

## CBSE 12 Biology (57/5/2) Question Paper with Solutions

Time Allowed :3 hours

Maximum Marks :70

Total questions :33

### General Instructions

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 33 questions. All questions are compulsory.
2. The question paper is divided into **FIVE sections**: Section A, B, C, D, and E.
3. **Section A**: Questions 1 to 16 are multiple-choice type questions. Each question carries 1 mark.
4. **Section B**: Questions 17 to 21 are very short answer-type questions. Each question carries 2 marks.
5. **Section C**: Questions 22 to 28 are short answer-type questions. Each question carries 3 marks.
6. **Section D**: Questions 29 and 30 are case-based questions. Each question carries 4 marks and has subparts with internal choice in one of the subparts.
7. **Section E**: Questions 31 to 33 are long answer-type questions. Each question carries 5 marks.
8. There is no overall choice. However, **internal choice** has been provided in some questions in Section B, Section C, and Section D. A candidate has to attempt only one of the alternatives in such questions.
9. A separate question paper is available for **Visually Impaired candidates**.
10. Wherever necessary, neat and properly labeled diagrams should be drawn.

## SECTION – A

Question Nos. 1 to 16 are Multiple Choice type Questions, carrying 1 mark each.

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1. If the sequence of nitrogen bases of the coding strand in a transcription unit is 5' – ATGAATG – 3', the sequence of bases in its RNA transcript would be: (A) 5' – AUGAAUG – 3'
- (B) 5' – UACUUAC – 3'
- (C) 5' – CAUUCAU – 3'
- (D) 5' – GUAAGUA – 3'

**Correct Answer:** (A) 5' – AUGAAUG – 3'

**Solution:**

The RNA transcript is complementary to the template strand and identical to the coding strand (except that uracil (U) replaces thymine (T) in RNA). Therefore, the RNA transcript of the sequence 5' – ATGAATG – 3' is 5' – AUGAAUG – 3'.

**Quick Tip**

Remember: RNA is complementary to the template strand and identical to the coding strand, except that U replaces T.

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2. How many base pairs will be there in 20 nucleosomes in a DNA double helix?

- (A) 4000
- (B) 40
- (C) 20
- (D) 2000

**Correct Answer:** (A) 4000

**Solution:**

Each nucleosome consists of approximately 200 base pairs of DNA. Therefore, for 20 nucleosomes:

$$20 \times 200 = 4000 \text{ base pairs.}$$

### Quick Tip

- Each nucleosome = 200 base pairs of DNA. - Total base pairs = Number of nucleosomes  $\times$  200.

### 3. A person with trisomy of 21<sup>st</sup> chromosome shows:

- (i) Furrowed tongue
- (ii) Characteristic palm crease
- (iii) Rudimentary ovaries
- (iv) Gynaecomastia

Select the correct option, from the choices given below:

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

**Correct Answer:** (D) (i) and (ii)

#### **Solution:**

A person with trisomy of 21<sup>st</sup> chromosome will be afflicted with Down's syndrome. This condition is characterized by a small round head, furrowed tongue, partially open mouth, and characteristic palm crease.

### Quick Tip

For conditions like Down's syndrome, remember that trisomy 21 leads to physical and developmental traits such as furrowed tongue and palm crease.

### 4. Single-step large mutation leading to speciation is also called:

- (A) Founder effect
- (B) Saltation
- (C) Branching descent
- (D) Natural selection

**Correct Answer:** (B) Saltation

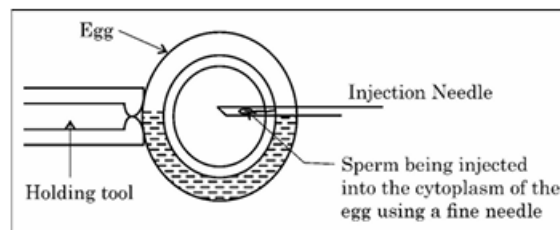
**Solution:**

Saltation refers to a single-step large mutation that leads to the sudden appearance of a new species or significant evolutionary change. It contrasts with gradual evolutionary changes and is proposed by the theory of "mutationism."

**Quick Tip**

- Saltation = Sudden evolutionary change due to a single-step large mutation.
- Contrasts with gradualism, which involves slow and continuous changes.

**5. Observe the schematic representation of assisted reproductive technology given below:**



Identify the most appropriate technique depicted in the above diagram.

- (A) IUT
- (B) IUI
- (C) ICSI
- (D) ZIFT

**Correct Answer:** (C) ICSI

**Solution:**

The diagram represents Intracytoplasmic Sperm Injection (ICSI), where a single sperm is directly injected into the cytoplasm of the egg using a fine needle. This technique is used in cases of severe male infertility or failed fertilization in conventional IVF.

**Quick Tip**

Remember: In ICSI, a single sperm is injected directly into the egg's cytoplasm using a fine needle.

