

## CBSE Class 12 2025 Biology Question Paper (57/2/2) With Solutions

<b>Time Allowed :3 Hour</b>	<b>Maximum Marks :70</b>	<b>Total questions :33</b>
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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. The number of autosomes present in a human secondary spermatocyte

(A) 44

(B) 22

(C) 23

(D) 46

**Correct Answer:** (B) 22

**Solution:**

**Step 1:** A human secondary spermatocyte is a haploid cell formed after the first meiotic division during spermatogenesis.

**Step 2:** Humans have 46 chromosomes in total (diploid), with 44 autosomes and 2 sex chromosomes. In a haploid cell, the chromosome number is halved, so it has 23 chromosomes (22 autosomes + 1 sex chromosome).

**Step 3:** Since the question asks for autosomes, we exclude the sex chromosome:  $23 - 1 = 22$  autosomes.

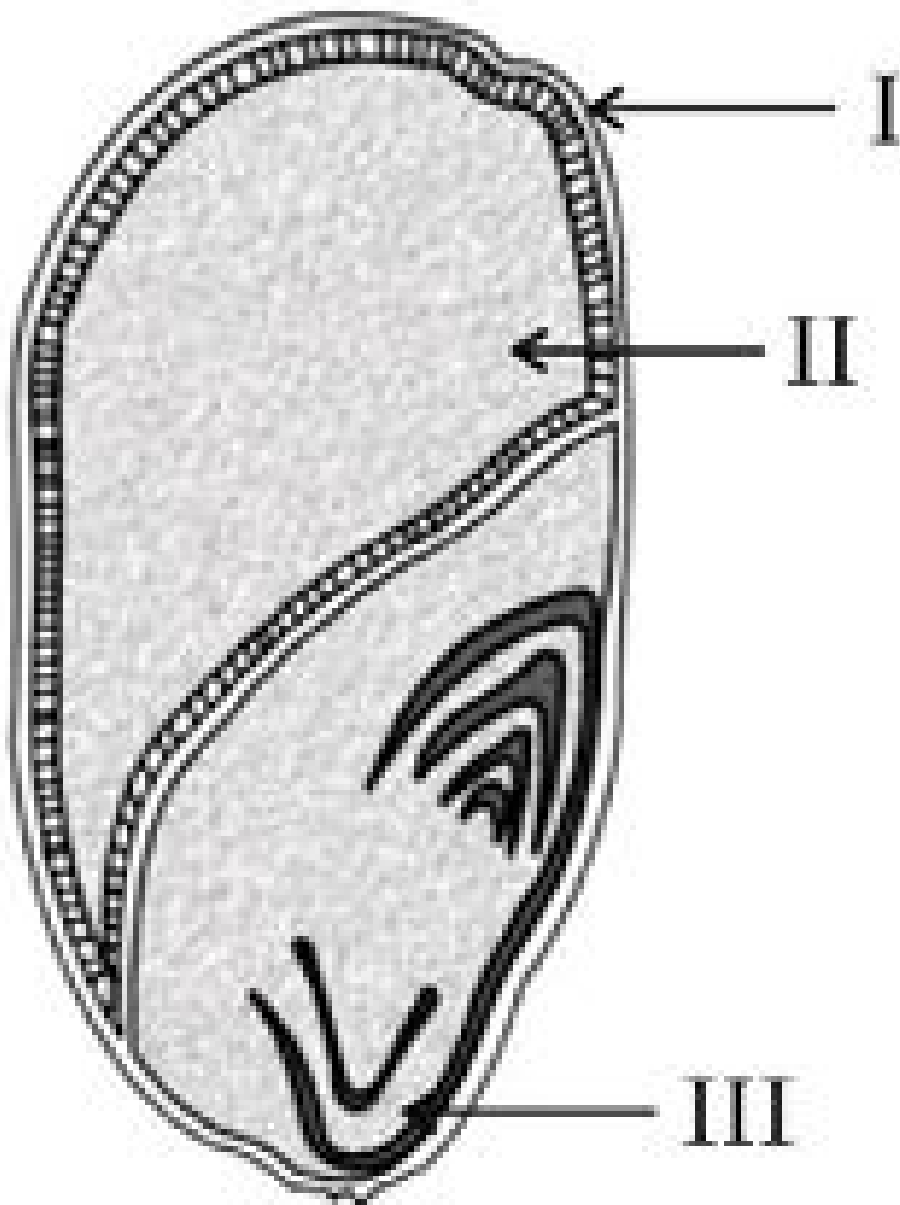
Thus, the number of autosomes in a human secondary spermatocyte is 22.

### Quick Tip

A secondary spermatocyte is haploid, so it contains half the diploid number of chromosomes, with autosomes being all chromosomes except the sex chromosomes.

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2. Given below is a diagram of T.S. of a monocot seed with parts I, II & III labelled :



**Choose the option where parts I, II and III are identified correctly.**

- (A) I: Pericarp, II: Endosperm, III: Scutellum
- (B) I: Pericarp, II: Endosperm, III: Coleorhiza
- (C) I: Scutellum, II: Pericarp, III: Coleorhiza
- (D) I: Coleorhiza, II: Scutellum, III: Pericarp

**Correct Answer:** (A) I: Pericarp, II: Endosperm, III: Scutellum

**Solution:**

**Step 1:** In the transverse section (T.S.) of a monocot seed, the outermost layer is the

pericarp, which is labelled as I.

**Step 2:** The large starchy storage tissue inside is the endosperm, which is labelled as II.

**Step 3:** The structure at the bottom, protecting the embryonic shoot, is the scutellum, labelled as III.

Thus, the correct identification is I: Pericarp, II: Endosperm, III: Scutellum.

