CBSE EXAMINATION PAPER-2024

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 3** are case based questions

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

v. **Section C** – questions number **20 to 25** are very short answer

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

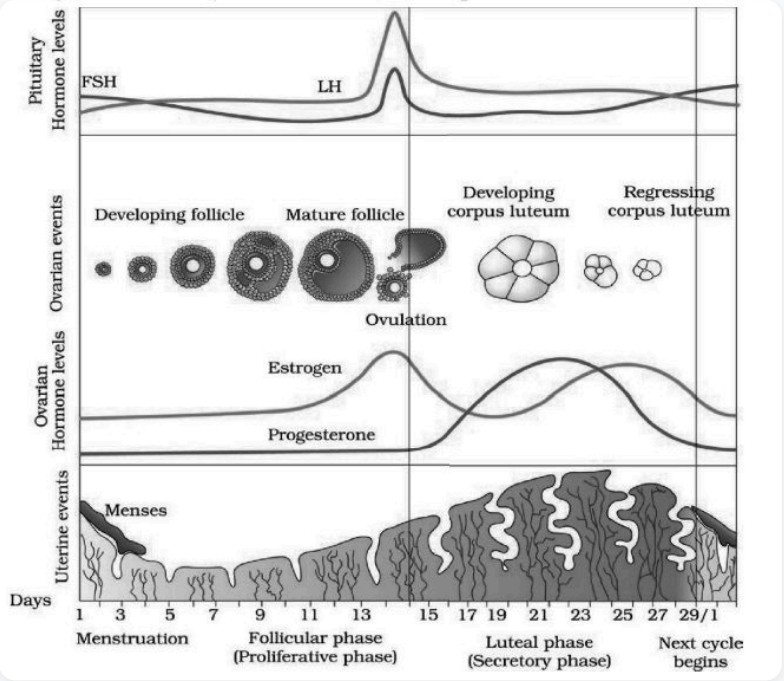
ix. Use of calculator is NOT allowed.

Section A

Question 1.

Question 2.

In a human female, the reproductive phase starts on the onset of puberty and ceases around middle age of the female. Study the graph given below regarding menstrual cycle and answer the questions that follow:



(1)

Name the hormones and their source organ, which are responsible for menstrual cycle at puberty.

[1 Marks]

Answer: The hormones responsible for the menstrual cycle at puberty are estrogen and progesterone, produced by the ovaries.

Key Points: 1. Hormones: estrogen and progesterone, 2. Source organ: ovaries

(2)

For successful pregnancy, at what phase of the menstrual cycle an early embryo (upto 3blastomeres) should be Implanted in the Uterus (IUT) of a human female who has opted for Assisted Reproductive Technology (ART)? Support your answer with a reason.

[1 Marks]

Answer: An early embryo (up to 3 blastomeres) should be implanted in the uterus during the luteal phase of the menstrual cycle, which occurs after ovulation. This phase is optimal because the endometrium is prepared for implantation due to increased levels of progesterone, which supports early embryonic development.

Key Points: Implantation occurs in the luteal phase; this phase prepares the endometrium; progesterone levels support embryo development

(3)

Name the hormone and its source organ responsible for the events. occurring during proliferative phase of menstrual cycle. Explain the event.

[1 Marks]

Answer: The hormone responsible for the events during the proliferative phase of the menstrual cycle is estrogen, which is produced by the ovaries. During this phase, estrogen stimulates the thickening and regeneration of the endometrial lining in preparation for possible implantation of a fertilized egg.

Key Points: Estrogen-Source: Ovaries-Endometrial thickening-Preparation for implantation

(4)

In a normal human female , why does menstruation only occurs if the released ovum is not fertilized ? explain?

[2 Marks]

Answer: Menstruation occurs in a normal human female if the released ovum is not fertilized because, without fertilization, the hormone levels (especially progesterone) drop. This hormonal change leads to the disintegration of the thickened endometrial lining, which is no longer needed to support a pregnancy. As a result, the endometrium is shed through menstruation, marking the beginning of a new menstrual cycle.

Key Points: Hormonal changes after ovulation-Disintegration of endometrium-Marking a new cycle

Question 3.

Read the following passage and answer the questions that follow:

"Mosquitoes are drastically affecting the human health in almost all the developing tropical countries. Different species of mosquitoes cause very fatal diseases so much so that many humans loose their life and if they survive, are unable to put in productive hours to sustain their life. With the result the health index of the country goes down."

(1)

Name a species of mosquito other than female Anopheles and the disease, for which it carries the pathogen.

[2 Marks]

Answer: One species of mosquito other than female Anopheles is Aedes aegypti, which carries the pathogen for dengue fever.

Key Points: Aedes aegypti - carries dengue fever; pathogenesis; indicates a different species of mosquito.

(2)

Name the form in which Plasmodium gains entry into (i) human body (ii) the female Anopheles body.

[1 Marks]

Answer: (i) Plasmodium gains entry into the human body as sporozoites through the bite of an infected female Anopheles mosquito. (ii) In the female Anopheles mosquito, Plasmodium enters in the form of parasites during the bite of an infected person.

Key Points: Sporozoites-humans; parasites-female Anopheles

(3)

Explain the events which occur within a female Anopheles mosquito afty it has sucked blood from a malaria patient.

