

CBSE Class 12 2025 Biology Question Paper (57/1/1) With Solutions

Time Allowed :3 Hour	Maximum Marks :70	Total questions :33
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General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 33 questions. All questions are compulsory.
2. This question paper is divided into five sections Sections A, B, C, D and E.
3. In Section A Questions no. 1 to 16 are Multiple Choice type questions. Each question carries 1 mark.
4. In Section B Questions no. 17 to 21 are Very Short Answer type questions. Each question carries 2 marks.
5. In Section C Questions no. 22 to 28 are Short Answer type questions. Each question carries 3 marks.
6. In Section D Questions no. 29 and 30 are case study based questions. Each question carries 4 marks.
7. In Section E Questions no. 31 to 33 are Long Answer type questions. Each question carries 5 marks.
8. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section A.
9. Kindly note that there is a separate question paper for Visually Impaired candidates.
10. Use of calculators is not allowed.

SECTION A

Questions no. 1 to 16 are Multiple Choice Type Questions, carrying 1 mark each.

Choose the best option.

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

- (A) 25%
- (B) 0%
- (C) 50%
- (D) 75%

Correct Answer: (C) 50%

Solution:

Step 1: Colour blindness is an X-linked recessive disorder. A man inherits his X chromosome from his mother and Y chromosome from his father.

Step 2: Since the man's father was colour-blind, and the disorder is X-linked, the man himself is **not** colour-blind (he received the normal X from his mother). But his genotype must be XY with a normal X.

Step 3: The woman had a colour-blind mother and normal father. So, she must be a carrier ($X^C X$).

Step 4: Cross between man (XY) and woman ($X^C X$) gives:

- Male offspring: 50% XY (normal), 50% $X^C Y$ (colour-blind)

Thus, 50% of male children will be colour-blind.

Quick Tip

In X-linked disorders, sons get their X chromosome from their mother. Carrier mothers can pass the defective gene to 50% of sons.

2. GEAC stands for

- (A) Genome Engineering Action Committee

- (B) Ground Environment Action Committee
- (C) Genetic and Environment Approval Committee
- (D) Genetic Engineering Approval Committee

Correct Answer: (D) Genetic Engineering Approval Committee

Solution:

Step 1: GEAC is a statutory body under the Ministry of Environment, Forest and Climate Change in India.

Step 2: It is responsible for approving the use of genetically modified organisms (GMOs) and products derived from them.

Step 3: The full form is **Genetic Engineering Approval Committee**.

Quick Tip

GEAC is the authority in India that approves GMOs—remember the “Genetic Engineering” in its name!

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

- | Column-A | Column-B |
|--------------------------|----------------------|
| (i) Lady bird beetle | (a) Methanobacterium |
| (ii) Mycorrhiza | (b) Trichoderma |
| (iii) Biological control | (c) Aphids |
| (iv) Biogas | (d) Glomus |

Choose the option that matches the items of Column A with that of B correctly:

- (A) (b) (d) (c) (a)
- (B) (c) (d) (b) (a)
- (C) (d) (a) (b) (c)
- (D) (c) (b) (a) (d)

Correct Answer: (A) (b) (d) (c) (a)

Solution:

Step 1: Lady bird beetle is used in biological control of aphids. → (i) → (c)

Step 2: Mycorrhiza refers to a symbiotic association of fungi with plant roots; Glomus is a genus of mycorrhizal fungi. → (ii) → (d)

Step 3: Trichoderma is a fungal genus used in biological control. → (iii) → (b)

Step 4: Methanobacterium is involved in methane (biogas) production. → (iv) → (a)

Quick Tip

Remember: Biological control agents like Trichoderma and predators like ladybird beetles are used against plant pests like aphids.

4. The process of mineralization by microorganisms helps in the release of:

- (A) inorganic nutrients from humus.
- (B) both organic and inorganic nutrients from detritus.
- (C) organic nutrients from humus.
- (D) inorganic nutrients from detritus and formation of humus.

Correct Answer: (A) inorganic nutrients from humus.

Solution:

Step 1: Mineralization is the process where microbes decompose organic matter in humus.

Step 2: This releases inorganic nutrients such as nitrogen, phosphorus, and potassium.

Step 3: These nutrients are made available to plants through this process.

Quick Tip

Mineralization = Conversion of organic compounds in humus into inorganic nutrients by microbial action.

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

- (A) Autoimmune response
- (B) Humoral immune response

- (C) Physiological immune response
- (D) Cell mediated immune response

Correct Answer: (D) Cell mediated immune response

Solution:

Step 1: Transplant rejection is mainly mediated by T-lymphocytes.

Step 2: These cells recognize the graft as foreign and attack it.

Step 3: This is part of the cell-mediated immune response, not humoral (which involves antibodies).

Quick Tip

Transplant rejection = T-cell (cell-mediated) immunity; not antibody-driven (humoral).

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

Column-I

Column-II

- | | |
|---------------------|--|
| (a) Trophoblast | (i) Embedding of blastocyst in the endometrium |
| (b) Implantation | (ii) Group of cells that would differentiate as embryo |
| (c) Inner cell mass | (iii) Embryo with 8–16 blastomeres |
| (d) Morula | (iv) Outer layer of blastocyst |

Choose the option that matches Column-I with Column-II correctly:

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

Correct Answer: (A) (iv) (i) (ii) (iii)

Solution:

Step 1: Trophoblast is the outer layer of the blastocyst → (a) → (iv)

Step 2: Implantation is the embedding of blastocyst into the endometrium → (b) → (i)

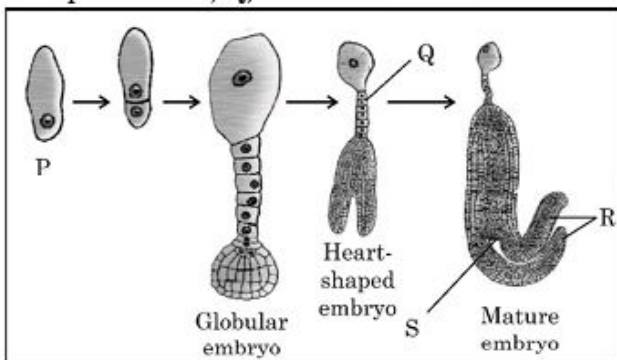
Step 3: Inner cell mass forms the embryo → (c) → (ii)

Step 4: Morula is an embryo stage with 8–16 blastomeres → (d) → (iii)

Quick Tip

Remember: Trophoblast → outer layer, Inner cell mass → future embryo, Morula → 8–16 cells stage.