#### Quick Tip

In a monocot seed, the scutellum is a single cotyledon that absorbs nutrients from the endosperm during germination.

**3. Given below is a heterogeneous RNA formed during Eukaryotic transcription:**



**How many introns and exons respectively are present in the hnRNA?**

- (A) 7, 7
- (B) 8, 7
- (C) 8, 8
- (D) 7, 8

**Correct Answer:** (D) 7, 8

**Solution:**

**Step 1:** Heterogeneous nuclear RNA (hnRNA) in eukaryotes contains both exons (coding regions) and introns (non-coding regions) before processing into mature mRNA.

**Step 2:** The diagram  $5' \sim\sim\sim\sim 3'$  typically represents a sequence with alternating exons and introns. If the diagram implies 15 total segments (as a simplified representation), we interpret it as 8 exons (including the ends) and 7 introns (the segments between exons).

**Step 3:** This matches the pattern of eukaryotic transcription where introns are removed, leaving exons in the mature mRNA.

Thus, the hnRNA has 7 introns and 8 exons.

#### Quick Tip

In eukaryotic hnRNA, introns are the non-coding regions between exons, and their number is typically one less than the number of exons in a linear sequence.

**4. If Meselson and Stahl's experiment is continued for 80 minutes (till III generation), what would be the ratio of DNA containing  $N^{15}/N^{15} : N^{15}/N^{14} : N^{14}/N^{14}$  in the medium?**

- (A) 1 : 1 : 0
- (B) 1 : 1 : 3
- (C) 0 : 1 : 8
- (D) 1 : 4 : 0

**Correct Answer:** (C) 0 : 1 : 8

#### Solution:

**Step 1:** Meselson and Stahl's experiment demonstrates semi-conservative DNA replication. Initially, all DNA is  $N^{15}/N^{15}$  (heavy). After one generation in  $N^{14}$  medium, all DNA is hybrid ( $N^{15}/N^{14}$ ).

**Step 2:** After the second generation (40 minutes, assuming 20 minutes per generation), half the DNA is  $N^{15}/N^{14}$  and half is  $N^{14}/N^{14}$  (1:1).

**Step 3:** After the third generation (80 minutes), the  $N^{15}/N^{14}$  DNA replicates to produce 2  $N^{15}/N^{14}$  and 2  $N^{14}/N^{14}$ , while the  $N^{14}/N^{14}$  DNA replicates to produce 4  $N^{14}/N^{14}$ . Thus, the ratio is 0  $N^{15}/N^{15} : 2 N^{15}/N^{14} : 6 N^{14}/N^{14}$ , which simplifies to 0:1:8 when considering relative proportions.

Thus, the ratio is 0 : 1 : 8.

#### Quick Tip

In Meselson and Stahl's experiment, after each generation in  $N^{14}$  medium, the proportion of  $N^{14}/N^{14}$  DNA doubles, while  $N^{15}/N^{15}$  disappears after the first generation.

**5. A child with blood group A has the father with blood group B and the mother with blood group AB. Choose the option that gives the correct genotypes of father, mother and the child :**

- (A) Father:  $I^A i$ , Mother:  $I^B i$ , Child:  $I^A i$
- (B) Father:  $I^A I^B$ , Mother:  $I^A i$ , Child:  $I^A I^A$
- (C) Father:  $I^B i$ , Mother:  $I^A I^B$ , Child:  $I^A i$
- (D) Father:  $I^B I^B$ , Mother:  $I^A I^B$ , Child:  $I^A I^A$

**Correct Answer:** (C) Father:  $I^B i$ , Mother:  $I^A I^B$ , Child:  $I^A i$

**Solution:**

**Step 1:** Blood group A in the child means the genotype is  $I^A I^A$  or  $I^A i$ .

**Step 2:** The father has blood group B (genotype  $I^B I^B$  or  $I^B i$ ) and the mother has blood group AB (genotype  $I^A I^B$ ).

**Step 3:** For the child to have blood group A, they must inherit  $I^A$  from the mother (since the father cannot provide  $I^A$ ) and either  $i$  or  $I^B$  from the father. Since the child's phenotype is A, the father must contribute  $i$ , making his genotype  $I^B i$ , and the child's genotype  $I^A i$ .

Thus, the correct genotypes are Father:  $I^B i$ , Mother:  $I^A I^B$ , Child:  $I^A i$ .

#### Quick Tip

In ABO blood group inheritance, a child with blood group A must inherit at least one  $I^A$  allele, which can come from a parent with blood group A or AB.

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**6. Which one of the following options shows the correct evolutionary order of the plants mentioned below?**

- (i) Ferns    (ii) Ginkgo    (iii) Zosterophyllum    (iv) Gnetales

**Choose the correct option.**

- (A) (i), (iii), (ii), (iv)
- (B) (iii), (i), (ii), (iv)
- (C) (i), (ii), (iii), (iv)
- (D) (iv), (ii), (i), (iii)

**Correct Answer:** (B) (iii), (i), (ii), (iv)

**Solution:**

**Step 1:** Zosterophyllum (iii) is one of the earliest land plants, appearing around 420 million years ago during the Silurian period.

**Step 2:** Ferns (i) evolved later, around 360 million years ago during the Devonian period.

**Step 3:** Ginkgo (ii) appeared around 270 million years ago in the Permian period, and Gnetales (iv) are more recent, evolving around 150 million years ago in the Mesozoic era. Thus, the correct evolutionary order is (iii) Zosterophyllum, (i) Ferns, (ii) Ginkgo, (iv) Gnetales.

#### Quick Tip

When determining the evolutionary order of plants, consider their first appearance in the fossil record, from oldest to most recent.