[1 Marks]

Answer: When a female Anopheles mosquito bites a malaria patient, it ingests blood containing malaria parasites. These parasites enter the mosquito's body and develop within it. They multiply to form sporozoites, which are then stored in the mosquito's salivary glands. Upon the next bite to a human, these sporozoites are injected into the bloodstream, thus transmitting malaria.

Key Points: Parasites enter mosquito's body; they multiply; form sporozoites; stored in salivary glands; transmitted to humans through saliva.

(4)

Why do the symptoms of malaria not appear in a person immediately after being bitten by an infected female Anopheles? Give one reason. Explain when and how do the symptoms of the disease would appear.

[1 Marks]

Answer: The symptoms of malaria do not appear immediately after being bitten by an infected female Anopheles mosquito because the Plasmodium parasites need time to multiply within the human body. After being bitten, the sporozoites are introduced into the bloodstream and migrate to the liver, where they multiply for about 1 to 2 weeks before re-entering the bloodstream and infecting red blood cells. Symptoms typically appear after this incubation period, leading to fever, chills, and other malaria-related signs.

Key Points: Plasmodium multiplication in liver-1-2 weeks incubation period-symptoms appear after this

Section B

Question 4.

A single gene that controls the expression of more than one trait is said to show

[1 Marks]

(A) Incomplete dominance

(B) Polygenic inheritance

(C) Multiple allelism

(D) Pleiotropism

Explanation: The correct option is Pleiotropism. Pleiotropism refers to a situation where one gene influences multiple phenotypic traits. This contrasts with other options like incomplete dominance, polygenic inheritance, and multiple allelism, which involve different genetic mechanisms.

Question 5.

A person with trisomy of 21+ chromosome shows

[1 Marks]

(A) Rudimentary ovaries

(B) Gynaecomastia

(C) Characteristic palm crease

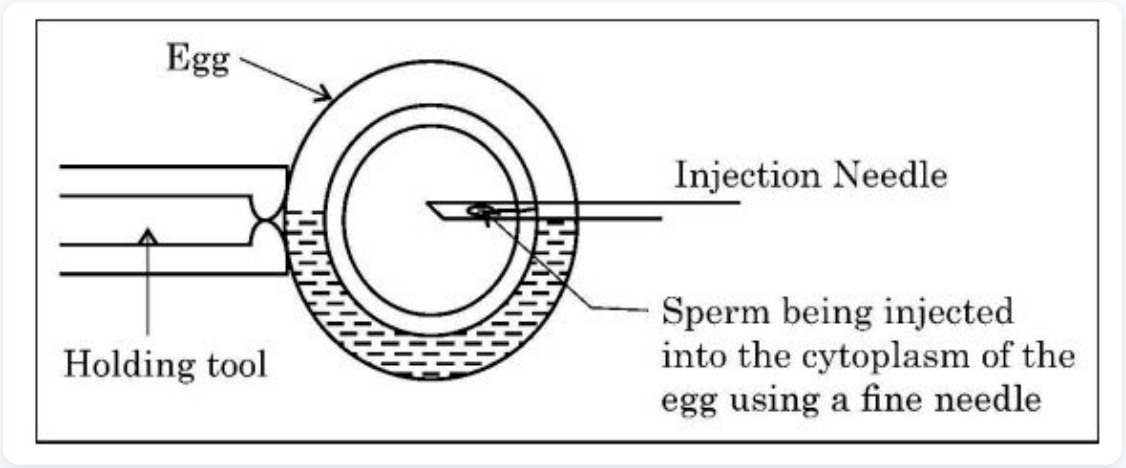
(D) Furrowed tongue

Explanation: The correct option is 'Characteristic palm crease'. This is because trisomy 21, also known as Down syndrome, is associated with distinct phenotypic traits, including a single transverse palmar crease. Other options like rudimentary ovaries, gynaecomastia, and furrowed tongue are not characteristically associated specifically with trisomy 21.

Question 6.

Observe the schematic representation of assisted reproductive technology given below, Egg Injection Needle—"Jesus Sperm being injected into the cytoplasm of the egg using a fine needle. Identify the most appropriate technique depicted in the above diagram.

[1 Marks]



(A) ICSI

(B) IUI

(C) IVF

(D) ZIFT

Explanation: The technique depicted is ICSI (Intracytoplasmic Sperm Injection), where a single sperm is directly injected into the cytoplasm of an egg to facilitate fertilization, which is clearly represented by the needle injecting sperm into the egg.

Question 7.

Interferons are proteins secreted by

[1 Marks]

(A) Bacteria infected cell

(B) WBC

(C) RBC

(D) Virus infected cell

Explanation: The correct answer is 'Virus infected cell'. Interferons are signaling proteins produced by host cells in response to the presence of pathogens, such as viruses. They play a crucial role in the immune response by interfering with viral replication and activating immune cells.

Question 8.

During biological treatment of sewage, the masses of bacteria held together by fungal filaments to form mesh-like structures are called

[1 Marks]

(A) Anaerobic sludge

(B) Primary sludge

(C) Activated sludge

(D) Flocs

Explanation: The correct answer is 'Flocs'. In the biological treatment of sewage, flocs are aggregates of bacteria and other microorganisms that are bound together by extracellular polysaccharides produced by the bacteria. This mesh-like structure allows for effective treatment as it facilitates the settling process and enhances the removal of contaminants from the sewage.

Question 9.

Which one of the following statements is correct in the context of observing DNA separation by agarose gel electrophoresis?