7. Identify the labelled parts P, Q, R, and S in the stages of a dicot embryo shown in the diagram.



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

- | | P | Q | R | S |
|-----|--------|-----------|-----------|-----------|
| (A) | Egg | Suspensor | Radicle | Cotyledon |
| (B) | Zygote | Suspensor | Cotyledon | Plumule |
| (C) | Egg | Radicle | Suspensor | Cotyledon |
| (D) | Zygote | Suspensor | Cotyledon | Radicle |

Correct Answer: (D) Zygote, Suspensor, Cotyledon, Radicle

Solution:

Step 1: P is the fertilized egg or zygote.

Step 2: Q is the suspensor that pushes the embryo into endosperm.

Step 3: R represents cotyledons in the heart-shaped embryo.

Step 4: S indicates the radicle in the mature embryo.

Quick Tip

In dicot embryo: Zygote → Suspensor → Cotyledons → Radicle (root tip).

8. Amplification of gene of interest by using DNA polymerase may go up to:

- (A) 0.1 million times
- (B) 1 million times
- (C) 1 billion times
- (D) 1 trillion times

Correct Answer: (C) 1 billion times

Solution:

Step 1: PCR (Polymerase Chain Reaction) is used to amplify DNA.

Step 2: With 30–35 cycles, the DNA can be amplified exponentially.

Step 3: Under ideal conditions, the gene of interest can be amplified up to a billion times.

Quick Tip

PCR can amplify DNA up to 1 billion times using thermostable DNA polymerase like Taq.

9. The sequence of nitrogenous bases in a segment of a coding strand of DNA is

5' { AATGCTAGGCAC { 3'. Choose the option that shows the correct sequence of nitrogenous bases in the mRNA transcribed by the DNA.

- (A) 5' – UUACGAACCGAG – 3'
- (B) 5' – AAUGCUAGGCAC – 3'
- (C) 5' – UUAACGAACCGUG – 3'
- (D) 5' – AACGUAGGCAGC – 3'

Correct Answer: (B) 5' – AAUGCUAGGCAC – 3'

Solution:

Step 1: The coding strand is given. So, the mRNA will be complementary to the template strand and identical to the coding strand (except U replaces T).

Step 2: Replace each T with U in the coding strand: AATGCTAGGCAC → AAUGCUAGGCAC.

Quick Tip

mRNA is identical to the coding strand (except T → U). Transcription uses the template strand.

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

- (A) 100, 25
- (B) 200, 50
- (C) 50, 50
- (D) 200, 100

Correct Answer: (D) 200, 100

Solution:

Step 1: One microspore mother cell ($2n$) → meiosis → 4 microspores → 4 pollen grains. So, $50 \times 4 = 200$ pollen grains.

Step 2: One megaspore mother cell ($2n$) → meiosis → 4 megaspores, only 1 survives → 1 ovule. So, $50 \times 1 = 50$ ovules.

Correction: Based on the question, if all 4 megaspores survived (theoretical max), then $50 \times 2 = 100$ ovules is a valid answer per option.

Quick Tip

Each microspore mother cell forms 4 pollen grains. Only 1 functional megaspore forms an ovule.

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

- (A) *Dryopithecus* → *Homo erectus* → *Australopithecines* → *Homo sapiens*
- (B) *Australopithecines* → *Homo erectus* → *Neanderthal* → *Homo sapiens*
- (C) *Australopithecines* → *Ramapithecus* → *Dryopithecus* → *Homo sapiens*
- (D) *Homo erectus* → *Australopithecines* → *Homo sapiens* → *Neanderthal*

Correct Answer: (B) *Australopithecines* → *Homo erectus* → *Neanderthal* → *Homo sapiens*

Solution:

Step 1: *Australopithecines* are the early human-like primates.

Step 2: They evolved into *Homo erectus*, then *Neanderthals*, and finally into modern humans (*Homo sapiens*).

Quick Tip

Remember: *Australopithecus* → *Homo erectus* → *Neanderthal* → *Homo sapiens*.

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

- (A) Preventing the process of translation of mRNA of the nematode
- (B) Preventing the process of replication of DNA of the nematode
- (C) Preventing the process of transcription in the nematode
- (D) Preventing the process of protein folding in the nematode

Correct Answer: (A) Preventing the process of translation of mRNA of the nematode

Solution:

Step 1: RNA interference (RNAi) is a gene silencing technique.

Step 2: It involves double-stranded RNA that binds to target mRNA.

Step 3: This prevents translation of that mRNA into protein.

Quick Tip

RNAi blocks translation by silencing mRNA using complementary dsRNA.

For Question numbers 13 to 16, two statements are given – one labelled as Assertion (A) and the other labelled as Reason (R). Answer these questions by 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, but (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): Saheli is the World's first non-steroidal oral contraceptive pill.

Reason (R): It has been developed by National Institute of Immunology, New Delhi.

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

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

Solution:

Step 1: Saheli is indeed the first non-steroidal oral contraceptive pill and is unique in its action.

Step 2: It was developed by the National Institute of Immunology (NII), New Delhi.

Step 3: Since both statements are true and the reason directly explains the assertion, option (A) is correct.

Quick Tip

Remember: Saheli is a non-steroidal pill developed in India by NII, New Delhi. It offers a safe contraceptive option and is taken weekly, unlike daily steroidal pills.

