

Sample Question Paper 03

BIOLOGY 12

Time : 3 Hrs.

Max. Marks : 70

General Instructions

1. All questions are compulsory.
2. The question paper has five sections and 33 questions.
3. Section-A has 16 questions of 1 mark each; Section-B has 5 questions of 2 marks each; Section- C has 7 questions of 3 marks each; Section- D has 2 case-based questions of 4 marks each; and Section-E has 3 questions of 5 marks each.
4. There is no overall choice. Answer all 33 questions. However, internal choices have been provided in some questions. A student has to attempt only one of the alternatives in such questions.
5. Wherever necessary, neat and properly labelled diagrams should be drawn.

Section A Multiple Choice Type Questions

Question Nos. 1 to 12 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions.

| I | II | III | IV |
|-------------------|---------------------------------|-------------------------------------------------|-------------------------------------------|
| Stage of origin | Stage of growth and replication | Stage of meiosis and formation of haploid cells | Stage of maturation into functional sperm |
| (a) Spermatids | Primary spermatocytes | Spermatogonia → Secondary spermatocytes | Spermatozoa |
| (b) Spermatogonia | Primary spermatocytes | Spermatids → Secondary spermatocytes | Spermatozoa |
| (c) Spermatogonia | Primary spermatocytes | Secondary spermatocytes → Spermatids | Spermatids |
| (d) Spermatogonia | Primary spermatocytes | Secondary spermatocytes → Spermatids | Spermatozoa |

3. Select the correct match from the following.

| Enzymes | Functions |
|------------------------------|------------------------------------------|
| (a) Restriction endonuclease | Removes nucleotides from the ends of DNA |
| (b) Restriction exonuclease | Cuts DNA at specific position |
| (c) DNA ligase | Cuts DNA at non-specific position |
| (d) <i>Taq</i> polymerase | Extends primers on genomic DNA template |

Stage II: Proficiency Level

4. $p^2 + 2pq + q^2 = 1$, this equation cannot operate in a population if

- (a) frequent mutations occur among the gene pool
- (b) there is no migration to a new habitat for a long time
- (c) free interbreeding occurs among all individuals
- (d) it is isolated from other populations

5. Given below are few statements related to restriction enzymes.

- (a) Restriction endonucleases recognise specific palindromic sequences in DNA.
- (b) *Eco RI* is a restriction enzyme that produces blunt ends.
- (c) *Hind II* was the first restriction endonuclease discovered.
- (d) Sticky ends are helpful in forming recombinant DNA.
- (e) Restriction enzymes are also called molecular scissors.

Which of the above statements are correct?

| | |
|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> (a) (i) (ii) (iv) and (v) (c) (ii), (iii), (iv) and (v) | <ul style="list-style-type: none"> (b) (i), (iii), (iv) and (v) (d) (i), (ii), (iii) and (v) |
|--------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------|

6. A male having abnormal arrangement of chromosome is sterile. He also shows feminine development due to unnatural presence of a X-chromosome. Mention the chromosomal disorder from which he suffers.

- (a) Turner's syndrome
- (b) Down's syndrome
- (c) Klinefelter's syndrome
- (d) Haemophilia

7. Select the incorrect statements among the following.

- (a) Smallpox can be completely eradicated by the use of vaccines and immunisation programmes.
- (b) The bone marrow is the main lymphoid organ where all blood cells including lymphocytes are produced.
- (c) AIDS is caused by retrovirus, which have an envelope enclosing the DNA genome.
- (d) Non-ionising radiations like UV cause DNA damage leading to neoplastic transformation.

8. Consider the formula given below.

$$N_t = N_0 e^{rt}$$

What does e in this formula signifies?

- (a) Population density after time t
- (b) Population density at time zero
- (c) The base of natural logarithms
- (d) Intrinsic rate of natural increase

9. A specific recognition sequence identified by endonuclease as to make cut at specific positions within the DNA is

- (a) poly (A) tail sequences
- (b) degenerate primer sequence
- (c) Okazaki sequences
- (d) palindromic nucleotide sequences

10. A researcher is synthesising a gene to be expressed in a bacterial cell. During translation, the ribosome stops prematurely at the codon UGA, preventing full-length protein formation. To troubleshoot, she checks other codons used in her gene.

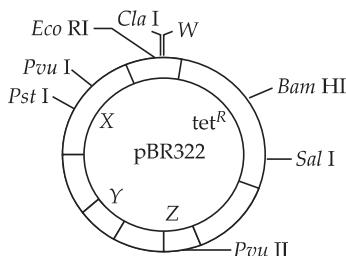
Based on your understanding of the genetic code, which of the following codons should she not worry about causing premature termination?