[1 Marks]

(A) Ethidium bromide stained DNA can be seen under UV light.

(B) DNA can be seen in visible light.

(C) DNA can be seen without staining in visible light.

(D) Ethidium bromide stained DNA can be seen in visible light.

Explanation: Ethidium bromide stained DNA can be seen under UV light because ethidium bromide intercalates between the bases of DNA and fluoresces when exposed to ultraviolet light, making the DNA bands visible.

Question 10.

A phenomenon where a male insect mistakenly identifies the patterns of an orchid flower as the female insect partner, and tries to copulate and thereby pollinates the flower is said to be

[1 Marks]

(A) Pseudofertilisation

(B) Pseudopollination

(C) Pseudoparthenocarpy

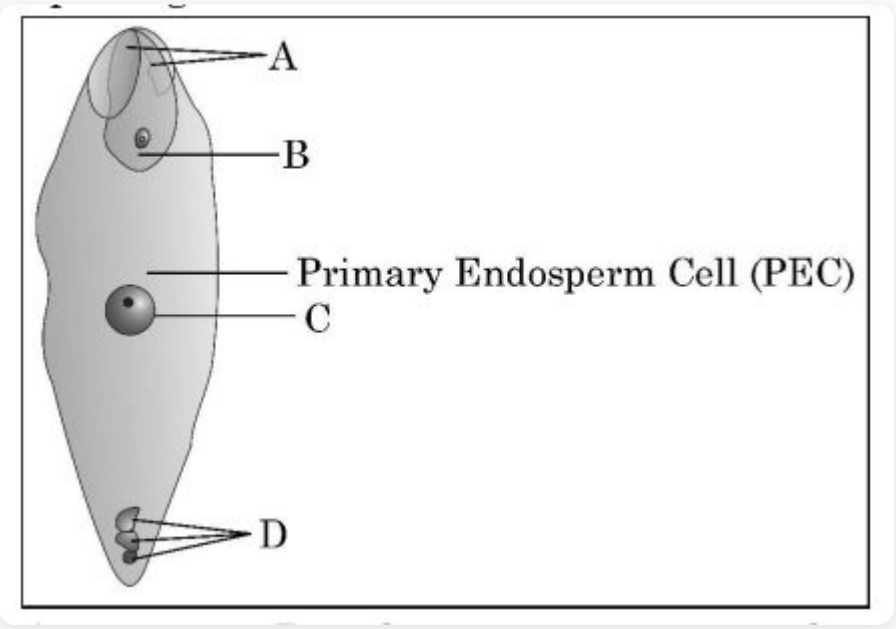
(D) Pseudocopulation

Explanation: The correct answer is Pseudocopulation. This term is used to describe the behavior where male insects are deceived by the mimicry of orchid flowers resembling female insects, leading them to attempt to mate with the flower, which inadvertently results in the transfer of pollen and pollination of the flower.

Question 11.

Identify the correct labellings in the figure of a fertilised embryo sac of an angiosperm given below

[1 Marks]



(A) A - degenerating synergids, B - zygote, C - degenerating antipodals, D - PEN

(B) A - degenerating synergids, B - zygote, C - PEN, D - degenerating antipodals

(C) A - degenerating antipodals, B - PEN, C - degenerating synergids, D - zygote

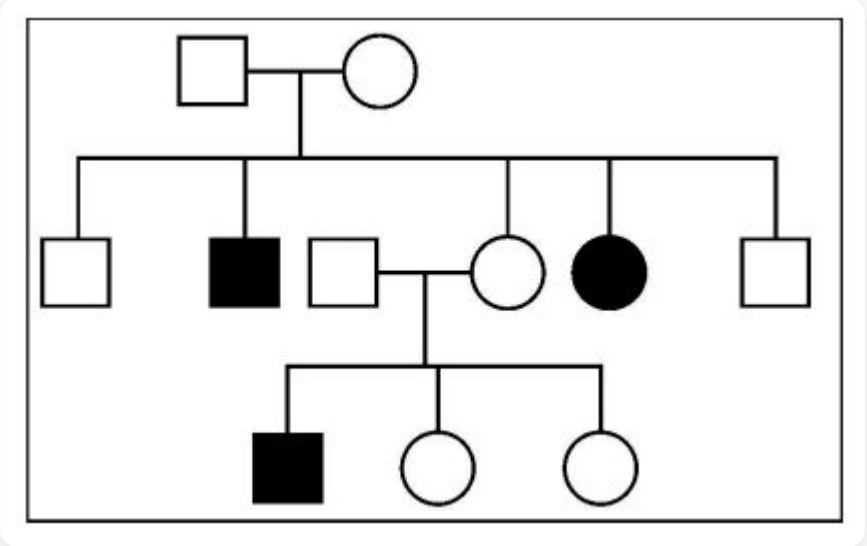
(D) A - zygote, B - degenerating synergids, C - degenerating antipodals, D - PEN

Explanation: After fertilization in the embryo sac of an angiosperm, the synergids degenerate as they helped in guiding the pollen tube. The zygote is formed by the fusion of the egg cell and one sperm nucleus (hence labelled B). The antipodal cells, located at the chalazal end, also degenerate after fertilization (labelled C). PEN stands for primary endosperm nucleus formed by fusion of the second sperm nucleus and two polar nuclei, which nourishes the developing embryo (labelled D). Therefore, the option A - degenerating synergids, B - zygote, C - degenerating antipodals, D - PEN is correctly labelled.