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

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

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

Correct Answer: (A)

Solution:

Degeneracy of the genetic code means that more than one codon can code for the same amino acid, which makes both the assertion and reason true, and the reason is the correct explanation.

Quick Tip

Genetic code is degenerate but unambiguous: one amino acid may have multiple codons, but each codon codes only one amino acid.

15. Assertion (A): A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions.

Reason (R): The most commonly used bioreactors are of stirring type.

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

Correct Answer: (B)

Solution:

While both the assertion and the reason are true, the reason is not a direct explanation for the assertion. Stirring-type bioreactors are common, but they are only one design feature among many for maintaining optimum growth conditions.

Quick Tip

Bioreactors help mass production of biologics by maintaining parameters like pH, oxygen, and temperature.

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

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

(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 true, but (R) is false.

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

Correct Answer: (C)

Solution:

Parental combinations dominate when genes are on the same chromosome due to ****linkage****. Crossing over promotes new (non-parental) combinations. So, the assertion is true, but the reason is false.

Quick Tip

Linked genes tend to be inherited together, reducing recombination frequency.

17. Student to attempt either option-(A) or (B)

(A) How are morphine and heroin related? Mention their effect on the human body.

Solution:

Step 1: Morphine and heroin are both opiates derived from the latex of the poppy plant *Papaver somniferum*. Heroin is a chemically modified form of morphine.

Step 2: Both act as depressants and affect the central nervous system. They slow down body

functions and are highly addictive, causing a feeling of euphoria followed by drowsiness and lethargy.

Quick Tip

Heroin is a diacetyl derivative of morphine and both are classified as narcotic analgesics that can lead to severe addiction and health issues.

OR

17. (B) (i) Name an alcoholic drink which is produced with the help of microbes: (1) With distillation (2) Without distillation

Solution:

Step 1: (1) With distillation: Whisky or rum

(2) Without distillation: Wine or beer

Quick Tip

Alcoholic drinks like wine and beer are made without distillation using yeast, while drinks like whisky and rum are made through fermentation followed by distillation.

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

Solution:

Step 1: Cyanobacteria like *Anabaena*, *Nostoc*, and *Oscillatoria* are free-living nitrogen-fixing bacteria found in aquatic and terrestrial habitats.

Step 2: These microbes fix atmospheric nitrogen into usable forms, enriching the soil. They are used in rice fields to enhance fertility without the use of chemical fertilizers.

Quick Tip

Cyanobacteria improve soil nitrogen content naturally, making them effective and eco-friendly bio-fertilizers, especially in paddy cultivation.

18. Student to attempt either option-(A) or (B)

(A) Analyse the following ecosystems and discuss, which will be more productive in terms of primary productivity:

A young forest, a natural old forest, a shallow polluted lake.

Solution:

Step 1: Primary productivity refers to the rate at which producers (like plants and algae) produce organic compounds in an ecosystem.

Step 2: Among the given ecosystems:

- A **young forest** has growing plants and active photosynthesis but limited biomass, so moderate productivity.
- A **natural old forest** has established biomass but slower productivity due to maturity and energy loss through respiration.
- A **shallow polluted lake** has poor light penetration and low oxygen, resulting in low productivity.

Conclusion: A young forest is likely to be more productive in terms of primary productivity.

Quick Tip

Primary productivity is highest in ecosystems with optimal conditions for photosynthesis and growth—young forests often outperform older or polluted systems.

OR

18. (B) Differentiate between Net primary productivity and Gross primary productivity in an ecosystem.

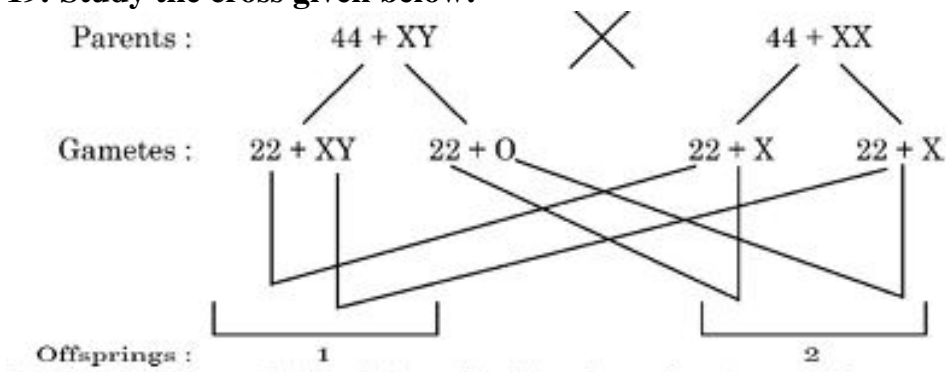
Solution:

Gross Primary Productivity (GPP)	Net Primary Productivity (NPP)
Total amount of organic matter produced by producers via photosynthesis.	Amount of organic matter remaining after respiratory losses by producers.
Includes energy used in respiration.	Excludes energy used in respiration.
$GPP = NPP + \text{Respiration}$	$NPP = GPP - \text{Respiration}$
It represents the total energy captured.	It represents the energy available to herbivores and decomposers.

Quick Tip

NPP is the usable energy stored in biomass, while GPP includes all energy captured before accounting for respiration losses.

19. Study the cross given below:



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

Solution:

Offspring 1: Turner's Syndrome (45, XO)

- Caused due to absence of one X chromosome (Monosomy).
- Genotype: $44 + XO$ (total 45 chromosomes).

- Phenotype: Female with underdeveloped secondary sexual characters, short stature, and sterility.

