (embryos) are then allowed to develop for a few days. Finally, one or two healthy embryos are transferred into the female's uterus to achieve pregnancy.
(b) No, gamete intra fallopian transfer (GIFT) is not considered a type of IVF. In GIFT, eggs and sperms are collected and immediately transferred into the fallopian tube where fertilisation occurs naturally inside the body. In contrast, IVF involves fertilisation outside the body in the laboratory and then transferring the embryo into the uterus. Thus, the main difference is the site of fertilisation: outside the body in IVF and inside the fallopian tube in GIFT.

Key Points: Steps of IVF include hormone stimulation, egg collection, sperm collection, fertilisation in lab, embryo transfer - GIFT is not IVF because fertilisation occurs inside fallopian tube not in lab - IVF fertilisation occurs outside the body

Question 31.

Draw a neat diagram of a maize grain showing the internal structure and label any five parts.

[3 Marks]

Answer: Diagram of Maize Grain: The maize grain is a simple, single-seeded fruit with distinct parts inside. Its internal structure includes:

1. **Pericarp**: The outer protective covering of the grain.

2. **Cotyledon (Scutellum)**: A large, shield-shaped structure inside that absorbs food from the endosperm to nourish the embryo.
3. **Endosperm**: The food storage tissue, rich in starch, that supplies energy to the growing embryo.
4. **Embryo**: The young root (radicle) and shoot (plumule) that develops into the new plant.
5. **Plumule**: The part of the embryo that grows into the shoot.

This diagram helps in understanding the seed structure and its function during germination and growth.

> **Key Points: Pericarp - Cotyledon (Scutellum) - Endosperm - Embryo - Plumule**

Question 32.

Cow dung and water are mixed and fed into a biogas plant to allow digestion of biowastes. The person performing this process says that there is no need to provide an inoculum.

(a) Do you agree with him ? Justify your answer.

(b) What happens to the biowaste inside the digester ?

(c) Name the useful by-products obtained from this process and mention how they are used.

[3 Marks]

Answer: (a) Yes, I agree with him because cow dung itself contains bacteria that help in the digestion process. Therefore, there is no need to add any external inoculum. The bacteria naturally present in the dung help break down the biowaste.
(b) Inside the digester, the biowaste undergoes anaerobic digestion, where the bacteria break down the organic matter in the absence of oxygen. This process produces biogas, mainly consisting of methane and carbon dioxide, while the leftover material becomes nutrient-rich slurry.
(c) The useful by-products are biogas and slurry. Biogas is a mixture of methane and carbon dioxide and is used as a clean fuel for cooking and lighting. The slurry, which is the digested residue, is used as a fertilizer in fields to enrich the soil with nutrients.

> **Key Points: Cow dung contains bacteria - Biowaste undergoes anaerobic digestion - Biogas used as fuel and slurry as fertilizer**

Question 33.

(a) Describe the experiment conducted by T.H. Morgan on Drosophila melanogaster involving eye colour and body colour.

(b) How did the results deviate from Mendelian inheritance pattern ?

(c) Explain the two genetic terms used by Morgan for his observations.

[3 Marks]

Answer:

(a) T.H. Morgan conducted dihybrid crosses using Drosophila melanogaster to study eye colour and body colour. He crossed yellow-bodied, white-eyed females with brown-bodied, red-eyed males and then intercrossed the F1 progeny.

(b) He observed that the genes for these two traits did not segregate independently, as the F2 progeny did not show the typical Mendelian 9:3:3:1 ratio but deviated significantly, indicating the genes were linked.

(c) Morgan used the terms "linked genes" for genes located close together on the same chromosome that tend to be inherited together, and "crossing over" for the process where linked genes were sometimes separated during meiosis, producing new gene combinations.

Key Points: Morgan performed dihybrid crosses on eye and body colour in Drosophila - F2 progeny ratios deviated from Mendel's 9:3:3:1 indicating gene linkage - Genetic terms used: linked genes and crossing over

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Section E

Question 34.

(i) Describe the series of experiments conducted by Frederick Griffith. Comment on the significance of the result obtained.

(ii) State the contribution of Avery, MacLeod and McCarty.

[5 Marks]

Answer: (i) Frederick Griffith conducted experiments in 1928 using two strains of Streptococcus pneumoniae bacteria: the virulent smooth (S) strain with a protective capsule and the non-virulent rough (R) strain without a capsule. He injected mice with live R strain, live S strain, heat-killed S strain, and a mixture of live R strain and heat-killed S strain. Mice injected with live R strain survived, those with live S strain died, and those with heat-killed S strain survived. Interestingly, mice injected

with the mixture of live R and heat-killed S strains died, and live S bacteria were recovered from them. This showed that a "transforming principle" from the dead S bacteria transformed the live R bacteria into virulent S bacteria. The significance of this result is that it provided the first evidence of transformation, indicating that some material from dead bacteria could genetically change live bacteria, suggesting the existence of a genetic material.