### 7. Study the items of Column-I and those of Column-II:

#### Column-I

(a) RNA polymerase I

(b) RNA polymerase II

(c) RNA polymerase III

#### Column-II

(i) 18s rRNA

(ii) SnRNAs

(iii) hnRNA

**Choose the option that correctly matches the items of Column-I with those of Column-II:**

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

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

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

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

**Correct Answer:** (D) (a)-(i), (b)-(iii), (c)-(ii)

**Solution:**

**Step 1:** RNA polymerase I synthesizes ribosomal RNA, including 18s rRNA, so (a) matches with (i).

**Step 2:** RNA polymerase II synthesizes heterogeneous nuclear RNA (hnRNA), which is a precursor to mRNA, so (b) matches with (iii).

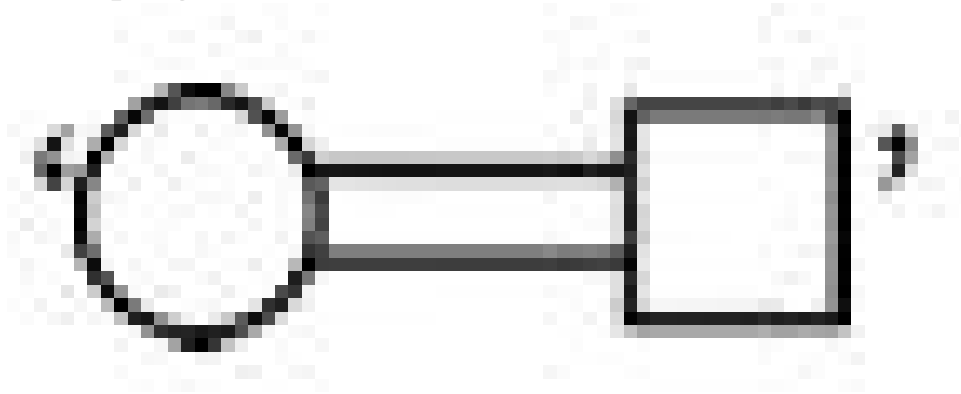
**Step 3:** RNA polymerase III synthesizes small nuclear RNAs (SnRNAs), so (c) matches with (ii).

Thus, the correct matching is (a)-(i), (b)-(iii), (c)-(ii).

#### Quick Tip

RNA polymerase I is responsible for rRNA, RNA polymerase II for mRNA precursors (hnRNA), and RNA polymerase III for small RNAs like SnRNAs.

### 8. In a pedigree chart




represents :

- (A) unrelated mating
- (B) affected individuals
- (C) mating between relatives (consanguineous mating)
- (D) Non-identical twins

**Correct Answer:** (C) mating between relatives (consanguineous mating)

#### Solution:

**Step 1:** In a pedigree chart, a circle typically represents a female and a square represents a male.

**Step 2:** A horizontal line connecting them with a specific symbol, such as , indicates a consanguineous mating, meaning mating between relatives.

**Step 3:** This symbol does not represent unrelated mating, affected individuals, or twins. Thus, the correct interpretation is mating between relatives (consanguineous mating).

### Quick Tip

In pedigree charts, consanguineous mating is often indicated by a double line or specific notation between the symbols for male and female.

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**9. The foetus receives some antibodies from their mother through the placenta during pregnancy. Choose the correct option that shows the type of immunity developed in the foetus.**

- (A) Naturally acquired active immunity
- (B) Artificially acquired passive immunity
- (C) Naturally acquired passive immunity
- (D) Artificially acquired active immunity

**Correct Answer:** (C) Naturally acquired passive immunity

### Solution:

**Step 1:** Passive immunity occurs when antibodies are transferred from another source.

**Step 2:** In the case of a fetus, maternal antibodies cross the placenta and provide immunity.

**Step 3:** Since this is naturally occurring (without medical intervention), it is called naturally acquired passive immunity.

### Quick Tip

Naturally acquired passive immunity is temporary and obtained via transfer of ready-made antibodies, such as from mother to fetus.

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**10. A diploid organism is heterozygous for three loci, how many types of gametes can be produced by that organism?**

- (A) 4 (B) 8
- (C) 16 (D) 32

**Correct Answer:** (B) 8

### Solution:

**Step 1:** For an organism heterozygous at  $n$  loci, the number of gamete types =  $2^n$ .

**Step 2:** Here,  $n = 3$ , so number of gametes =  $2^3 = 8$ .

#### Quick Tip

Use  $2^n$  to calculate gametes, where  $n$  is the number of heterozygous loci.

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**11. During gel electrophoresis migration of DNA fragments leading to their separation takes place on the agarose gel. Choose the correct option:**

- (A) The smaller the fragment size, the farther it moves.
- (B) Positively charged fragments moves to farther end.
- (C) The larger the fragment size, the farther it moves.
- (D) The negatively charged fragments do not move.

**Correct Answer:** (A) The smaller the fragment size, the farther it moves.

#### Solution:

**Step 1:** DNA is negatively charged and moves towards the positive electrode in electrophoresis.

**Step 2:** Smaller DNA fragments pass more easily through the agarose matrix, moving farther than larger ones.

**Step 3:** Therefore, separation is based on size: smaller = farther.

#### Quick Tip

In gel electrophoresis, smaller DNA fragments migrate faster and farther than larger ones.

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**12. Identify the organism whose product has been commercialised as blood cholesterol lowering agent.**

- (A) *Trichoderma polysporum*
- (B) *Monascus purpureus*
- (C) *Saccharomyces cerevisiae*

(D) *Aspergillus niger*

**Correct Answer:** (B) *Monascus purpureus*

**Solution:**

**Step 1:** *Monascus purpureus* produces statins, which are used as cholesterol-lowering drugs.

**Step 2:** These compounds inhibit HMG-CoA reductase, an enzyme involved in cholesterol synthesis.

**Step 3:** Hence, the correct organism is *Monascus purpureus*.

**Quick Tip**

*Monascus purpureus* produces statins — used to reduce blood cholesterol levels.