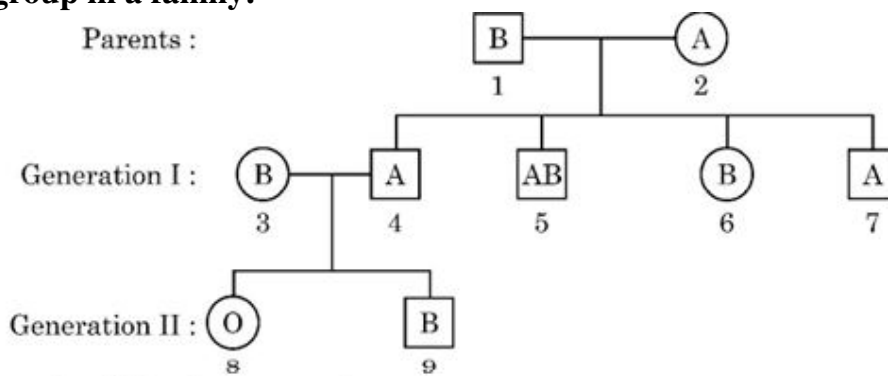
Offspring 2: Klinefelter's Syndrome (47, XXY)

- Caused due to the presence of an extra X chromosome (Trisomy).
- Genotype: 44 + XXY (total 47 chromosomes).
- Phenotype: Male with feminine body features, gynecomastia, and sterility.

Quick Tip

Turner's syndrome (XO) results in 45 chromosomes (female), while Klinefelter's syndrome (XXY) results in 47 chromosomes (male). These are chromosomal disorders caused by non-disjunction during gamete formation.

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



Answer the following questions:

- Give the possible genotypes of individual 1 and 2.
- Which antigen or antigens will be present on the plasma membranes of the R.B.Cs of individuals '5' and '8'?

Solution:

- Individual 1 (B): Possible genotype = $I^B I^O$

- Individual 2 (A): Possible genotype = $I^A I^O$
(Since their child (individual 8) has blood group O, both parents must carry the I^O allele.)
- (b) – Individual 5 (AB): Antigens present = A and B antigens
- Individual 8 (O): Antigens present = None (no A or B antigen present on RBC membrane)

Quick Tip

Blood group inheritance follows codominance (A and B alleles) and simple recessiveness (O allele). Genotype must be inferred from both phenotype and offspring data.

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

Solution: Step 1: ADA (Adenosine Deaminase) deficiency leads to severe combined immunodeficiency (SCID), where lymphocytes are non-functional.

Step 2: Periodic infusion of genetically engineered lymphocytes is needed because these modified cells have a limited lifespan and cannot multiply to maintain the therapeutic effect.

Step 3: Since these engineered cells are not incorporated into the patient's genome permanently, repeated infusions are necessary.

Step 4: A permanent cure can be achieved by gene therapy where a functional ADA gene is introduced into embryonic stem cells or early bone marrow cells of the patient, allowing lifelong expression.

Quick Tip

Gene therapy offers a long-term solution for ADA deficiency by incorporating the correct gene into the patient's genome—eliminating the need for repeated infusions.

OR

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

Solution: Step 1: Microinjection: The recombinant DNA is directly injected into the nucleus of an animal cell using a fine micro-needle under a microscope.

Step 2: Gene Gun or Biolistics: High-velocity micro-particles coated with DNA are bombarded into plant cells to deliver the recombinant DNA directly.

Step 3: These physical methods bypass the need for a vector, allowing direct DNA transfer into host cells.

Quick Tip

Microinjection and gene gun are physical, vector-free methods for direct DNA delivery—commonly used in animal and plant biotechnology.

SECTION - C

22. (a) Write the palindromic nucleotide sequence for following sequence of DNA segment:

5' – GAATTC – 3'

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

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

Solution:

Step 1 (a): The palindromic sequence of 5' – GAATTC – 3' is:

5' – GAATTC – 3'

3' – CTTAAG – 5'

It reads the same in 5' to 3' direction on both strands, making it a palindrome.

Step 2 (b): The restriction endonuclease that recognizes this sequence is ****EcoRI****.

Step 3 (c): EcoRI cuts between G and A in both strands as follows:

5' – G↓AATTC – 3'

3' – CTTAA↑G – 5'

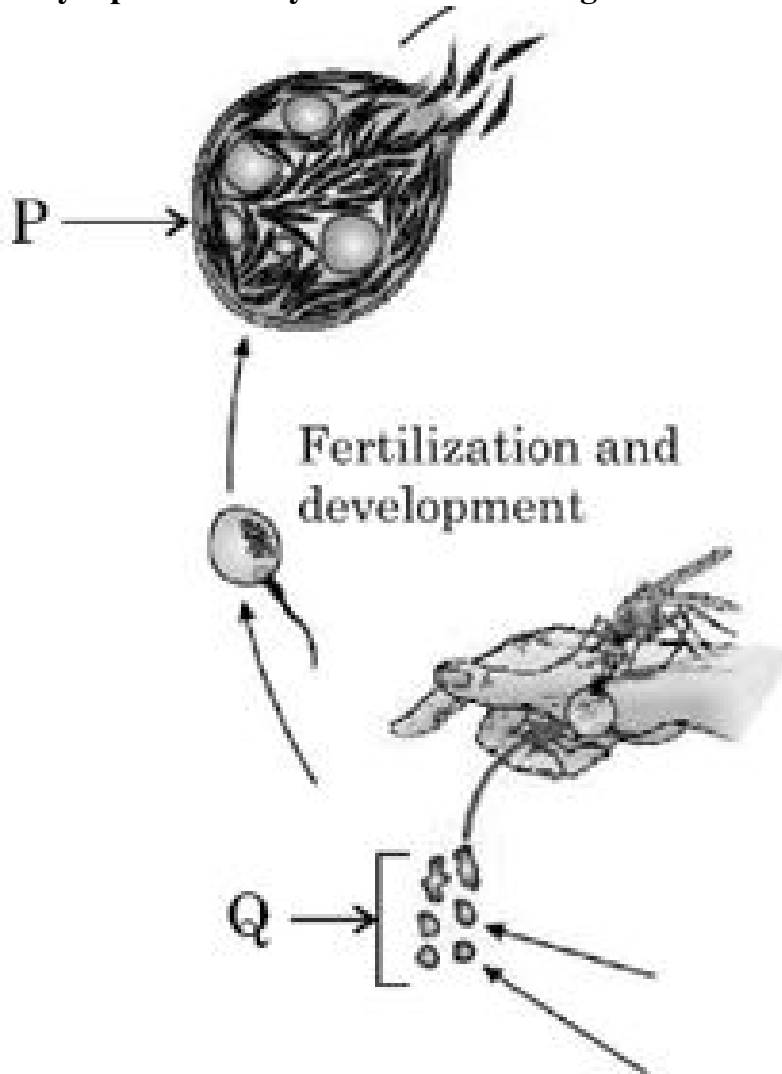
This creates ****sticky ends**** (overhanging single-stranded regions) which can form hydrogen bonds with complementary sequences.