Question 12.

Study the pedigree chart of a family showing the inheritance pattern of a certain disorder. Select the option that correctly identifies the nature of the trait depicted in the pedigree chart.

[1 Marks]



(A) Autosomal dominant

(B) Dominant X-linked

(C) Autosomal recessive

(D) Recessive X-linked

Explanation: Autosomal recessive traits require two copies of the mutated gene for the disorder to be expressed, meaning the trait can skip generations when carriers (who have only one copy) do not show symptoms but can pass the gene to offspring. This pattern is identifiable in pedigree charts when the trait appears sporadically and affects both males and females equally. This matches the description given where autosomal recessive traits can skip generations and are not linked to sex chromosomes.

Question 13.

Match the following genes of the lac operon listed in column ‘A’ with their respective products listed in column ‘B’.

Select the correct option:

[1 Marks]

	A Gene		B Products
a.	‘i’ gene	(i)	β-galactosidase
b.	‘z’ gene	(ii)	lac permease
c.	‘a’ gene	(iii)	repressor
d.	‘y’ gene	(iv)	transacetylase

Select the correct option :

Options :

	a	b	c	d
(A)	(i)	(iii)	(ii)	(iv)
(B)	(iii)	(i)	(ii)	(iv)
(C)	(iii)	(i)	(iv)	(ii)
(D)	(iii)	(iv)	(i)	(ii)

(A) Option B

(B) Option C

(C) Option A

(D) Option D

Explanation: The correct answer is based on the functions of the genes within the lac operon. Each gene has a specific product that contributes to lactose metabolism in bacteria, such as β-galactosidase, which breaks down lactose into glucose and galactose. Matching the genes to their respective products is essential for understanding gene regulation and metabolic pathways.

Question 14.

If both the parents are carriers for thalassaemia, the chances of an afflicted child to be born to them is:

[1 Marks]

(A) 100%

(B) 75%

(C) 25%

(D) 50%

Explanation: When both parents are carriers for thalassaemia (genotype Tt, where T = normal and t = thalassaemia gene), the probability of their child being affected (tt) is 25%. This is determined using a Punnett square, which shows that out of four possible genotype combinations (TT, Tt, Tt, tt), only one results in the child being afflicted with thalassaemia.

Question 15.

If the sequence of nitrogen bases of the coding strand in a transcription unit is 5' - ATGAATG - 3', the sequence of bases in its RNA transcript would be:

[1 Marks]

(A) 5' - CAUUCAU - 3'

(B) 5' - GUAAGUA - 3'

(C) 5' - UACUUAC - 3'

(D) 5'-AUGAAUG-3'

Explanation: The correct RNA transcript is 5' - AUGAAUG - 3'. During transcription, the DNA coding strand is used as a template to synthesize RNA, replacing thymine (T) with uracil (U). The DNA sequence 5' - ATGAATG - 3' corresponds to the RNA sequence 5' - AUGAAUG - 3' due to base pairing (A with U and T with A).

Question 16.

Assertion (A): AIDS is a syndrome caused by HIV.

Reason (R): HIV is a virus that damages the immune system with DNA as its genetic material.

[1 Marks]

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

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

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

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

Explanation:

Both (A) and (R) are true and (R) is the correct explanation of (A) because AIDS is indeed caused by the HIV virus, which specifically attacks and weakens the immune system, leading to the development of AIDS. The statement about HIV being a virus with DNA as its genetic material is also accurate.

Question 17.

Assertion (A): In molecular diagnosis, single stranded DNA or RNA tagged with radioactive molecule is called a probe.

Reason (R): A probe always searches and hybridises with its complementary DNA in a clone of cells.

[1 Marks]

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

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

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

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

Explanation: A probe is a single stranded DNA or RNA fragment tagged with a radioactive molecule. It is used in molecular diagnosis to identify specific DNA sequences because it can hybridise (bind) to its complementary DNA sequence in a clone of cells. This hybridization property allows detection of the target DNA sequence, making both the assertion and reason true, and the reason correctly explaining the assertion.

Question 18.

Assertion (A): In birds the sex of the offspring is determined by males.

Reason (R) : Males are homogametic while females are heterogametic.

[1 Marks]

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

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

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

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

Explanation: In birds, males are homogametic (ZZ) and females are heterogametic (ZW). The sex of the offspring is determined by the female through the type of egg (Z or W chromosome) she provides, not by the male. Therefore, while both (A) and (R) are true statements individually, (R) does not correctly explain (A) because the sex of offspring is determined by females in birds, not males.

Question 19.

Assertion (A): Communities that comprise of more species tend to be more stable.

Reason (R) : A higher number of species results in less year to year variation in total biomass.

[1 Marks]

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

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

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

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

Explanation: Both (A) and (R) are true and (R) is the correct explanation of (A). The assertion states that communities with more species are more stable, which is true because greater biodiversity can buffer against environmental changes. The reason given specifies that this stability is due to reduced year-to-year variation in total biomass, highlighting a mechanism that supports the assertion.

Section C

Question 20.

"Farmers prefer apomictic seeds to hybrid seeds." Justify giving two reasons.

[2 Marks]

Answer: Farmers prefer apomictic seeds due to their ability to produce seeds that are genetically identical to the parent plant, ensuring uniformity in crop characteristics. This trait allows farmers to maintain desirable traits in their crops consistently. Additionally, apomictic seeds can be harvested and replanted without losing viability, minimizing the need to purchase new seeds each planting season, which can reduce costs and enhance sustainability in farming practices.