- (a) UAA
- (b) UGA
- (c) AUG
- (d) UAG

11. BOD of wastewater is estimated by measuring the amount of

- (a) total inorganic matter
- (c) biodegradable organic matter
- (b) oxygen evolution
- (d) oxygen consumption

12. The given figure is the diagrammatic representation of the vector pBR322. Which one of the given options correctly identifies its certain component(s)?



- (a) Y—Original restriction enzymes
- (b) Z—Reduced osmotic pressure
- (c) W—Selectable markers
- (d) X—Antibiotic resistance genes

Assertion-Reason Based Questions

Question No. 13 to 16 consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

- (a) Both A and R are true and R is the correct explanation of A.
- (b) Both A and R are true and R is not the correct explanation of A.
- (c) A is true but R is false.
- (d) A is false, but R is true.

13. **Assertion (A)** Diaphragms, cervical caps and vaults are the barriers made up of rubber.

Reason (R) Diaphragms, cervical caps and vaults are used to cover the male copulatory organ during coitus.

14. **Assertion (A)** Turner's syndrome is caused due to the presence of extra X-chromosome.

Reason (R) Individuals suffering from Turner's syndrome have rudimentary ovaries and lack secondary sexual characteristics.

15. **Assertion (A)** tRNA recognises its corresponding codon in mRNA.

Reason (R) For each codon, there is an individual tRNA.

16. **Assertion (A)** Mycorrhiza is a mutualistic inter-relationship.

Reason (R) Mycorrhiza is an association between fungi and roots of higher plants.

Section B Very Short Answer Type Questions

17. Attempt either option (a) or (b).

- (a) Explain when is a genetic code is said to be
 - (i) degenerate.
 - (ii) universal.

Or (b) A molecular biology lab analysed the genetic material extracted from two samples, one from the nucleus and another from the cytoplasm of a human cell. The nuclear sample was found to contain equal amounts of adenine and thymine. The cytoplasmic sample contained uracil and showed variable amounts of each nitrogenous base.

- (i) Identify which sample contains DNA and which contains RNA. Justify your answer based on the nitrogenous base composition.
- (ii) Define genomics. Give any two applications of genomics.

18. The table below shows a hypothetical hormonal report of a female patient across her menstrual cycle.

| Hormone Tested | Observed Level (with Unit) | Reference Range (Follicular Phase) |
|------------------------------------|----------------------------|-------------------------------------------------|
| Follicle Stimulating Hormone (FSH) | 3.0 mIU/mL | 3.5–12.5 mIU/mL |
| Luteinizing Hormone (LH) | 2.5 mIU/mL | 2.4–12.6 mIU/mL |
| Oestrogen | 80 pg/mL | 70–400 pg/mL |
| Progesterone | 0.3 ng/mL | 0.1–0.8 ng/mL (Follicular), 2–25 ng/mL (Luteal) |
| Menstrual Status | Delayed by 10 days | Normal cycle: 28 ± 2 days |

(a) Based on the hormone levels and the menstrual status, identify the likely phase disruption. What could be the reason for the delay in menstruation?
 (b) Which hormone typically shows a sharp rise before ovulation and what is its role?

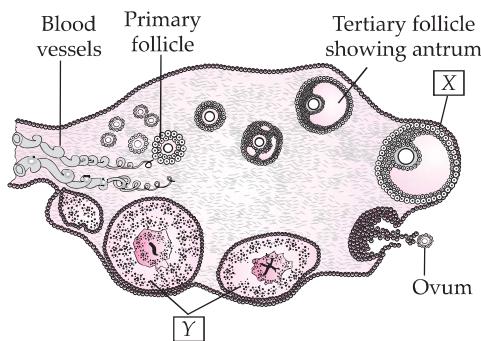
19. What is a detritus food chain made up of? How does the organisms in detritus food chain meet their energy and nutritional requirements?

20. Give the name of the source organism of the gene *cry* IAc and its target pest. Mention the uses of cloning vector in biotechnology.

21. In the experiment, done by Miller and Urey name the gases used in order to simulate primitive atmosphere and state the significance of the experiment.