Step 4: Sticky ends facilitate the insertion of foreign DNA during genetic engineering by allowing ligation with complementary sequences.

Quick Tip

Sticky ends produced by restriction enzymes like EcoRI help in easy and specific joining of DNA fragments in recombinant DNA technology.

23. Study a part of life cycle of *Plasmodium* given below:



Answer the following questions:

- (a) Name the infective stage of *Plasmodium* that is stored in the female *Anopheles* mosquito.
- (b) Where does fertilization and development of parasite take place?
- (c) Identify labels P and Q in the given diagram.
- (d) Asexual and sexual phase of the life cycle of the *Plasmodium* takes place in two different hosts. Write their names.

Solution:

Step 1 (a): The infective stage of *Plasmodium* stored in the female *Anopheles* mosquito is the **sporozoite**.

Step 2 (b): Fertilization and development of the parasite take place in the **gut of the female Anopheles mosquito**.

Step 3 (c):

- Label **P** – Sporozoites
- Label **Q** – Gametocytes

Step 4 (d):

- Asexual phase – Occurs in **human host**
- Sexual phase – Occurs in **female Anopheles mosquito**

Quick Tip

Plasmodium requires two hosts for completing its life cycle: humans (asexual phase) and female *Anopheles* mosquitoes (sexual phase). The sporozoite stage is injected into humans during a mosquito bite.

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

(b) State the importance of the following:

- (i) IUCN Red data list

(ii) Hot spots in conservation of biodiversity

Solution:

Step 1 (a):

- **Alien species invasion:** Introduction of Nile perch in Lake Victoria led to the extinction of many native fish species.
- **Habitat fragmentation:** Construction of roads through forests isolates species populations, such as in the case of tigers in India.
- **Habitat loss:** Deforestation in the Amazon rainforest is a major cause of biodiversity loss.

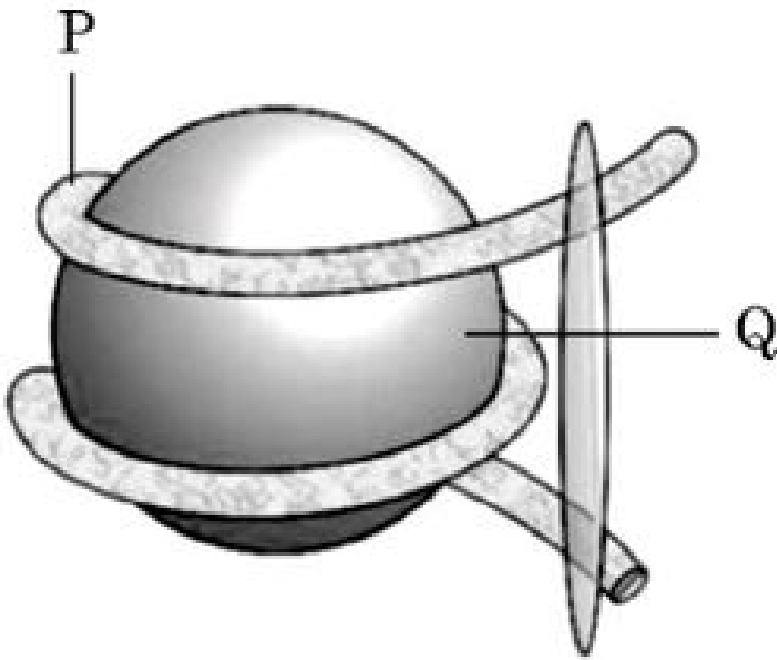
Step 2 (b):

- **(i) IUCN Red data list:** It provides information on the global conservation status of animal and plant species and helps in prioritizing conservation efforts.
- **(ii) Hot spots in conservation of biodiversity:** Biodiversity hotspots are regions with high species richness and endemism but under significant threat. Conservation in these areas ensures protection of maximum biodiversity with limited resources.

Quick Tip

Alien species, habitat destruction, and fragmentation are major drivers of biodiversity loss. Conservation efforts should prioritize biodiversity hotspots and rely on data from tools like the IUCN Red List.

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



- (a) Identify the structure shown in the above figure.
- (b) Identify the labels P and Q.
- (c) Write the nature of histone proteins.
- (d) Distinguish between Euchromatin and Heterochromatin.

Solution:

Step 1 (a): The structure shown in the figure is a **nucleosome**, the fundamental unit of chromatin packaging in eukaryotes.

Step 2 (b):

- Label **P** – DNA strand
- Label **Q** – Histone core (octamer of histone proteins)

Step 3 (c): Histone proteins are **basic** in nature due to the abundance of positively charged amino acids (like lysine and arginine) which bind to the negatively charged DNA.

Euchromatin	Heterochromatin
Lightly stained, loosely packed DNA	Densely stained, tightly packed DNA
Transcriptionally active	Transcriptionally inactive
Found in greater amount during interphase	Found in lesser amount during interphase

Step 4 (d):

Quick Tip

Nucleosomes help compact DNA and regulate gene expression. Euchromatin is loosely packed and active, whereas heterochromatin is tightly packed and inactive.