(ii) Oswald Avery, Colin MacLeod, and Maclyn McCarty further studied Griffith's transforming principle to determine its chemical nature. Between 1933 and 1944, they purified various biomolecules such as proteins, DNA and RNA from heat-killed S bacteria and tested their ability to transform live R bacteria into S bacteria. They discovered that only DNA was able to cause transformation, proving that DNA is the genetic material responsible for heredity. Their contribution was crucial because it changed the scientific view from proteins being the genetic material to DNA holding genetic information, laying the foundation for molecular genetics.

Key Points: Griffith used S and R strains of Streptococcus pneumoniae - Heat-killed S strain transformed live R strain to virulent S strain - Discovery of "transforming principle" indicating genetic material - Avery, MacLeod and McCarty identified DNA as the transforming principle - DNA is the genetic material - Experiment disproved proteins as genetic material

Question 35.

The following questions are based on haemophilia

(i) Work out the crosses between :

(a) Normal female and Haemophilic male

(b) Carrier female and Normal male

(c) Carrier female and Haemophilic male

(ii) Write the conclusions you draw from these crosses. Comment on the type of inheritance of the disease.

(Use : X – Normal, Xh – Haemophilic

[5 Marks]

Answer: (i) **Crosses:**
(a) Normal female (XX) x Haemophilic male (XhY)
Genotypes: Female: XX, Male: XhY
Gametes: Female: X, Male: Xh or Y
F1 Offspring: Females – XXh (carriers, normal phenotype), Males – XY (normal)
(b) Carrier female (XXh) x Normal male (XY)

Genotypes: Female: XXh, Male: XY
Gametes: Female: X or Xh, Male: X or Y
F1 Offspring: Females – XX (normal), XXh (carriers); Males – XY (normal), XhY (haemophilic)
(c) Carrier female (XXh) x Haemophilic male (XhY)
Genotypes: Female: XXh, Male: XhY
Gametes: Female: X or Xh, Male: Xh or Y
F1 Offspring: Females – XXh (carriers), XhXh (haemophilic); Males – XY (normal), XhY (haemophilic)

(ii) **Conclusions and type of inheritance:**
Haemophilia is a sex-linked recessive disorder caused by the recessive gene Xh on the X chromosome.
Normal males have genotype XY and do not carry the gene.
Females can be normal (XX), carriers (XXh) or rarely haemophilic (XhXh).
Carrier females generally do not show symptoms but can pass the gene to their sons who may be affected.
The disorder appears mostly in males because they have only one X chromosome.
Crosses demonstrate that affected males cannot pass the disease to their sons but all daughters of affected males become carriers if the mother is normal.
This shows that haemophilia is inherited in an X-linked recessive manner.
Thus, disease affects males more frequently and females act as carriers.

> **Key Points: Haemophilia is X-linked recessive - Carrier females can pass gene to sons - Males with Xh gene are affected - Females usually carriers - Disease passes through female carriers to males**

Question 36.

(i) Explain any two basic principles/core techniques on which biotechnology is based.

(ii) Describe any three key tools used in Recombinant DNA technology.

[4 Marks]

Answer: (i) Two basic principles/core techniques of biotechnology are:
1. Genetic Engineering : It involves the manipulation and modification of an organism's genes using biotechnology tools to create recombinant DNA which can be introduced into host organisms to express desired traits.
2. Recombinant DNA Technology : It is the process of combining DNA molecules from different sources into one molecule to create new genetic combinations that are of value in research, medicine, and industry.

(ii) Three key tools used in Recombinant DNA technology are:
1. Restriction Enzymes : Also known as restriction endonucleases, these enzymes cut DNA at

specific sequences, creating fragments that can be used for genetic recombination.
2. DNA Ligase : This enzyme joins DNA fragments together by forming phosphodiester bonds, essential for connecting inserted DNA fragments into a vector.
3. Vectors : These are DNA molecules like plasmids or viruses used to carry foreign DNA into a host cell where it can be replicated and/or expressed. They help in gene cloning and transfer.

Key Points: Genetic engineering - Recombinant DNA technology - Restriction enzymes - DNA ligase - Vectors

Question 37.

‘‘Early and accurate diagnosis of diseases is vital in medical technology.’’