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**Question numbers 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, 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):** XX – XY type of sex-determination mechanism is an example of male heterogamety.

**Reason (R):** In birds male heterogamety is observed as males produce two different types of gametes.

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

**Solution:**

**Step 1:** In humans and many other organisms, the XX–XY system shows male heterogamety where males produce two types of gametes (X and Y), so Assertion (A) is true.

**Step 2:** However, in birds, females are the heterogametic sex (ZW), and males are homogametic (ZZ), making Reason (R) false.

**Step 3:** Since (R) is incorrect, it cannot explain (A).

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

#### Quick Tip

In humans, males are heterogametic (XY), while in birds, females are heterogametic (ZW).

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**14. Assertion (A): The number of white-winged moths decreased after industrialisation in England.**

**Reason (R): Effects of industrialisation were more marked in rural areas of England.**

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

#### Solution:

**Step 1:** Industrialisation in England led to soot deposition, darkening tree bark, making white-winged moths more visible to predators. Hence, Assertion (A) is true.

**Step 2:** The effects of industrialisation were more marked in urban, not rural, areas—making Reason (R) false.

**Step 3:** Since (R) is incorrect, it does not explain (A).

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

### Quick Tip

Industrial melanism is a case of natural selection observed during urban industrialisation, not in rural areas.

**15. Assertion (A): Secondary immune response is quicker and stronger than the primary immune response.**

**Reason (R): Our body appears to have the memory of the first encounter therefore response to the subsequent encounter with the same pathogen is quick.**

(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:** In the immune system, secondary response is faster and more effective than the primary response, so Assertion (A) is true.

**Step 2:** This is due to memory B and T cells formed during the first encounter, which makes Reason (R) true.

**Step 3:** Since memory is the reason for faster secondary response, (R) correctly explains (A). Thus, both (A) and (R) are true and (R) is the correct explanation of (A).

### Quick Tip

Memory cells help the immune system respond faster and more robustly upon second exposure to the same antigen.

**16. Assertion (A): A patient of ADA-deficiency requires periodic or repeated infusion of genetically-engineered lymphocytes.**

**Reason (R): Lymphocytes are not immortal, but have life span.**

- (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:** ADA-deficiency leads to immunodeficiency and one treatment is gene therapy using engineered lymphocytes. So, Assertion (A) is true.

**Step 2:** Since lymphocytes have limited lifespan, the treatment must be repeated—making Reason (R) true.

**Step 3:** As the short life of lymphocytes explains the need for repeated infusion, (R) correctly explains (A).

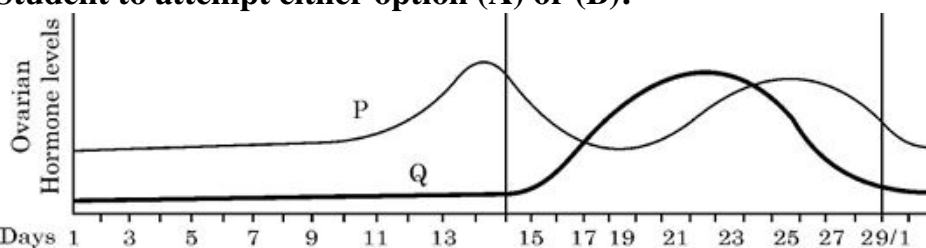
Thus, both (A) and (R) are true and (R) is the correct explanation of (A).

**Quick Tip**

In ADA-deficiency, periodic infusion of modified lymphocytes is needed due to their limited lifespan unless permanent gene correction is done in stem cells.

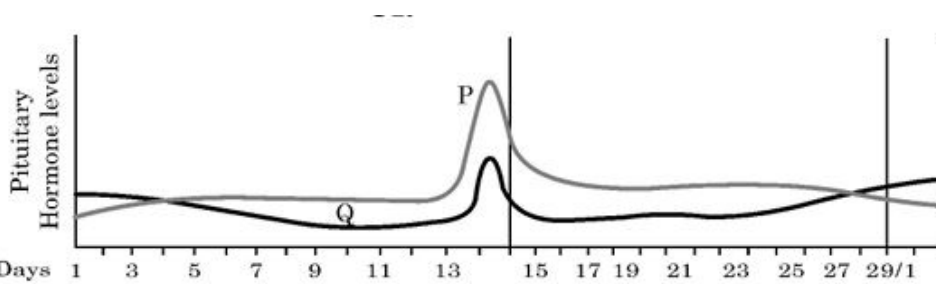
**SECTION B**

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



- (A) Days 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29/1
- (i) Identify 'P' and 'Q' labelled in the diagram.
- (ii) Specify the source of the hormone 'P' and 'Q' marked in the diagram.

**OR**



- (B) Days 1 3 5 7 9 11 13 15 17 19 21 23 25 27 29/1
- (i) Identify 'P' and 'Q' labelled in the above diagram.
- (ii) Write down the role of hormone 'P' in both males and females.

**Solution:**

**Option (A):**

**Step 1:** In the ovarian hormone graph, hormone 'P' is progesterone and hormone 'Q' is estrogen.

**Step 2:** Progesterone (P) is secreted by the corpus luteum after ovulation. Estrogen (Q) is primarily secreted by the growing follicles (Graafian follicle) in the ovary.

**OR**

**Option (B):**

**Step 1:** In the pituitary hormone graph, hormone 'P' is Luteinising Hormone (LH) and hormone 'Q' is Follicle Stimulating Hormone (FSH).