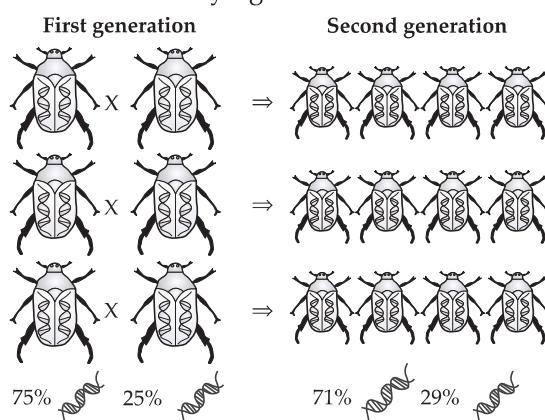
Section C Short Answer Type Questions

22. Observe the diagram given below and answer the following questions.



(a) Identify the structures labelled X and Y.
 (b) What is the function of the structure labelled X during the menstrual cycle?
 (c) Mention the hormonal role of the structure labelled Y.

23. Shown below is population of beetles in varying seasonal environment.

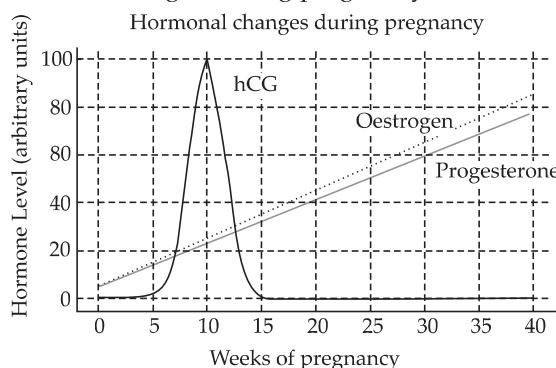


(a) Which evolutionary process, is best illustrated in the given diagram and why?
 (b) How does the change in beetle colour frequency between generations affect the genetic diversity of the population?

24. Suggest a suitable evolutionary explanation for the following cases with justification.

(a) A population of moths in England shifted from mostly light-coloured to mostly dark-coloured forms during the Industrial Revolution.
 (b) The wings of a bat and the flippers of a whale have similar underlying bone structures despite serving different functions.
 (c) The wings of a butterfly and the wings of a bird are used for flying but have different structural origins.

25. The graph below shows hormonal changes during pregnancy.



Observe the graph and answer the following questions.

(a) Which hormone shows a sharp rise in the early weeks of pregnancy and what is its role?
 (b) Why is it necessary for progesterone and oestrogen levels to increase continuously throughout pregnancy? What could happen if their levels fall prematurely?

26. Attempt either option (a) or (b).

(a) Expand the term GEAC. State the role of GEAC in regulating biotechnology. Mention one of its key responsibilities.

Or (b) How has biotechnology helped in developing pest-resistant crops? Name one such genetically modified crop and the gene responsible for this trait.

27. A student observed that a DNA fragment was cut at specific sites using an enzyme and produced sticky ends. Name the enzyme responsible and explain how this property is useful in genetic engineering

28. When does a geneticist need to carry a test cross? Why is pedigree analysis done in the study of human genetics? State the conclusion that can be drawn from it.

Section D Case Based Questions

29. A group of environmental scientists conducted a study to assess the impact of various waste discharges on the Biological Oxygen Demand (BOD) of a river flowing through an industrial and urban zone. BOD is a measure of the amount of Dissolved Oxygen (DO) required by aerobic microbes to breakdown organic matter in water. The scientists collected samples from four different sites.

The given data shows the BOD Levels and DO levels from sampling sites.

| Sampling sites | BOD level (mg/L) | DO level (mg/L) |
|----------------|------------------|-----------------|
| Site A | 2.9 | 6.7 |
| Site B | 6.5 | 3.2 |
| Site C | 8.7 | 2.5 |
| Site D | 3.8 | 5.5 |

The permissible limit for BOD in surface water is < 3 mg/L and for DO is > 5 mg/L (as per CPCB standards).

- Which sampling site shows clear water, abundant fish and minimal organic matter?
- What can be inferred about the relationship between BOD and DO?