(i) Name the conventional methods of diagnosis and their disadvantages.

(ii) Which three diagnostic techniques have been developed through Biotechnology ? Explain how each one helps in detecting diseases.

[5 Marks]

Answer: (i) Conventional methods of diagnosis: These include serum analysis, urine analysis, X-ray imaging, and microscopy to detect pathogens or abnormalities.
Disadvantages: They often detect diseases at a late stage, are less sensitive and less specific, may give false results, and cannot identify infection at molecular level for early diagnosis.
(ii) Three diagnostic techniques developed through Biotechnology:
1. Recombinant DNA Technology: It helps in detecting diseases by identifying specific genetic markers or genes related to pathogens. This allows early detection of infections and genetic disorders by analyzing DNA sequences.
2. Polymerase Chain Reaction (PCR): PCR amplifies small amounts of DNA from pathogens to detectable levels. This enables detection of infectious agents even when their quantity is very low, facilitating early and accurate diagnosis.
3. Enzyme Linked Immunosorbent Assay (ELISA): ELISA detects the presence of antigens or antibodies in a patient's sample using enzyme-linked antibodies. It helps diagnose infectious diseases like HIV, dengue, and malaria by confirming the immune response to pathogens.
These biotechnology techniques improve early detection, accuracy, and help in timely treatment of diseases.

Key Points: Conventional methods: serum and urine analysis-disadvantages: late detection, less sensitivity-biotechnology techniques: Recombinant DNA technology, PCR, ELISA -each helps in early and accurate disease detection

Question 38.

Oogenesis is a discontinuous process that begins before birth and is completed after puberty.

(i) Trace the development of a gamete mother cell till its release from the ovary during ovulation.

(ii) Name the two pituitary hormones that play an important role in the process.

[5 Marks]

Answer: (i) Oogenesis begins in the female embryo when oogonia, the gamete mother cells with 46 chromosomes, multiply by mitosis. These oogonia then differentiate into primary oocytes which enter the first meiotic division but get arrested in prophase I, a stage where they remain until puberty. Each primary oocyte is surrounded by a layer of cells forming a primary follicle. After puberty, with each menstrual cycle, some primary follicles mature through folliculogenesis to become secondary follicles and then Graafian follicles. The primary oocyte completes the first meiotic division to form a secondary oocyte and a polar body just before ovulation. The secondary oocyte begins the second meiotic division but is arrested in metaphase II. During ovulation, the Graafian follicle ruptures and releases the secondary oocyte into the fallopian tube. If fertilization occurs, meiosis II completes; otherwise, the oocyte degenerates. (ii) The two pituitary hormones that regulate this process are Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH). FSH promotes the growth and maturation of ovarian follicles, while the LH surge triggers ovulation and the formation of the corpus luteum.

Key Points: Oogonia divide by mitosis to form primary oocytes - Primary oocytes arrest in prophase I until puberty - Follicle development from primary to Graafian follicle (folliculogenesis) - Primary oocyte completes meiosis I to form secondary oocyte during ovulation - Secondary oocyte arrested in metaphase II is released during ovulation - FSH and LH regulate the process

Question 39.

(i) Draw a labelled two-celled structure of male gametophyte of an angiosperm.

(ii) Name the three layers that surround the cytoplasm of a male gametophyte starting from innermost to outermost layer.

(iii) Which organic material makes the outermost layer ? Mention its advantage.

(iv) Why is the outermost layer of male gametophyte not continuous ?

[5 Marks]

Answer: (i) The male gametophyte of an angiosperm is a two-celled structure consisting of a larger vegetative cell and a smaller generative cell inside it. The vegetative cell contains a vegetative nucleus which controls the growth of the pollen tube, and the generative cell divides to form two male gametes (sperms). A labelled diagram shows the vegetative cell with vegetative nucleus and the

generative cell inside it.

(ii) The three layers surrounding the cytoplasm of a male gametophyte starting from innermost to outermost are: 1. Plasma membrane 2. Intine 3. Exine

(iii) The outermost layer, the exine, is mainly made up of an organic material called sporopollenin. The advantage of sporopollenin is that it is highly resistant to physical damage, chemical degradation, and enzymatic attack, thus protecting the pollen grain during its transfer from anther to stigma.

(iv) The outermost layer, exine, is not continuous because it has thin areas called germ pores. These germ pores allow the pollen tube to emerge during germination, facilitating the fertilization process.

Key Points: Two-celled male gametophyte structure - Layers surrounding male gametophyte: plasma membrane, intine, exine - Exine made of sporopollenin providing protection - Exine has germ pores for pollen tube emergence