**Step 2:** In females, LH triggers ovulation and formation of the corpus luteum. In males, LH stimulates Leydig cells to produce testosterone.

#### Quick Tip

Pituitary hormones like LH and FSH regulate ovarian function in females and testicular activity in males; LH shows a sharp peak at ovulation.

**18. (a) Write two closely linked genes that control  $\alpha$ -thalassemia.**

**(b) Differentiate between thalassemia and sickle cell anaemia on the basis of their effect on globin molecule of Haemoglobin.**

**Solution:**

(a) The two closely linked genes that control  $\alpha$ -thalassemia are *HBA1* and *HBA2*, which are present on chromosome 16.

(b)

- **Thalassemia:** Caused by deletion or mutation of globin genes, leading to reduced or absent synthesis of one of the globin chains. The structure of the globin molecule is normal, but the quantity is insufficient.
- **Sickle Cell Anaemia:** Caused by a point mutation in the  $\beta$ -globin gene, resulting in abnormal hemoglobin (HbS). The globin molecule becomes deformed under low oxygen conditions, causing sickling of RBCs.

#### Quick Tip

Thalassemia affects the quantity of globin chains, while sickle cell anaemia affects the quality of the globin molecule due to structural change.

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**19. Student to attempt either option (A) or (B):**

**(A) Describe any two situations where a medical doctor would recommend injection of a pre-formed antibodies (antitoxins) into the body of a patient.**

**OR**

**(B) The symptoms of malaria do not appear immediately after the entry of sporozoites into the human body when bitten by female *Anopheles* mosquito. Explain why it happens.**

**Solution:**

**Option (A):**

**Step 1:** One situation is tetanus infection, where antitoxins are given to neutralize the tetanus toxin produced by *Clostridium tetani*.

**Step 2:** Another situation is snakebite envenomation, where antivenom containing antibodies is administered to neutralize the venom.

**OR**

**Option (B):**

**Step 1:** After entering the bloodstream, the sporozoites of *Plasmodium* travel to the liver.

**Step 2:** They undergo asexual reproduction inside liver cells and are released as merozoites after several days, which then infect RBCs and cause symptoms. This delay in multiplication accounts for the asymptomatic phase.

**Quick Tip**

Passive immunity is provided by injecting pre-formed antibodies. In malaria, the liver phase delays the onset of symptoms as no RBCs are destroyed initially.

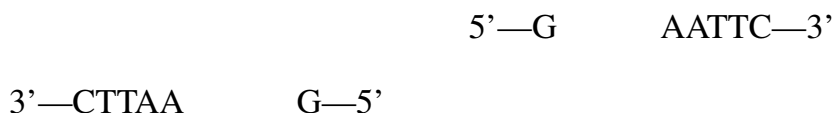
**20. Observe the given sequence of nitrogenous bases on a DNA fragment and answer the following questions:**

5'	C	A	G	A	A	T	T	C	T	T	A	3'
3'	G	T	C	T	T	A	A	G	A	A	T	5'

- (a) Name the restriction enzyme which can recognise the DNA sequence.
- (b) Write the sequence after restriction enzyme cuts the palindrome.
- (c) Why are the ends generated after digestion called as 'Sticky Ends'?

**Solution:**

- (a) The restriction enzyme that recognises this palindromic sequence is **EcoRI**, which identifies the sequence GAATTC.
- (b) EcoRI cuts the DNA between G and A in the sequence GAATTC. After digestion, the resulting sequences are:



- (c) The ends are called 'Sticky Ends' because the single-stranded overhangs can form hydrogen bonds with complementary sequences, making it easier to join DNA fragments.

### Quick Tip

Sticky ends allow for easy and specific binding with complementary sequences, making recombinant DNA technology efficient.

**21. Student to attempt either option (A) or (B):**

**(A) Construct a pyramid of biomass starting with phytoplankton, label its three trophic levels. Is the pyramid upright or inverted? Justify your answer.**

**OR**

**(B) Draw a pyramid of number where a large population of insects feed upon a very big tree. The insects in turn, are eaten by small birds which in turn are fed upon by big birds.**

**Solution:**

**Option (A):**

**Step 1:** In an aquatic ecosystem, the biomass pyramid is usually inverted. The three trophic levels are:

1. Phytoplankton (producers)
2. Zooplankton (primary consumers)
3. Small fishes (secondary consumers)

**Step 2:** It is inverted because the biomass of phytoplankton is less at any given time, yet they reproduce rapidly to support higher trophic levels.

**OR**

**Option (B):**

**Step 1:** In a pyramid of numbers with one large tree at the base, it supports many insects.

**Step 2:** These insects are eaten by fewer small birds, which are in turn consumed by even fewer big birds.

**Step 3:** This results in a spindle-shaped or inverted pyramid of numbers.

### Quick Tip

Biomass pyramids can be upright or inverted depending on the ecosystem. In contrast, pyramids of number often become inverted when a single large producer supports many consumers.

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## SECTION C

- 22. (a) A bilobed dithecous anther has 200 microspore mother cells per microsporangium. How many male gametophytes can be produced by this anther?**  
**(b) Write the composition of intine and exine layers of a pollen grain.**

**Solution:**

(a) A bilobed anther has 2 lobes, each with 2 microsporangia = 4 microsporangia.  
Each microsporangium has 200 microspore mother cells (MMCs).

So, total MMCs =  $4 \times 200 = 800$ .

Each MMC undergoes meiosis to form 4 microspores (male gametophytes).

**Total male gametophytes** =  $800 \times 4 = 3200$ .

(b) - **Exine** is made of sporopollenin, which is resistant to physical and biological decomposition.