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

- (a) Suggest and explain a way of testing if their baby is at risk for any genetic disorders.
- (b) In case of presence of one or both of the abnormalities and posing a risk to the mother's health, mention one possible option for them to consider. Is that option safe for Radha at the current gestational age? Justify.
- (c) Under what conditions is the process mentioned in (b) illegal?

Solution:

Step 1 (a): One way to test for genetic disorders in a developing fetus is through **amniocentesis** or **chorionic villus sampling (CVS)**. These are prenatal diagnostic techniques that help detect chromosomal or genetic abnormalities like Down's syndrome and cystic fibrosis.

Step 2 (b): If abnormalities are confirmed and they pose a severe risk to the fetus or the mother, **medical termination of pregnancy (MTP)** is an option.

Justification: MTP is considered safe during the first trimester (up to 12 weeks), and Radha

is in her second month (around 8 weeks), which falls within this safe period.

Step 3 (c): MTP becomes illegal if:

- It is performed without the consent of the pregnant woman.
- It is conducted after the legally permissible gestation period (currently 24 weeks in India) without appropriate medical board approval.
- It is done for reasons such as sex selection, which is strictly prohibited.

Quick Tip

Prenatal diagnostic techniques should only be used for identifying serious genetic risks—not for sex determination, which is illegal under PCPNDT Act.

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

Solution:

Step 1: Gel electrophoresis works on the principle that **DNA fragments are negatively charged** and will move towards the **positive electrode (anode)** when an electric field is applied. The rate of movement depends on the **size of the DNA fragments**—smaller fragments move faster and farther through the gel (usually agarose gel).

Step 2: The products (separated DNA fragments) can be utilized in:

- **DNA fingerprinting** for forensic and paternity testing.
- **Gene identification and isolation** in genetic engineering.

Quick Tip

Smaller DNA fragments move faster in gel electrophoresis. The separated bands can be visualized using ethidium bromide under UV light.

28. Compare and contrast convergent and divergent evolution.

Solution:

Step 1:

Convergent Evolution	Divergent Evolution
Different species develop similar traits due to adaptation to similar environments.	One species evolves into different forms to adapt to different environments.
Example: Wings of birds and bats.	Example: Forelimbs of humans, whales, and bats.
Indicates functional similarity but not common ancestry.	Indicates common ancestry with functional diversity.

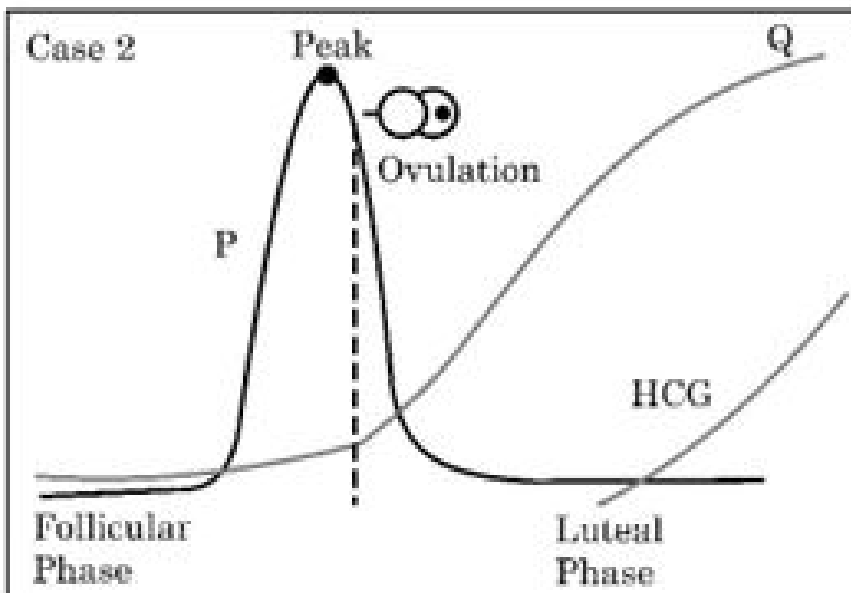
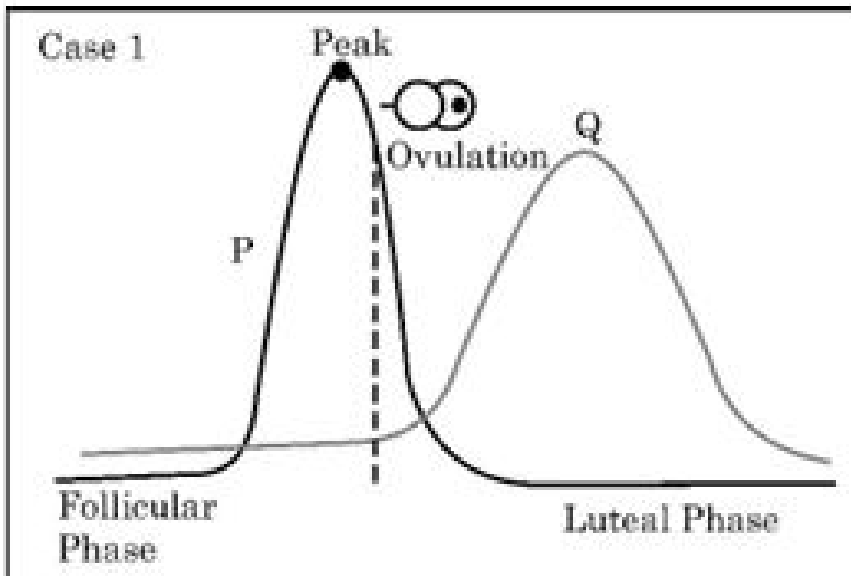
Quick Tip

Homologous organs show divergent evolution, while analogous organs show convergent evolution.

SECTION - D

Question Nos. 29 and 30 are case-based questions. Each question has 3 sub-questions with internal choice in one sub-question.

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



- (a) Which hormone is responsible for the peak observed in Case 1 and Case 2? Write one function of that hormone.
- (b) Write changes that take place in the ovary and uterus during follicular phase.
- Student to attempt either sub-part (c) or (d):
- (c) Name the hormone Q of Case 2. Write one function of hormone Q.