Key Points: Genetic uniformity-Cost efficiency-Sustainability

Question 21.

Mention one advantage and one disadvantage of amniocentesis.

[2 Marks]

Answer: One advantage of amniocentesis is that it provides accurate genetic information about the fetus, allowing for the early detection of chromosomal abnormalities such as Down syndrome. However, one disadvantage is that it carries a small risk of miscarriage, estimated to be around 1 in

300 to 1 in 500 procedures, which can lead to a loss of the pregnancy. Thus, it is important to weigh the benefits against the risks.

Key Points: Advantage: accurate genetic information-disadvantage: risk of miscarriage-importance of weighing benefits and risks.

Question 22.



a) Name the restriction enzyme that recognises the given specific sequence of bases. What are such sequence of bases referred to as?

(b) What are the arrows in the given figure indicating? Write the result obtained thereafter.

[2 Marks]

Answer: The restriction enzyme that recognizes the specific sequence of bases is EcoRI, which recognizes the GAATTC sequence. Such specific sequences are referred to as restriction sites or recognition sequences. The arrows in the figure typically indicate the cleavage sites where the restriction enzyme acts, resulting in the DNA being cut into fragments. These fragments can then be analyzed or used in various molecular biology techniques, such as cloning or genetic engineering.

Key Points: EcoRI-recognition sequence-GAATTC-restriction site-cleavage sites-fragments-analysis-molecular biology

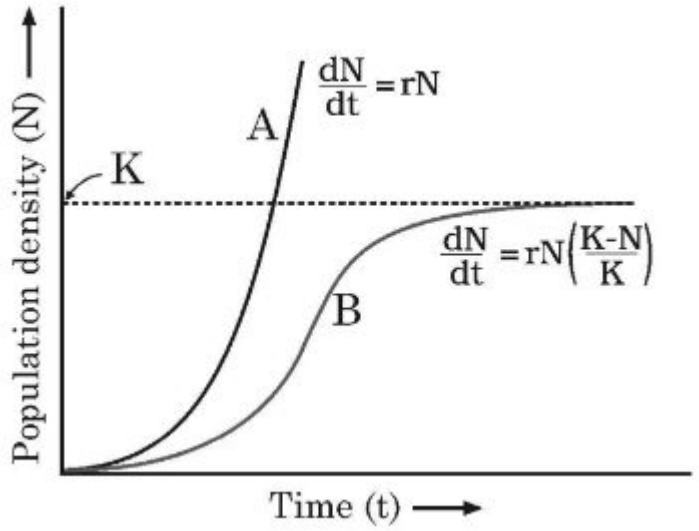
Question 23.

Observe the population growth curve and answer the questions given below:

(a) State the conditions under which growth curve 'A' and growth curve B plotted in the graph are possible.

(b) Mention what does 'K' in the graph represent

[2 Marks]



Answer: Growth curve 'A' represents exponential growth, which occurs under ideal conditions with unlimited resources, such as food and space, typical of newly introduced species. Growth curve 'B' shows logistic growth, indicating a population that grows rapidly at first but slows down as it reaches carrying capacity 'K', where resource limitations begin to affect growth. 'K' represents the carrying capacity of the environment, the maximum sustainable population size that can be supported by available resources.

Key Points: Conditions for growth curve 'A': unlimited resources; Conditions for growth curve 'B': resources limited, approaching carrying capacity; 'K' represents carrying capacity.

Question 24.

Explain how are plants benefitted by their association with "Glomus species

[2 Marks]

Answer: Plants benefit from their association with Glomus species, which are arbuscular mycorrhizal fungi. These fungi enhance nutrient absorption, particularly phosphorus, by extending the root surface area through their hyphal network. This symbiotic relationship improves plant growth, increases drought resistance, and enhances overall soil health. Furthermore, Glomus species aid in protecting plants from pathogens and help in nutrient cycling, significantly contributing to plant vitality and ecosystem stability.

Key Points: enhanced nutrient absorption, particularly phosphorus-hyphal network increases root surface area-improved plant growth and drought resistance

Question 25.

If the base adenine constitutes 31% of an isolated DNA fragment, then write what will be the expected perrentage of the base cytosine in it.

Explain how did you arrive at the answer given.

[2 Marks]

Answer: In DNA, adenine (A) pairs with thymine (T) and cytosine (C) pairs with guanine (G). Since adenine makes up 31% of the bases, thymine also accounts for 31%. Therefore, adenine and thymine together constitute 62% of the DNA. The remaining percentage, which is 38%, is shared between cytosine and guanine. Thus, cytosine and guanine each account for 19% of the bases in the DNA fragment. Therefore, the expected percentage of cytosine is 19%.

Key Points: Adenine pairs with Thymine; Adenine is 31%; DNA is double stranded; Remaining bases are divided equally; Cytosine percentage is found.

Section D

Question 26.

Identify a, b, c, d, e and fin the table given below:

[3 Marks]

Sl. No.	Organism	Bioactive Molecule	Use
1.	*Monascus purpureus*	a	b
2.	c	d	Antibiotic
3.	e	Cyclosporin A	f

Answer: To identify the variables a, b, c, d, e, and f in the given table, we must first analyze the data presented. A close look at the rows and columns will reveal patterns or correlations that define these variables. For instance, if a is a dependent variable influenced by b, and if c, d, e represent various independent variables affecting a, we should utilize mathematical relationships such as those in linear equations or statistical methods to derive their values. It is important to also use any given formulas or relationships provided in the context to properly deduce each variable's identity and potential numerical value. Cross-referencing with the context can ensure accurate identification.