6. Match the following genes of the lac operon listed in column 'A' with their respective products listed in column 'B':

A (Gene)	B (Products)
a. 'i' gene	(i) $\beta$ -galactosidase
b. 'z' gene	(ii) lac permease
c. 'a' gene	(iii) repressor
d. 'y' gene	(iv) transacetylase

Select the correct option:

(A) (i), (iii), (ii), (iv)

(B) (iii), (i), (iv), (ii)

(C) (iii), (i), (iv), (ii)

(D) (iii), (iv), (i), (ii)

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

**Solution:**

In the lac operon: - The 'i' gene codes for the repressor protein, which inhibits the operon when lactose is absent.

- The 'z' gene produces  $\beta$ -galactosidase, which breaks down lactose into glucose and galactose.

- The 'a' gene encodes transacetylase, which helps in lactose metabolism.

- The 'y' gene produces lac permease, which facilitates the entry of lactose into the cell.

#### Quick Tip

Remember the lac operon genes: - 'i' gene  $\rightarrow$  Repressor - 'z' gene  $\rightarrow$   $\beta$ -galactosidase - 'y' gene  $\rightarrow$  Lac permease - 'a' gene  $\rightarrow$  Transacetylase

7. Which one of the following enzymes a fungal cell should be treated with to get the DNA along with other macromolecules released from it?

(A) Lysozyme

(B) Cellulose

(C) Ribonuclease

(D) Chitinase

**Correct Answer:** (D) Chitinase

**Solution:**

Fungal cell walls contain chitin as a major component. Treating the cell with the enzyme chitinase breaks down the chitin, releasing the DNA and other macromolecules from the fungal cells.

**Quick Tip**

- Fungal cell walls contain chitin. Use chitinase to break it and extract DNA or macromolecules.

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

- (A) Primary sludge
- (B) Floccs
- (C) Activated sludge
- (D) Anaerobic sludge

**Correct Answer:** (B) Floccs

**Solution:**

Floccs are masses of bacteria held together by fungal filaments. These structures play a key role in the secondary treatment of sewage by helping in the breakdown of organic matter.

**Quick Tip**

- Floccs = Bacteria + fungal filaments, essential for sewage treatment.

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**9. Which one of the following is *not* a characteristic feature of “humus” that is formed during decomposition of detritus?**

- (A) Amorphous, colloidal, dark-coloured substance
- (B) Amorphous, colloidal, light-coloured substance
- (C) Substance resistant to microbial action

(D) Colloidal substance

**Correct Answer:** (B) Amorphous, colloidal, light-coloured substance

**Solution:**

Humus is an amorphous, colloidal, dark-coloured substance that forms during decomposition. It is resistant to microbial action and helps improve soil fertility.

Light-coloured substances are not a characteristic of humus.

#### Quick Tip

- Humus = Dark, colloidal, and resistant to microbial decomposition.
- Improves soil fertility by retaining water and nutrients.

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**10. Interferons are proteins secreted by:**

(A) RBC

(B) WBC

(C) Bacteria infected cell

(D) Virus infected cell

**Correct Answer:** (D) Virus infected cell

**Solution:**

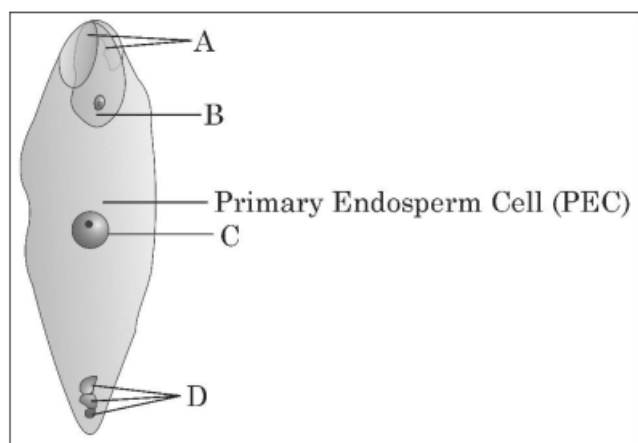
Interferons are signaling proteins that are secreted by virus-infected cells in response to viral infections. When a cell becomes infected by a virus, it releases interferons as a defense mechanism. These proteins help neighboring cells to prepare for possible viral infections by stimulating the production of antiviral proteins, thereby enhancing the immune response.

- **Option (A) RBC (Red Blood Cells):** Incorrect. RBCs do not secrete interferons. Their primary role is to transport oxygen. - **Option (B) WBC (White Blood Cells):** Incorrect. WBCs play a critical role in immunity, but they do not secrete interferons directly. - **Option (C) Bacteria infected cell:** Incorrect. Interferons are not secreted by bacteria-infected cells. They are specifically produced by virus-infected cells. - **Option (D) Virus infected cell:** Correct. Virus-infected cells release interferons to protect neighboring healthy cells from being infected.

### Quick Tip

Interferons are part of the body's innate immune response and are crucial for fighting viral infections.