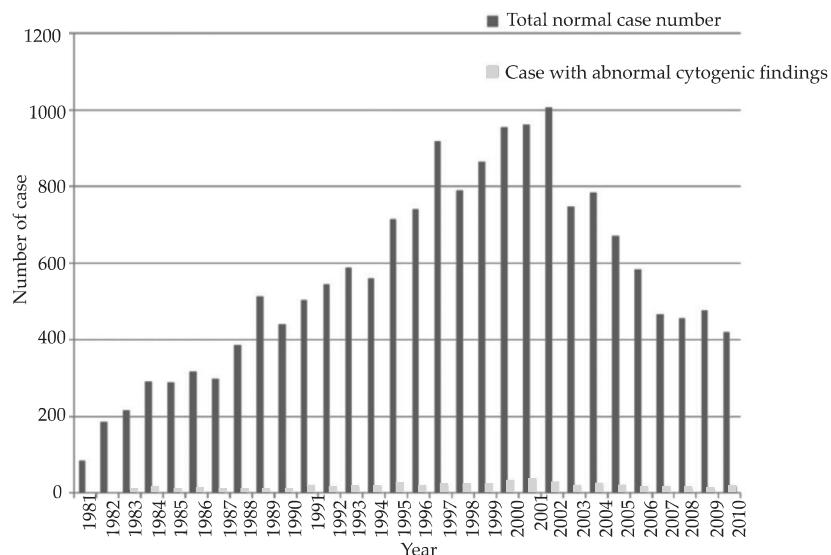
Attempt either subpart (c) or (d).

- What is primary treatment in sewage management?

Or (d) What is secondary treatment in sewage management?

30. Observe the graph below and answer the questions that follows.

The graph represents the variations in the number of cases of amniocentesis observed over the years.



- After 2002, cases of amniocentesis were observed to be declining. Explain why.
- After amniocentesis evaluation, the doctor advised a pregnant women to terminate the pregnancy. Explain what could be the reason behind this decision.

Attempt either subpart (c) or (d).

- Graph shows a sharp contrast between the high number of total amniocentesis cases and the very low number of cases with abnormal cytogenetic findings during a given time period. Why there be such a large number of amniocentesis procedures despite very few abnormal findings?

Or (d) Amniocentesis is a pre-natal diagnostic procedure to assess chromosomal abnormalities and foetal infections. How is this made possible?

Section E Long Answer Type Questions

31. (a) (i) How does smoking tobacco in human lead to oxygen deficiency in their body?
(ii) How does moderate and high dosage of cocaine affect the human body?
(iii) 1. Name the causative agent of typhoid in humans and the test administered to the confirm the disease.
2. How does the pathogen gain entry into the human body? Write the diagnostic symptoms and mention the body organ that gets affected in severe cases.

Or (b) (i) The three microbes are listed below. Name the product produced by each one of them and mention their use.

1. *Aspergillus niger*
3. *Monascus purpureus*

2. *Trichoderma polysporum*

(ii) Name the category of microbes naturally occurring in sewage and making it less polluted during the treatment.
 (iii) Write the scientific name of the microbe used for fermenting malted cereals and fruit juices.

32. (a) Read the sequence of the nucleotides in the given segment of *mRNA* and the respective amino acid sequence in the polypeptide chain.

mRNA AUG UAC CCUAAU GGC GUU UCU CUC UGA
 1 2 3 4 5 6 7 8

Polypeptide P → Tyr → Pro → Asp → Gly → Val → Ser → Leu

(i) Draw the nucleotide sequence of the DNA strand from which this *mRNA* was transcribed. What does P coded by AUG represents? If AUG is replaced by UAA, how will translation of *mRNA* chain suffer?
 (ii) A mutation occurred at 6th codon in the *mRNA* where 'G' was replaced by 'A'. What is this type of mutation called and how will it affect the polypeptide chain?

Or (b) (i) Explain the law of segregation and the law of independent assortment with a suitable example for each.

(ii) In a monohybrid cross, a homozygous dominant pea plant (tall) is crossed with a homozygous recessive pea plant (dwarf). Draw a Punnett square for the F_1 -generation and predict the genotypic and phenotypic ratios of the F_2 - generation.
 (iii) Given below is a Punnett square showing a dihybrid cross between pea plants. Calculate the phenotypic ratio of the offspring and name the Mendelian law demonstrated by this cross. Explain how the diagram supports this law.

| | | Dihybrid cross | | | |
|----|----|----------------|------|------|------|
| | | RY | Ry | rY | ry |
| RY | RY | RRYY | RRYY | RrYy | Ryy |
| | Ry | RrYy | RrYy | RrYy | rrYy |
| rY | RY | RrYy | RrYy | RYy | rryy |
| | ry | rryy | rryy | rryy | rryy |

33. (a) Justify the following statements related to biodiversity, its loss and conservation with suitable proof or examples:
 (i) Biodiversity is essential for the stability and productivity of ecosystems.
 (ii) Habitat loss is the most significant cause of biodiversity decline worldwide.
 (iii) Invasive alien species are a major threat to native biodiversity.
 (iv) *Ex situ* conservation is crucial when *in situ* methods are not feasible.
 (v) Biodiversity hotspots need urgent conservation attention.