Key Points: Analyze data in the table-Determine relationships among variables-Use formulas or statistics to deduce values

Question 27.

Tropical regions harbour more species than the temperate regions. How have biologists tried to explain this in their own ways? Explain.

[3 Marks]

Answer: Biologists attribute the greater biodiversity in tropical regions to several factors. One significant reason is the stable climate, which allows for year-round growth and reproduction, unlike temperate zones that experience seasonal fluctuations. Tropical areas also benefit from high levels of solar energy, leading to lush vegetation and complex ecosystems. Furthermore, mid-domain effect suggests that species richness peaks in the tropics due to geographical constraints. Lastly, historical processes, such as climatic stability over millions of years, have also allowed for greater speciation in these regions.

Key Points: Stable climate promotes year-round growth; high solar energy enhances vegetation; mid-domain effect increases richness; historical stability fosters speciation.

Question 28.

(i) What does an ecological pyramid represent?

(ii) The Ecological pyramids may have an 'upright' or an 'inverted' shape. Justify with the help of suitable examples.

[3 Marks]

Answer: An ecological pyramid is a graphical representation of the distribution of biomass, numbers, or energy among the trophic levels in an ecosystem. It typically illustrates three main types: pyramid of numbers, biomass, and energy. An upright pyramid shows that each higher trophic level has less biomass or energy than the one below it, which is typical in ecosystems like a forest. Conversely, an inverted pyramid, such as that of phytoplankton in a marine ecosystem, indicates that the biomass of producers can be less than that of consumers, due to rapid turnover rates. Hence, the shape conveys crucial information about the structure and function of ecological communities.

Key Points: Definition of ecological pyramid-Types of ecological pyramids (numbers, biomass, energy)-Upright pyramid example (forest ecosystem)-Inverted pyramid example (marine ecosystem)

Question 29.

(a) What are transgenic animals?

(b) Name the transgenic animal having the largest number amongst all the existing transgenic animals.

(c) State any 3 reasons for which these types of animals are being produced.

[3 Marks]

Answer: Transgenic animals are organisms that have been genetically modified to carry genes from other species. This genetic modification is accomplished using techniques like recombinant DNA technology. The transgenic animal with the largest number is the mouse, which has been widely used in research and has a high frequency of successful genetic modifications. There are several reasons for producing transgenic animals: to study genetic diseases, to develop new medical treatments, and to improve agricultural productivity through enhanced traits like disease resistance.

Key Points: Definition of transgenic animals-Genetic modification techniques-Mouse as the most transgenic animal-Research on genetic diseases-Medical treatment development-Agricultural improvement

Question 30.

If the cells in the leaves of a maize plant contain 10 chromosomes each, write the number of chromosomes in its endosperm and zygote. Name and explain the process by which an endosperm and a zygote are formed in maize.

[3 Marks]

Answer: In maize, a diploid plant has cells with 10 chromosomes. During fertilization, one sperm cell fuses with the egg cell to form a zygote, which will also contain 10 chromosomes, as it receives one set from each parent. The endosperm, crucial for seed development, is formed when a second sperm cell fertilizes two polar nuclei in the embryo sac, resulting in a triploid cell with 15 chromosomes (2 sets from polar nuclei + 1 set from sperm). This triploid endosperm provides nutrients to the developing zygote and is essential for seed viability.

Key Points: Chromosome number in zygote is 10-chromosome number in endosperm is 15-endosperm formed by double fertilization

Question 31.

(a) Why does DNA replication occur within a replication fork and not in its entire length simultaneously?

(b) "DNA replication is continuous and discontinuous on the two strands within the replication fork." Explain with the help of a schematic representation.

[3 Marks]

Answer: DNA replication occurs at the replication fork because it allows for the separation of the two strands of the DNA double helix, enabling the synthesis of new strands. The enzymes involved, such as DNA polymerase, need access to single-stranded DNA. The replication fork creates a localized

area where the DNA unwinds and new nucleotides are added. Importantly, the leading strand is synthesized continuously in the direction of the fork movement, while the lagging strand is synthesized discontinuously, forming Okazaki fragments.

Key Points: Replication fork provides localized access for enzymes- Leading strand synthesized continuously in same direction as fork- Lagging strand synthesized discontinuously into Okazaki fragments- Allows for efficient and accurate DNA replication.

Question 32.

Explain the processing of heterogeneous nuclear RNA OmRNA) into a fully functional mRNA in eukaryotes. Where does this processing occur in the coll?

[3 Marks]

Answer: In eukaryotes, heterogeneous nuclear RNA (hnRNA) undergoes several processing steps to become mature mRNA. This processing occurs in the nucleus. Initially, the hnRNA undergoes 5' capping, where a methylguanylate cap is added to the 5' end, protecting it from degradation and aiding in ribosome binding during translation. Next, introns, which are non-coding sequences, are removed through splicing, performed by the spliceosome. Exons are then joined together. Finally, a poly-A tail is added to the 3' end of the mRNA, enhancing its stability and export to the cytoplasm. The mature mRNA is then transported out of the nucleus for translation.