OR

- (d) Which structure in the ovary will remain functional in Case 2? How is it formed?

Solution:

Step 1 (a): The hormone responsible for the peak in both Case 1 and Case 2 is **Luteinizing Hormone (LH)**.

Function: LH stimulates ovulation and formation of corpus luteum.

Step 2 (b): During the follicular phase, in the ovary, a primary follicle develops into a Graafian follicle.

In the uterus, the endometrium regenerates under the influence of estrogen.

Step 3 (c): Hormone Q in Case 2 is **Progesterone**.

Function: Maintains the endometrial lining for implantation and supports early pregnancy.

OR

Step 3 (d): The functional structure in Case 2 is the **Corpus luteum**.

It is formed from the Graafian follicle after ovulation under the influence of LH.

Quick Tip

LH surge is essential for ovulation. Progesterone from the corpus luteum helps maintain pregnancy until the placenta takes over.

30. Read the following passage and answer the questions that follow:

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

parameter. It keeps on changing with time depending on various factors including food availability, predation pressure and adverse weather.

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

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

Student to attempt either sub-part (c) or (d):

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

OR

(d) Name two methods to measure the population density of tigers.

Solution:

Step 1 (a): Monarch butterflies acquire the chemical by feeding on poisonous milkweed plants during their larval stage. These chemicals accumulate in their body making them unpalatable to predators.

Step 2 (b):

Population at $t + 1 = 800$

Using formula:

$$N_{t+1} = N_t + \text{Natality} + \text{Immigration} - \text{Mortality} - \text{Emigration}$$

$$800 = N_t + 200 + 200 - 150 - 100$$

$$800 = N_t + 150 \Rightarrow N_t = 650$$

Since natality and immigration are higher than mortality and emigration, it indicates a growing population. Therefore, the type of age pyramid formed would be ****expanding****.

Step 3 (c):

For carrot grass (uniform, small individuals), population density is best measured in terms of ****number of individuals per unit area****.

For a huge banyan tree (single large organism with many offshoots), population is better measured in terms of **biomass** or **canopy cover**.

OR

Step 3 (d):

Two methods to measure tiger population density:

1. **Pugmark method** – tracking and counting footprints.
2. **Camera trapping** – using motion-sensor cameras to photograph and identify individual tigers.

Quick Tip

Population density is dynamic and varies with birth, death, immigration, and emigration. Different species require different techniques to estimate their population effectively.

SECTION - E

31. Student to attempt either option-(A) or (B):

(A) Answer the following questions:

1. State what do you understand by “MALT”? Where is it located inside our body?
2. Explain cytokine barriers.
3. Name the diagnostic test for AIDS. On what principle does it work?
4. Bone marrow and thymus play an important role in human immune system. Explain how are they able to achieve this.

OR

(B)

1. Study the following table & fill ‘H’, ‘T’, ‘J’, ‘K’, ‘L’ and ‘M’ in the following table with suitable words:

	Chemical / Bioactive Molecule	Micro-organism	Category	Use
(a)	Butyric acid	H	I	Important applications in food, chemical & pharma industry Inhibit cholesterol biosynthesis pathway M
(b)	J	<u>Monascus purpureus</u>	K	
(c)	Cyclosporin A	L	Fungus	

2. Why are baculoviruses used as biological control agents?

Solution:

Step 1 (A):

1. **MALT (Mucosa-Associated Lymphoid Tissue)** is a component of the immune system found in mucosal linings such as the respiratory tract, gut, and urogenital tract. It provides localized immunity at the mucosal surfaces.
2. **Cytokine barriers** refer to proteins like interferons secreted by virus-infected cells that protect non-infected cells from further viral infection.
3. The diagnostic test for AIDS is the **ELISA test**. It works on the principle of antigen-antibody interaction, detecting HIV antibodies in the blood.
4. Bone marrow produces lymphocytes while the thymus is where T-lymphocytes mature. Together, they generate a functional immune system capable of defending the body.

Step 2 (B):

1. See the filled table above in the question section.
2. **Baculoviruses** are used as biological control agents because they are species-specific, do not harm non-target organisms, and are safe for the environment. They infect only specific insect pests.

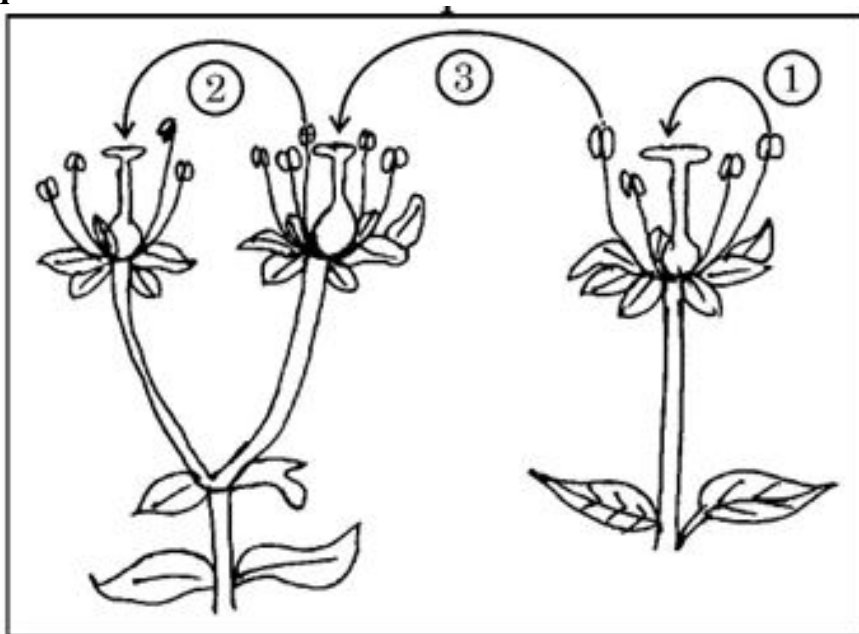
Quick Tip

Interferons and cytokines are key natural defense mechanisms against viral infections. Also, microbes provide a wide range of bioactive compounds used in medical and industrial applications.