- **Intine** is made of cellulose and pectin, and is continuous around the cytoplasm of the pollen grain.

### Quick Tip

One microspore mother cell gives rise to four haploid microspores through meiosis. Sporopollenin in exine makes pollen grains resistant to harsh conditions.

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- 23. (a) Abbreviations used for the different modes of assisted reproductive technology are given below. Expand the abbreviations:**

(i) ZIFT    (ii) ICSI    (iii) IUT    (iv) GIFT

**(b) Why is there a statutory ban on Amniocentesis? Give at least two reasons.**

**Solution:**

- (a) (i) ZIFT – Zygote Intra Fallopian Transfer
- (ii) ICSI – Intra Cytoplasmic Sperm Injection
- (iii) IUT – Intra Uterine Transfer
- (iv) GIFT – Gamete Intra Fallopian Transfer

(b) Amniocentesis is banned due to the following reasons:

1. It is often misused for sex determination, leading to female foeticide.
2. It promotes social bias and imbalance in the sex ratio, especially in certain regions.

**Quick Tip**

Assisted reproductive technologies help infertile couples. However, prenatal diagnostic techniques like amniocentesis should be ethically regulated.

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**24. Using a Punnett square, workout the distribution of an autosomal phenotypic feature in the first filial generation after a cross between a homozygous female and a heterozygous male for a single locus.**

**Solution:**

Let the dominant allele be  $A$  and the recessive allele be  $a$ .

**Parent Genotypes:** Female –  $aa$ , Male –  $Aa$

**Punnett Square:**

	$A$	$a$
$a$	$Aa$	$aa$
$a$	$Aa$	$aa$

**Result:** - 50%  $Aa$  (dominant phenotype)

- 50%  $aa$  (recessive phenotype)

**Quick Tip**

Punnett squares help predict genetic ratios in offspring. A heterozygous  $\times$  homozygous recessive cross yields a 1:1 phenotypic ratio.

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**25. How does the process of Natural Selection affect Hardy-Weinberg equilibrium? Explain with the help of graphs.**

**Solution:**

Natural selection disrupts Hardy-Weinberg equilibrium by favoring certain alleles over others, leading to changes in allele frequencies.

Hardy-Weinberg assumes no evolution, but selection creates a differential reproductive success.

**Graphically:**

- The equilibrium predicts constant allele frequencies: a horizontal line.
- Under natural selection, a beneficial allele (say  $A$ ) increases in frequency, resulting in a sigmoid curve showing directional selection.

**Quick Tip**

Hardy-Weinberg equilibrium is maintained only in the absence of evolutionary forces. Natural selection is one of the major forces that causes deviation.

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**26. Samples of blood and urine of a sportsperson are collected before any sports event for drug tests.**

- (a) Why there is a need to conduct such tests?
- (b) Name the drugs the authorities usually look for.
- (c) Write the generic names of two plants from which these drugs are obtained.

**Solution:**

- (a) To ensure fair play and detect use of performance-enhancing drugs, which give an unfair advantage.
- (b) The drugs usually looked for include steroids, stimulants, and narcotics.
- (c) Two common plants:
  - Coca plant – source of cocaine (stimulant)

- Poppy plant – source of morphine (narcotic)

#### Quick Tip

Anti-doping tests protect the integrity of sports by preventing the misuse of plant-derived and synthetic performance-enhancing drugs.

- 
- 27. (a) The insulin synthesised in our body is different from that synthesised by Eli Lilly company using recombinant DNA technology. Differentiate between them.**  
**(b) Why the insulin extracted from an animal source is not in use these days?**

**Solution:**

(a) Natural human insulin is produced by beta cells of the pancreas.

Recombinant insulin (Humulin) by Eli Lilly is synthesized using genetically engineered bacteria (*E. coli*) containing human insulin genes.

(b) Animal-derived insulin caused allergic reactions due to slight structural differences. Recombinant insulin is identical to human insulin and safer.

#### Quick Tip

Recombinant DNA technology enables the production of human-compatible insulin, eliminating the risks associated with animal insulin.

- 
- 28. (a) Draw a graph for a population whose population density has reached the carrying capacity.**  
**(b) Out of the two population growth curves, which one is considered a more realistic for most populations? Why?**  
**(c) Draw a growth curve where resources are not limiting for the growth of a population and give its equation.**

**Solution:**

(a) **Logistic Growth Curve:** S-shaped graph. The population stabilizes at the carrying capacity  $K$ .

(b) Logistic growth curve is more realistic as it considers limiting resources and environmental resistance.

(c) **Exponential Growth Curve:** J-shaped. Resources are unlimited.

**Equation:**  $N_t = N_0e^{rt}$

where  $N_t$  = population at time  $t$ ,  $N_0$  = initial population,  $r$  = intrinsic growth rate.

#### Quick Tip

Exponential growth assumes ideal conditions, while logistic growth reflects natural resource limitations and carrying capacity.

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### SECTION D

**Question Nos.29 and 30 are case based questions.**

**29. Immunity in our body is of two types: (i) Innate immunity and (ii) acquired immunity. Innate immunity is a non-specific defence mechanism, whereas acquired immunity is pathogen-specific; it is called specific immunity too. Acquired immunity is characterised by memory. Antibodies are specific to antigens and there are different types of antibodies produced in our body: they are IgA, IgE, IgG and IgM. It shows primary response when it encounters the pathogen for the first time and secondary response during the subsequent encounters with the same Antigen/Pathogen.**

**(a) Name the two types of specialised cells which carry out the primary and secondary immune response.**

**(b) Why is the antibody-mediated immunity also called as humoral immune response?**

**Attempt either sub-part (c) or (d):**

**(c) The organ transplants are often rejected if not taken from suitable compatible persons.**

**(i) Mention the characteristic of our immune system that is responsible for the graft rejection.**

**(ii) Name the type of immune response and the cell involved in it.**

**OR**

**(d) How is active immunity different from passive immunity?**

**Solution:**

**Step 1:** For (a), the two types of specialized cells that carry out the primary and secondary immune responses are B-lymphocytes (B-cells), which produce antibodies, and T-lymphocytes (T-cells), which assist in coordinating the immune response and forming memory cells for faster secondary responses.