Key Points: 5' capping-intron removal-splicing-poly-A tail formation-nucleus

Question 33.

The world is facing accelerated rates of species extinction largely due to human activities. Explain any three human activities responsible for accelerated rates of species extinction.

[3 Marks]

Answer: Human activities play a significant role in the accelerated extinction of species around the globe. First, habitat destruction, due to urbanization and agriculture, leads to loss of natural environments, which are crucial for many species' survival. Second, pollution, including plastic waste and chemical runoff, contaminates ecosystems and poses serious threats to wildlife health. Lastly, overexploitation of species through activities such as overfishing and poaching directly reduces their populations to unsustainable levels, disrupting ecological balance and leading to extinction.

Key Points: 1. Habitat destruction from urbanization and agriculture. 2. Pollution from plastic waste and chemicals harming wildlife. 3. Overexploitation through overfishing and poaching threatening species populations.

Section E

Question 34.

(i) Draw a schematic diagram of the cloning vector pBR 322 and label (1) Bam HI site (2) gene for ampicillin resistance (3) 'ori (4) 'rop' gene.

(ii) State the role of 'rop' gene.

(iii) A cloning vector does not have a selectable marker. How will it affect the process of cloning?

(iv) Why is insertional inactivation preferred over the use of selectable markers in cloning vectors?

[5 Marks]

Answer: The pBR322 cloning vector is a widely used plasmid in recombinant DNA technology. In part (i), the schematic diagram includes the origin of replication ('ori'), which is essential for plasmid replication within a host cell. The Bam HI site serves as a restriction site for inserting foreign DNA. The gene for ampicillin resistance allows for the selection of transformed cells, while the 'rop' gene helps regulate the replication of the plasmid to ensure a stable yield of cloned products. In part (ii), the 'rop' gene plays a crucial role by encoding a protein that facilitates the replication process and maintains the cloning vector's stability by regulating plasmid copy number. For part (iii), if a cloning vector does not possess a selectable marker, it will be challenging to identify successfully transformed cells, as there would be no way to differentiate between cells that have taken up the plasmid and those that have not, leading to low efficiency in cloning. Finally, in part (iv), insertional inactivation is often preferred because it provides a more straightforward mechanism to confirm successful cloning; when foreign DNA is inserted, it disrupts the function of a marker gene, allowing for easy identification of positive clones. This is more reliable than solely relying on selectable markers, which may sometimes yield false positives.

Key Points: pBR322 structure includes 'ori', Bam HI site, ampicillin resistance gene, and 'rop' gene; Rop gene regulates copy number; Lack of selectable markers makes identification of transformed cells difficult; Insertional inactivation allows efficient identification of successful clones.

Question 35.

(i) Name the nematode (scientific name) that infects the roots of tobacco plant and reduces its yield.

(ii) Name the vector that is used to introduce nematode-specific genes into the host plant (tobacco).

(iii) How do sense and anti-sense RNAs function?

(iv) Why could parasite not survive in a transgenic tobacco plant?

[5 Marks]

Answer: The nematode that infects the roots of the tobacco plant, reducing its yield, is Meloidogyne spp., commonly known as root-knot nematodes. These parasites form galls on the roots, leading to significant yield loss in tobacco cultivation due to impaired nutrient and water absorption. To introduce nematode-specific genes into the host tobacco plant, Agrobacterium tumefaciens is commonly used as a vector. Sense and anti-sense RNAs play critical roles in gene expression regulation. Sense RNA corresponds to the coding sequence and is involved in normal protein synthesis, while anti-sense RNA is complementary to the sense RNA, inhibiting its expression by binding to it, forming double-stranded RNA which triggers RNA interference (RNAi). Transgenic tobacco plants are engineered to express anti-sense RNA specific to the nematode's genes, effectively silencing these genes. As a result, the parasites are unable to complete their life cycle and survive, leading to reduced infestation and improved yield.

> **Key Points: Meloidogyne spp. (root-knot nematodes); Agrobacterium tumefaciens (vector); sense RNA (coding, protein synthesis); anti-sense RNA (inhibitory, silencing); RNA interference mechanism; transgenic tobacco (expresses anti-sense RNA); nematode survival affected.**

Question 36.

(i) Draw a diagram of a human sperm. Label any four parts and write their functions.

(ii) In a human female, probability of an ovum to get fertilized by more than one sperm is impossible. Give reason.

[5 Marks]

Answer: A human sperm is a complex cell with several specialized structures. The main parts include the head, which contains the nucleus with genetic material; the midpiece, packed with mitochondria for energy production; and the tail, or flagellum, which propels the sperm forward. Each part has a specific function: the head aids in penetration of the ovum, the midpiece provides energy needed for motility, and the tail ensures movement towards the egg. In regard to ovum fertilization, only one sperm can fertilize an ovum due to the block mechanisms that prevent polyspermy. After the first sperm penetrates the egg, changes in the egg's membrane occur, preventing additional sperm from entering, ensuring the correct amount of genetic material is present, and thus maintaining the species' proper genetic structure.

Key Points: Head (contains nucleus with genetic material); Midpiece (contains mitochondria for energy); Tail (propels sperm); Fertilization blocked to prevent polyspermy (membrane changes after first sperm entry); Ensures proper genetic material.

Question 37.

(i) With the help of labelled diagram only, show the different stages of embryo development in a dicot plant.