Or (b) (i) How does the pyramid of energy support the second law of thermodynamics in an ecosystem?
 (ii) The table below shows the energy available at different trophic levels in a grassland ecosystem.

| Trophic level | Energy available (kJ/m ² /year) |
|---------------------|--------------------------------------------|
| Producers | 10,000 |
| Primary consumers | 1,000 |
| Secondary consumers | 100 |
| Tertiary consumers | 10 |

Shows this type of trend from producers to tertiary consumers.

Explanations

1. (b) *Ascaris*, the common roundworm causes ascariasis. Symptoms of this disease includes the internal bleeding, muscular pain, fever, anaemia and of intestinal blockage. [1]

2. (d) Spermatogenesis starts with spermatogonia (diploid stem cells), which divide mitotically to form primary spermatocytes. These undergo meiosis I to form secondary spermatocytes, which then undergo meiosis II to produce spermatids. Spermatids mature into spermatozoa, the functional haploid male gametes. [1]

3. (d) Option (d) is correctly matched. Rest all are incorrect and can be corrected as

- Restriction endonuclease cuts the DNA at a specific position.
- Restriction exonucleases removes the nucleotides from the end of DNA.
- DNA ligase joins the DNA fragments. [1]

4. (a) Hardy-Weinberg equation ($p^2 + 2pq + q^2 = 1$) applies to a population where the allelic frequencies are stable from one generation to the next. The Hardy-Weinberg principle cannot be applied to a population where frequent mutations arise, as these will keep changing, leading to new phenotypes. [1]

5. (b) Statements (i), (iii), (iv) and (v) are correct, while statement (ii) is incorrect and can be corrected as
Eco RI is a restriction enzyme that produces sticky ends. [1]

6. (c) A male having abnormal arrangement of chromosome, (i.e. 47; XXY) is sterile and shows the feminine development due to the presence of extra X-chromosome. The male here is suffering from the chromosomal disorder called Klinefelter's syndrome. [1]

7. (c) Statement given in option (c) incorrect and it can be corrected as
AIDS is caused by the Human Immunodeficiency Virus (HIV), a member of a group of virus called retrovirus, which have an envelope enclosing the RNA genome. [1]

8. (c) e in the formula $N_t = N_0 e^{rt}$ signifies the base at natural logarithms. [1]

9. (d) Restriction endonuclease recognises a specific sequence of DNA that is called palindromic nucleotide sequence [1]

10. (c) AUG – It is a start codon, whereas UAA, UAG and UGA are stop codons. [1]

11. (d) BOD of waste water is estimated by measuring the amount of consumption of oxygen. [1]

12. (d) Option (d) contains the correctly identified components as amp^R (ampicillin resistance gene) and tet^R (tetracycline resistance gene) are antibiotic resistance genes. Rest all options are incorrect and can be corrected as

- *ori* is the origin of replication, *rop* codes for proteins involved in replication of the plasmid.
- *Hind* III as well as *Eco* RI are restriction sites. [1]

13. (c) A is true, but R is false. R can be corrected as
Diaphragms, cervical caps and vaults are the contraceptive barriers which are made up of rubber. They are inserted into the female reproductive tract to cover the cervix during coitus. These barriers helps to prevent conception by blocking the entry of sperms through the cervix. [1]

14. (d) A is false, but R is true. A can be corrected as
Turner's syndrome is caused due to the absence of X-chromosome. Individuals having single X-chromosome, (i.e. 2A + XO (45)) have female sexual differentiation, but ovaries are rudimentary. Other associated phenotypes of this condition are short stature, webbed neck, broad chest, lack of secondary sexual characteristics and sterility. [1]

15. (c) A is true, but R is false. R can be corrected as
As there are 61 codons specifying amino acids, the cell should contain 61 different tRNA molecules, each with a different anticodon. The number of tRNA molecule discovered is much less than 61. This implies that the anticodons of some tRNAs read more than one codon on mRNA. [1]

16. (b) Both A and R are true and R is not the correct explanation of A.
Mutualism is a type of positive interaction, in which the organisms, forming an association are benefitted. For example, mycorrhiza is an association of fungi and roots of higher plants. In this association, fungi helps in water and mineral absorption by the plant. In exchange of this, fungi obtain prepared food material. [1]

17. (a) (i) Genetic code is said to be degenerate when some amino acids are coded by more than one codon, e.g. UUU and UUC, both code for phenylalanine. [1]
(ii) Genetic code is said to be universal when a particular codon codes for the same amino acid in all organisms, for example, from bacteria to human UUU codes for phenylalanine. [1]

Or (b) (i) The nuclear sample contains DNA and the cytoplasmic sample contains RNA. [1]

(ii) Genomics is the branch of biology that deals with the study of the structure, function, mapping the complete set of DNA, including all of its genes, in an organism.