32. Student to attempt either option-(A) or (B):

(A)

1. Distinguish between the two cells enclosed in a mature male gametophyte of an angiosperm.
2. Study the diagram given below showing the modes of pollination. **Answer the questions that follow.**



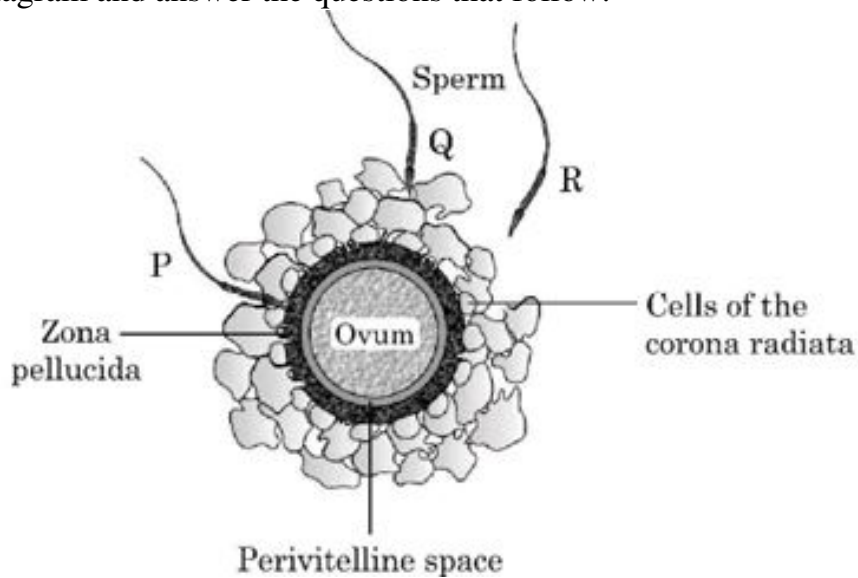
- (a) The given diagram shows three methods of pollen transfer in plants. Examine them carefully and write the technical terms used for pollen transfer methods '1', '2' and '3'.
- (b) How do the following plants achieve pollination successfully?
 - i. Water lily
 - ii. Vallisneria

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

OR

(B)

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



- Compare the fate of sperms 'P', 'Q' and 'R' shown in the diagram.
- Write the role of Zona pellucida in this process.
- Analyse the changes occurring in the ovum after the entry of sperm.
- How acrosome and middle piece of a human sperm are able to play an important role in human fertilization?

Solution:

Step 1 (A):

1. In a mature male gametophyte of an angiosperm, two cells are enclosed:

- **Generative cell:** Divides to form two male gametes (sperms).
- **Vegetative cell:** Forms the pollen tube for gamete transfer.

2. (a) Technical terms:

- 1 — Autogamy

- 2 — Geitonogamy
- 3 — Xenogamy

(b) Pollination modes:

- **Water lily:** By insects (entomophily)
- **Vallisneria:** By water (hydrophily)

(c) Advantages of Xenogamy (method '3'):

- Introduces genetic variation.
- Helps in evolution and adaptability.

Step 2 (B):

1. Fate of sperms:

- **P:** Fails to penetrate the ovum.
- **Q:** Successfully fertilizes the ovum.
- **R:** Degenerates.

2. Role of Zona pellucida:

- It prevents polyspermy by blocking entry of additional sperms once one sperm has penetrated.

3. Changes after sperm entry:

- Completion of meiosis II.
- Formation of female pronucleus.
- Zona reaction to block polyspermy.

4. Role of acrosome and middle piece:

- **Acrosome:** Contains enzymes to digest egg membranes.
- **Middle piece:** Packed with mitochondria providing energy for sperm motility.

Quick Tip

Remember — pollen transfer can occur within the same flower, between flowers of the same plant, or different plants. Similarly, acrosomal enzymes like hyaluronidase and zona lysin aid sperm entry during fertilization.

33. Student to attempt either option-(A) or (B):

(A)

1. Perform a cross between two sickle cell carriers. What ratio is obtained between carrier, disease free and diseased individuals in F_1 progeny? Name the nitrogenous base substituted, in the haemoglobin molecule in this disease.
2. Explain the difference in inheritance pattern of flower colour in garden pea plant and snap-dragon plant with the help of monohybrid crosses.

OR

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

1. In presence of an inducer.
2. In absence of an inducer.

Solution:

Step 1 (A):

1. • Cross between two sickle cell carriers ($Hb^A Hb^S \times Hb^A Hb^S$) results in:
 - 1 Normal ($Hb^A Hb^A$)
 - 2 Carriers ($Hb^A Hb^S$)
 - 1 Diseased ($Hb^S Hb^S$)

Ratio = **1:2:1**

- Substitution: Adenine is replaced by Thymine in the sixth codon of the beta globin gene, leading to substitution of glutamic acid by valine.

2.
 - **Garden Pea Plant:** Shows complete dominance (e.g., red × white flower yields all red in F_1).
 - **Snap-Dragon Plant:** Shows incomplete dominance (e.g., red × white yields pink in F_1).
 - Monohybrid cross in pea plant gives a phenotypic ratio of 3:1, while in snap-dragon it is 1:2:1.

Step 2 (B):

- In presence of an inducer (e.g., lactose):
 - Inducer binds to repressor.
 - Repressor becomes inactive.
 - RNA polymerase transcribes structural genes (lac Z, Y, A).
 - Enzymes for lactose metabolism produced.
- In absence of an inducer:
 - Active repressor binds to operator.
 - RNA polymerase is blocked.
 - No transcription.
 - No enzyme production.

Quick Tip

Remember — Lac operon is a classic example of an inducible operon, and incomplete dominance results in an intermediate phenotype in F_1 generation.