(ii) Endosperm development precedes embryo development. Justify.

[5 Marks]

Answer: The development of the embryo in a dicot plant occurs through several distinct stages, beginning with the fertilization of the ovule, which leads to the formation of a zygote. This zygote undergoes a series of cell divisions, transforming into a multicellular structure. The first noticeable change is the formation of a proembryo, which then develops into a globular embryo. This globular form eventually elongates to form the heart stage embryo and finally matures into a torpedo stage before transitioning into a mature embryo. The stages of development are not simply structural; they involve complex physiological processes that ensure successful plant growth. Endosperm development is crucial as it provides the necessary nourishment to the growing embryo. The endosperm forms from the fertilization of the central cell of the ovule and is rich in starch, proteins, and oils that sustain the embryo during its initial growth. This nutrient supply allows the embryo to develop properly. Therefore, endosperm development, which occurs in parallel with zygote formation, serves the essential role of feeding the embryo, making it critical for successful plant reproduction.

Key Points: Stages of embryo development: zygote, proembryo, globular embryo, heart stage, torpedo stage, mature embryo; Role of endosperm: provides nourishment, supports embryo growth, formed from fertilization of central cell.

Question 38.

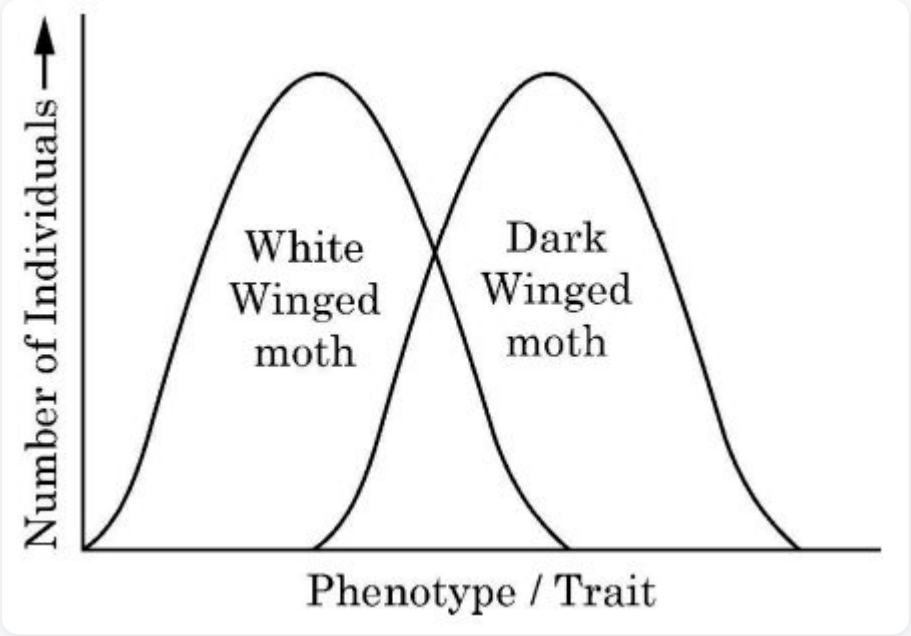
(a) Natural selection operates in different ways in nature.

(i) Identify the type of natural selection depicted in the graph above.

(ii) In England after industrialisation, the population of dark winged moths were more favoured than white winged moth. Explain.

(ii) Anthropogenic action can enhance the rate of evolution. Explain with the help of an example.

[5 Marks]



Answer: Natural selection can take on different forms, notably stabilizing, directional, and disruptive selection. In the context of industrialization in England, the type of natural selection depicted in the graph is directional selection. During this period, darker winged moths increased in frequency due to the soot-covered trees offering better camouflage from predation by birds, leading to a higher survival rate compared to white-winged moths. Over time, as environmental changes continued, the lighter-colored moths faced a decline due to their visibility against the darkened bark. Additionally, anthropogenic actions such as pollution and habitat destruction can significantly enhance evolution rates. For instance, Darwin's finches have adapted their beak sizes in response to changes in available food sources due to human influence. Such changes create selective pressures, leading to rapid evolutionary adaptations within species, affirming that human impact can drive natural selection markedly.

Key Points: Directional selection; dark-winged moths favored; camouflage against predation; industrialization effects; anthropogenic actions enhance evolution; example of Darwin's finches; changes in beak size; selective pressures from human activities

Question 39.

(i) Why did Hershey and Chase use S and P in their experiment? Explain.

(ii) State the importance of (1) blending and (2) centrifugation in their experiment.

(ii) Write the conclusion they arrived at the end of their experiment.

[5 Marks]

Answer: Hershey and Chase conducted their famous experiment using radioactive isotopes of sulfur and phosphorus to trace the molecules that contain genetic information. Sulfur-35 was used to label proteins, while phosphorus-32 labeled DNA, allowing them to determine which molecule was responsible for transferring genetic material during viral infection. Blending is crucial as it separates viral coats from the infected bacteria, ensuring only the genetic material enters the cells.

Centrifugation then aids in separating lighter viral proteins from the heavier bacterial cells, revealing that only the phosphorus-labeled DNA entered the bacteria. Their conclusion was groundbreaking: DNA, not protein, is the genetic material in viruses.

Key Points: Use of S35 to label proteins; Use of P32 to label DNA; Blending separates viral coats from bacteria; Centrifugation separates components based on density; Conclusion that DNA is the genetic material rather than protein.