Applications of Genomics

1. **Medical Diagnosis** Helps in identifying genetic disorders and developing personalised treatments.
2. **Agriculture** Used to develop high-yield, disease-resistant and climate-tolerant crop varieties. [1]

18. (a) The follicular phase appears to be disrupted. The observed FSH level (3.0 mIU/mL) is slightly below the normal follicular range (3.5–12.5 mIU/mL), which may indicate insufficient stimulation of follicle development. As a result, ovulation may not have occurred, leading to a delay in menstruation. The low LH and low progesterone also suggest that the luteal phase has not been reached, supporting the idea that ovulation has been delayed or missed. [1]

(b) The hormone is Luteinizing Hormone (LH). It shows a sharp surge mid-cycle, triggering the release of a mature egg from the ovary (ovulation). This LH surge is essential for transitioning from the follicular phase to the luteal phase. [1]

19. Detritus food chain is made up of dead organic matter (detritus) and the organisms that feed on it, i.e. some bacteria and fungi. Organisms in detritus food chain meet their energy and nutrient requirements by degrading the dead organic matter or detritus. [2]

20. The source organism of the gene *cry* IAc is *Bacillus thuringiensis* and its target is cotton bollworms. [1]

Cloning vector in biotechnology helps in linking the foreign/alien DNA with the host's DNA and helps in the selection of recombinants from the non-recombinants. [1]

21. The significances of the experiment are as follows

- In this experiment, the main objective was to create the atmospheric conditions that are prevalent on the primitive earth. Hence, the gases are NH_3 , H_2O , CH_4 and H_2 that used in this experiment.
- The Miller and Urey's experiment was conducted to provide validation to Oparin-Haldane's theory of chemical theory of life.
- It provided the first evidence that organic molecules needed for life could be formed from inorganic

components and confirms that abiotic synthesis may have occurred in primitive atmospheric conditions. [2]

22. (a) The structure labelled X is the Graafian follicle and Y is the corpus luteum. [1]

(b) The Graafian follicle X is the mature follicle that undergoes ovulation. It ruptures to release the secondary oocyte (ovum) around the 14th day of the menstrual cycle. [1]

(c) The corpus luteum Y secretes progesterone, which plays a crucial role in maintaining the endometrial lining of the uterus and preparing it for possible implantation of the fertilised egg. [1]

23. (a) The diagram best illustrates genetic drift as an evolutionary process. The change in the proportion of green and brown beetles between generations is small and random, not due to any selective advantage. This indicates that chance events, rather than environmental pressures, are influencing allele frequencies in the population. [1½]

(b) The shift from 75% green and 25% brown beetles in the first generation to 71% green and 29% brown beetles in the second generation shows a minor change in allele frequencies, but both colour variants are still present. This maintains genetic diversity in the population, which is important for adaptability to future environmental changes. [1½]

24. (a) **Industrial melanism** – moth colour change

During the Industrial Revolution, soot from factories darkened tree bark, making light-coloured moths more visible to predators. Dark-coloured (melanic) moths had better camouflage, survived longer and reproduced more. This is natural selection in action, where environmental change shifted the population's colour frequency. [1]

(b) **Homologous structures** – bat wings and whale flippers

The wings of a bat and the flippers of a whale have the same underlying skeletal framework because they evolved from a common ancestor. Their differences in function (flying vs. swimming) arose due to divergent evolution, where similar structures adapted to different environments. [1]

(c) **Analogous structures** – butterfly wings and bird wings

Butterfly wings and bird wings both serve the function of flight, but they evolved independently from different ancestral origins and have different anatomical structures. This is an example of convergent evolution, where unrelated organisms evolve similar adaptations due to similar environmental pressures. [1]

A. Mistake Alert

Students should not confuse between homology and analogy as homologous organs have common origin but perform different functions, while analogous organs have different origins but perform similar functions.