**Step 2:** For (b), antibody-mediated immunity is called humoral immunity because it involves antibodies produced by B-cells, which are dissolved in body fluids (historically called "humors") like blood and lymph, targeting extracellular pathogens.

**Sub-part (c):**

**Step 3:** For (c)(i), the characteristic of the immune system responsible for graft rejection is its ability to recognize foreign antigens, specifically the major histocompatibility complex (MHC) molecules on the donor organ, as non-self.

**Step 4:** For (c)(ii), the type of immune response is a cell-mediated immune response, and the cell involved is the cytotoxic T-cell (T-killer cell), which attacks the foreign graft cells.

**OR**

**Sub-part (d):**

**Step 5:** For (d), active immunity is developed by the body's own immune system through exposure to a pathogen or vaccine, producing memory cells for long-term protection, while passive immunity involves the transfer of pre-formed antibodies (e.g., via mother's milk or injections), providing immediate but temporary protection without memory cell formation. Thus, B- and T-cells drive immune responses, humoral immunity involves antibodies in body fluids, graft rejection is due to MHC recognition by cytotoxic T-cells, and active immunity differs from passive by involving self-generated, long-term immunity.

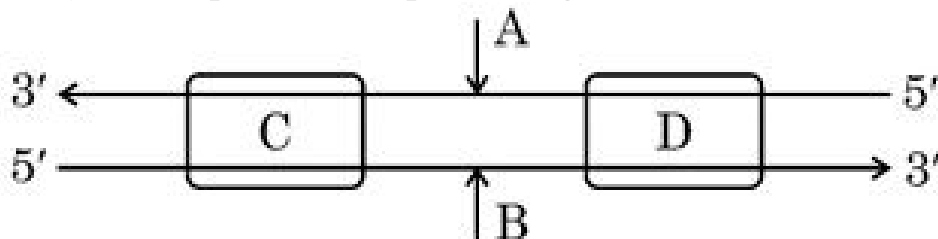
**Quick Tip**

Humoral immunity targets extracellular pathogens via antibodies, while cell-mediated immunity, involving T-cells, is crucial for rejecting grafts and fighting intracellular pathogens.

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**30. The process of copying the genetic information from one strand of DNA into RNA is termed as transcription. The principle of complementarity of bases governs the process of transcription, also except that uracil comes in place of thymine.**

**Study the complete transcription unit given below and answer the following questions:**



**(a) Name the main enzyme involved in the process of transcription.**

**(b) Identify coding strand and template strand of DNA in the transcription unit.**

**Attempt either sub-part (c) or (d):**

**(c) Identify (C) and (D) in the diagram, mention their significance in the process of transcription.**

**OR**

**(d) Describe the location of (C) and (D) in the transcription unit.**

**Solution:**

**Step 1:** For (a), the main enzyme involved in transcription is RNA polymerase, which synthesizes RNA by reading the DNA template strand and adding complementary RNA nucleotides.

**Step 2:** For (b), in the transcription unit, the strand with 5' to 3' direction (bottom strand, B) is the coding strand, as it has the same sequence as the RNA (except T is replaced by U). The strand with 3' to 5' direction (top strand, A) is the template strand, as RNA polymerase reads it to synthesize RNA in the 5' to 3' direction.

**Sub-part (c):**

**Step 3:** For (c), (C) is the promoter region, where RNA polymerase binds to initiate transcription, and (D) is the terminator region, where transcription stops, signaling RNA polymerase to release the RNA and DNA. Their significance lies in defining the start and end of the transcription process.

**Sub-part (d):**

**Step 4:** For (d), (C) is located at the 5' end of the coding strand (or start of the transcription unit), serving as the promoter, and (D) is at the 3' end of the coding strand (or end of the transcription unit), acting as the terminator.

Thus, RNA polymerase drives transcription, the bottom strand (B) is coding and the top strand (A) is the template, with (C) and (D) as promoter and terminator, located at the start and end of the transcription unit, respectively.

#### Quick Tip

In transcription, the promoter (C) and terminator (D) are critical regulatory regions that control where RNA polymerase starts and stops synthesizing RNA.

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### SECTION E

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

**(A)**

**(i) Draw a diagrammatic sectional view of human seminiferous tubule (enlarged) and label the following:**

- (a) Cell that undergoes spermiogenesis**
- (b) Cell that nourish male gametes**
- (c) Cell which undergoes meiosis I and meiosis II.**

**(ii) State what is seminal plasma. Mention two constituents of seminal plasma. How is it different from semen?**

**OR**

**(B)**

**(i) Mention the event that induces the completion of the meiotic division of the secondary oocyte in humans.**

**(ii) Trace the journey of the zygote until its implantation inside the uterus.**

**Solution:**

**Option (A):**

**Step 1:** The diagrammatic sectional view of a human seminiferous tubule should show:

- (a) Spermatids (undergoing spermiogenesis),
- (b) Sertoli cells (that nourish the male gametes), and
- (c) Primary and secondary spermatocytes (undergoing meiosis I and II).

**Step 2:** Seminal plasma is the fluid part of semen secreted by accessory glands (seminal vesicles, prostate gland, and bulbourethral glands).