25. (a) The hormone that shows a sharp rise in early pregnancy is hCG (human Chorionic Gonadotropin). It maintains the corpus luteum, which continues to secrete progesterone during the early stages of pregnancy. [1½]
 (b) Progesterone and oestrogen are crucial for maintaining the uterine environment and supporting foetal growth. A fall in their levels may lead to preterm labor or spontaneous abortion, as the uterine lining may shed or contract in the absence of these hormones. [1½]

26. (a) GEAC stands for Genetic Engineering Approval Committee. [1]

GEAC is a statutory body under the Ministry of Environment, Forest and Climate Change, Government of India. It is responsible for monitoring, regulating and approving the use of Genetically Modified Organisms (GMOs) and products derived from them in research, agriculture and industry.

One of its key responsibilities is to ensure the biosafety and environmental impact assessment of GMOs before they are released for commercial or field use. [2]

Or (b) Biotechnology has enabled the development of pest-resistant crops by introducing genes that produce insecticidal proteins. For example, *Bt* cotton has been genetically modified by inserting the cry gene from the bacterium *Bacillus thuringiensis*, which produces a toxin that kills insect pests like bollworms. [3]

27. The enzyme used is a restriction endonuclease (e.g., *Eco* RI). [1]

These enzymes cut DNA at specific palindromic sequences, generating sticky ends—short single-stranded overhangs. Sticky ends are useful because they can base-pair with complementary sequences on other DNA fragments, facilitating specific and stable. Insertion of a foreign gene into a vector, which is essential in recombinant DNA technology. [2]

28. A geneticist needs to carry a test cross when he/she wants to determine the genotype of an organism, with a dominant phenotype trait, whether it is homozygous or heterozygous. [1]

The study of inheritance of genetic traits in several generations of a human family in the form of a family diagram is called pedigree analysis. Inheritance pattern of traits in human beings cannot be studied by crosses. Thus, pedigree analysis is done. Based on the pedigree studies, inheritance of a specific trait, abnormality or disease can be easily traced. [2]

29. (a) Site A has a BOD level of 2.9 mg/L (below the permissible limit of 3 mg/L) and a DO level of 6.7 mg/L (above the safe limit of 5 mg/L), indicating clean water, sufficient dissolved oxygen for aquatic life, and low organic pollution. [1]
 (b) There is an inverse relationship between BOD (Biological Oxygen Demand) and DO (Dissolved Oxygen) in water bodies. As the BOD increases, it indicates a higher amount of organic matter present in the water, which requires more oxygen for decomposition by aerobic microbes. [2]
 (c) Primary treatment is the initial stage of sewage treatment that physically removes large and suspended solids through screening and sedimentation to reduce the organic load. [1]

Or

(d) Secondary treatment is the biological treatment of sewage in which microorganisms (mainly aerobic bacteria) are used to decompose organic matter present in the effluent from primary treatment. [1]

30. (a) After 2002, cases of amniocentesis were observed to be declining due to the strict steps taken by the government against it. Moreover, in many countries the amniotic fluid test has also been banned by the government. [1]
 (b) The doctor advised Medical Termination of Pregnancy (MTP) as the foetus may be unviable or the pregnancy is harmful for mother or foetus (or both). [1]
 (c) The high number of amniocentesis procedures despite few abnormal findings is often due to routine testing without medical necessity, parental anxiety or misuse for illegal sex-determination lack of awareness and poor regulation also contribute to its unnecessary use. [2]

Or

(d) In amniocentesis, a small amount of amniotic fluid containing foetal cells is extracted from the amnion surrounding the developing foetus. These cells are then cultured and karyotype analysis is carried out. This reveals any genetic abnormality if present in the foetus, such as Down's syndrome, cystic fibrosis, etc. [2]

31. (a) (i) Smoking increases carbon monoxide content in blood and reduces the concentration of haem-bound oxygen. This causes oxygen deficiency in the body. [1]

(ii) Moderate dosage of cocaine have a stimulating action on control nervous system. It produces a sense of euphoria and increased energy. However, high dosage of cocaine causes hallucinations. [1]

(iii) 1. Typhoid is caused by a bacteria *Salmonella typhi*. Typhoid is confirmed by the widal test. [1]

2. Pathogens enter the human body through contaminated food and water. [1]

Diagnostic symptoms includes high fever, weakness, stomach pain, etc. The body organ affected in severe cases is small intestine. [1]

Or

(b) (i) 1. The product obtained by *Aspergillus niger* is citric acid. [1]

2. The product obtained by *Trichoderma polysporum* is cyclosporin-A. [1]

3. The product obtained by *Monascus purpureus* is statins. [1]

(ii) The category of microbes naturally occurring in sewage and making it less polluted are bacteria and fungi, wherein masses of bacteria get associated with filaments of fungi to form mesh-like structure called flocks. [1]

(iii) *Saccharomyces cerevisiae* also called Brewer's yeast is the microbe used for fermenting malted cereals and fruit juices. [1]

32. (a) (i) TAC-ATG-GGA-TTA-CCG-CAA-AGA-GAG-ACT is the DNA sequence from which mRNA was transcribed. P is methionine coded by AUG. It starts the translation of mRNA sequence. AUG is start codon, while UAA is the stop codon. If UAA appears at the beginning, the translation of mRNA chain will not initiate. [2½]

(ii) At 6th place, GUU codon is present, a mutation replacing G with A is called a point mutation. The new codon will become AUU. The original codon GUU codes for valine while the mutated codon AUU codes for isoleucine.

By altering just one amino acid, the entire peptide may change, thereby changing the entire protein. It may alter some other characteristics or function of the protein formed. [2½]

Or (b) (i) Law of segregation, alleles for a single trait separate during gamete formation.

Example A heterozygous plant (Pp) produces gametes with either a P or a p allele.

Law of Independent Assortment, a Alleles for different traits sort into gametes independently of each other.

Example A plant with genotype RrYy produces four types of gametes (RY, Ry, rY, ry) in equal proportions. [1½]

(ii) Monohybrid Cross of F_1 -generation produces $\{TT \text{ (tall)} \times tt \text{ (dwarf)}\}$ all F_1 -offspring are Tt (tall). F_2 -generation Cross between Tt \times Tt

| | | |
|---|----|----|
| | T | t |
| T | TT | Tt |
| t | Tt | tt |

phenotypic ratio is 3:1

genotypic ratio is 1:2:1 [1½]

(iii) In the given dihybrid cross between two heterozygous pea plants ($RrYy \times RrYy$), the traits considered are seed shape (Round – R, Wrinkled – r) and seed colour (Yellow – Y, Green – y).

When a Punnett square is constructed for this cross, it yields 16 combinations of offspring. Based on these combinations, the phenotypic ratio observed is 9:3:3:1, where 9 offspring show round yellow seeds, 3 show round green, 3 show wrinkled yellow and 1 shows wrinkled green.

This classic 9:3:3:1 ratio demonstrates Mendel's Law of Independent Assortment. According to this law, alleles of different genes (in this case, seed shape and seed colour) assort independently during gamete formation. The appearance of all possible combinations of these traits among the offspring supports the idea that the inheritance of one trait does not influence the inheritance of another. Thus, the Punnett square for this dihybrid cross clearly illustrates Mendel's second law through the independent assortment of the two traits. [2]

33. (a) (i) Biodiversity ensures ecosystems are productive and resilient. Different species perform key roles like pollination, decomposition and pest control. For example, diverse forests support stable food chains and nutrient cycles.

(ii) Human activities like deforestation and urbanisation destroy habitats, pushing species toward extinction. For instance, Amazon Rainforest clearing has led to the decline of many endemic species.

(iii) Non-native species often outcompete or harm local species. Examples the Nile perch in Lake Victoria caused the extinction of native cichlid fish.

(iv) When natural habitats are unsafe or destroyed, conservation in zoos, gene banks, etc., is vital. Example: The Mauritius kestrel was saved through captive breeding.

(v) Biodiversity hotspots have rich, unique species but are highly threatened. Example The Western Ghats in India face habitat destruction and need protection. [1×5]

Or (b) (i) The second law of thermodynamics states that energy transformations are not 100% efficient—some energy is always lost, usually as heat. The pyramid of energy demonstrates this principle in ecosystems, as energy flows from one trophic level to the next, a large portion is lost as heat, movement or metabolic processes. Only about 10% of energy is passed on to the

next level. Therefore, energy decreases as we move up the pyramid, supporting the Second Law. [2]

(ii) The data shows a sharp decline in energy at each successive trophic level. From 10,000 kJ at the producer level, energy drops to just 10 kJ at the tertiary consumer level. This trend illustrates the unidirectional flow and progressive loss of energy in an ecosystem.

There are two main reasons for this decrease:

1. Energy loss as heat during respiration and metabolic activities at each level.
2. Not all biomass is consumed or converted into energy available for the next trophic level — some parts are indigestible or unassimilated. [3]

My Reflection & Problem Points

Write down any difficulties, doubts, or mistakes you faced in this paper.

Discuss these points with your teacher and sort them out.

Concept (s) I got stuck on

Question (s) I couldn't complete

What confused me most

Time issue faced in