Two constituents of seminal plasma are:

- (i) Fructose (provides energy to sperm), and
- (ii) Prostaglandins (aid in sperm motility and uterine contractions).

Semen is the combination of seminal plasma and spermatozoa (sperms), whereas seminal plasma refers only to the fluid portion.

**OR**

**Option (B):**

**Step 3:** The event that induces the completion of meiotic division of the secondary oocyte is the entry of the sperm into the ovum during fertilization. This triggers the secondary oocyte to complete meiosis II, forming the ovum and a second polar body.

**Step 4:** Journey of the zygote: After fertilization in the ampullary region of the fallopian tube, the zygote undergoes repeated mitotic divisions (cleavage) forming a blastomere. It moves through the fallopian tube and becomes a morula, then a blastocyst. The blastocyst reaches the uterus and implants itself in the endometrial lining of the uterine wall, typically around the 7th day post-fertilization.

#### Quick Tip

Sertoli cells support spermatogenesis, seminal plasma nourishes sperm, and the sperm's entry into the secondary oocyte is essential for completing meiosis II and initiating zygote development.

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

**(A)**

**(i) Explain how is a bacterial cell made 'competent' to take up recombinant DNA from the medium.**

**(ii) Explain the steps of amplification of gene of interest using PCR technique.**

**OR**

**(B)**

**(i) What are transgenic animals?**

**(ii) Why are these animals being produced? Explain any four reasons.**

**Solution:**

**Option (A):**

**Step 1:** To make a bacterial cell 'competent' to take up recombinant DNA, it is treated with a specific concentration of divalent cation such as calcium ions ( $\text{Ca}^{2+}$ ) which increases the permeability of the cell wall. The cells are then exposed to a brief heat shock (e.g.,  $42^\circ\text{C}$  for 30–90 seconds) to facilitate the uptake of recombinant DNA through the cell membrane.

**Step 2:** Amplification of a gene of interest using the PCR (Polymerase Chain Reaction) technique involves:

(i) **Denaturation:** The double-stranded DNA is heated to around  $94 - 96^\circ\text{C}$  to separate it into two single strands.

(ii) **Annealing:** The temperature is lowered to  $50 - 65^\circ\text{C}$  to allow primers to bind to the specific sequences on both strands.

(iii) **Extension:** DNA polymerase (usually Taq polymerase) adds nucleotides to the primers to synthesize new DNA strands at  $72^\circ\text{C}$ .

These steps are repeated for 20–35 cycles to exponentially amplify the target DNA segment.

**OR**

**Option (B):**

**Step 3:** Transgenic animals are those animals whose genome has been deliberately altered by the introduction of a foreign gene through genetic engineering techniques. This results in the expression of new or modified traits.

**Step 4:** Transgenic animals are produced for various purposes:

(i) **Normal physiology and development:** To study how genes regulate normal body functions.

(ii) **Disease models:** To develop models for studying human genetic diseases and testing therapies.

(iii) **Biological products:** To produce proteins or drugs like human insulin, antithrombin, etc., in milk.

(iv) **Vaccine safety testing:** Transgenic mice are used to test the safety of vaccines before human use.

#### Quick Tip

Calcium ions and heat shock help bacteria take up DNA. PCR enables rapid gene amplification. Transgenic animals are powerful tools for medicine, research, and biotechnology.

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

**(A)**

**(i) Explain giving three reasons why tropics show greatest levels of species diversity.**

**(ii) Draw a graph showing species-area relationship. Name the naturalist who studied such relationship. Write the observation made by him.**

**OR**

**(B)**

**(i) The world is facing the accelerated rate of species extinctions due to human activities. Explain any three major causes of biodiversity losses.**

**(ii) Describe 'Ex situ' approach for conserving biodiversity. Give any two examples.**

**Solution:**

**Option (A):**

**Step 1:** The tropics show the greatest levels of species diversity due to the following reasons:

(i) **Stable climate:** Tropical regions have a relatively stable and warm climate throughout the year, which promotes continuous biological activity and evolution.

(ii) **Long evolutionary time:** Tropics have remained undisturbed by glaciations, giving species more time to evolve and diversify.

(iii) **High productivity:** Solar energy availability is high, resulting in increased primary productivity, which supports a larger number of species.

**Step 2:** The graph below shows the species-area relationship:

```
[ axis lines = left, xlabel = Area (log scale), ylabel = Species richness (log scale), xmin=0,
xmax=5, ymin=0, ymax=5, xtick=, ytick=, domain=0:4.5, samples=100, smooth, ] [thick,
blue] 1.5*ln(x+1);
```

**Name of naturalist:** Alexander von Humboldt.

**Observation:** He observed that within a region, species richness increased with increasing area but only up to a certain limit, following a logarithmic pattern.

**OR**

**Option (B):**

**Step 3:** Three major causes of biodiversity losses due to human activities are:

(i) **Habitat loss and fragmentation:** Destruction of habitats due to deforestation, urbanization, and agriculture leads to decline or extinction of species.

(ii) **Over-exploitation:** Unsustainable use of natural resources such as overfishing and hunting leads to species depletion.

(iii) **Invasive species:** Introduction of alien species disrupts native ecosystems and outcompetes indigenous species.

**Step 4: Ex situ conservation** involves the protection of biodiversity components outside their natural habitats. It includes conservation of genetic material, species, or ecosystems in controlled environments.

Two examples of ex situ conservation are:

(i) Zoological parks (e.g., zoos)

(ii) Seed banks and botanical gardens

### Quick Tip

Tropics are biodiversity hotspots due to stable climate and long evolutionary time. Ex situ conservation preserves species away from their natural habitat, ensuring survival when in situ methods fail.

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