**11. Identify the correct labellings in the figure of a fertilised embryo sac of an angiosperm given below:**



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

**Correct Answer:** (B) A – degenerating synergids, B – zygote, C – PEN, D – degenerating antipodals

### Solution:

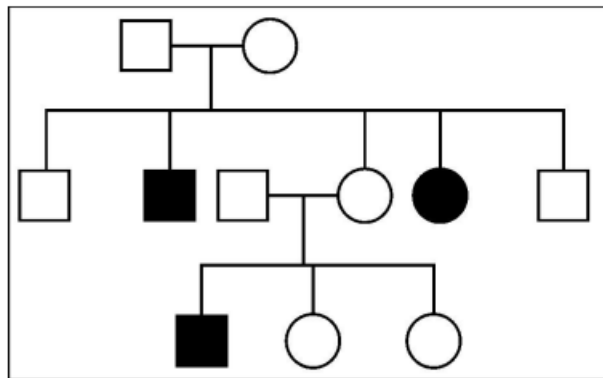
The correct labellings in the figure are:

- A represents degenerating synergids as they are no longer needed after fertilization.
- B is the zygote formed after the fusion of the male and female gametes.
- C is the primary endosperm nucleus (PEN) formed by the fusion of a sperm with two polar nuclei.
- D represents degenerating antipodals as their function is complete.

### Quick Tip

In a fertilised embryo sac: - Zygote forms at the center of the sac. - Degenerating synergids and antipodals are found at opposite poles. - PEN results from the fusion of a sperm with two polar nuclei.

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



- (A) Dominant X-linked
- (B) Recessive X-linked
- (C) Autosomal dominant
- (D) Autosomal recessive

**Correct Answer:** (D) Autosomal recessive

#### **Solution:**

The disorder depicted in the pedigree chart follows an autosomal recessive inheritance pattern. This can be inferred from the following observations:

1. The trait skips generations, which is typical for recessive traits.
2. Both males and females are equally affected, indicating an autosomal pattern.
3. The trait is expressed only when an individual inherits two copies of the recessive allele, one from each parent.

### Quick Tip

In pedigree analysis: - Recessive traits often skip generations. - Autosomal traits affect males and females equally. - X-linked traits show gender bias (males more affected in recessive traits, females more affected in dominant traits).

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

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

(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:**

The assertion (A) and reason (R) are both true, and the reason correctly explains the assertion. Let's break down why:

- **Assertion (A):** "Communities that comprise of more species tend to be more stable." This is true. In ecological studies, it has been observed that biodiversity (the variety of species in a community) contributes to the stability of the ecosystem. More species in a community can create a balance, with different species playing different roles (e.g., herbivores, predators, decomposers), which helps buffer the community against environmental changes and disturbances.

- **Reason (R):** "A higher number of species results in less year-to-year variation in total biomass." This is also true. The presence of multiple species helps stabilize the biomass in an ecosystem. If one species experiences a decline due to environmental factors, other species can compensate for the loss, ensuring that the overall biomass remains relatively constant. This buffering effect reduces year-to-year variation in biomass levels.

Thus, the reason (R) explains why communities with more species are more stable, as the diversity of species helps mitigate fluctuations in total biomass.

- **Option (A):** Correct. Both the assertion and reason are true, and the reason correctly

explains the assertion. - **Option (B):** Incorrect. Both (A) and (R) are true, but the reason does not correctly explain the assertion. - **Option (C):** Incorrect. The assertion is true, but the reason is not false. - **Option (D):** Incorrect. Both (A) and (R) are true.

#### Quick Tip

Biodiversity enhances ecosystem stability by allowing different species to perform complementary roles, which buffer the community against environmental changes.

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**14. Assertion (A):** The sugar-phosphate backbone of two chains in DNA double helix show anti-parallel polarity.

**Reason (R):** The phosphor-diester bonds in one strand go from a 3' carbon of one nucleotide to a 5' carbon of adjacent nucleotide, whereas those in complementary strand go vice versa.

(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:

- **Assertion (A):** "The sugar-phosphate backbone of two chains in DNA double helix show anti-parallel polarity." This is true. In the DNA double helix structure, the two strands run in opposite directions, meaning one strand runs from 5' to 3', while the other runs from 3' to 5'. This arrangement is referred to as "anti-parallel polarity." This orientation is critical for the proper pairing of nitrogenous bases in the two strands of DNA, and for the function of enzymes during processes such as DNA replication and transcription.

- **Reason (R):** "The phosphor-diester bonds in one strand go from a 3' carbon of one nucleotide to a 5' carbon of adjacent nucleotide, whereas those in complementary strand go vice versa." This is also true. In the sugar-phosphate backbone of DNA, the phosphodiester bond connects the 3' carbon of one nucleotide to the 5' carbon of the adjacent nucleotide. In one strand, this bond runs in the 5' to 3' direction, while in the complementary strand, the direction is reversed, with phosphodiester bonds running from 3' to 5'. This ensures the

anti-parallel orientation of the two DNA strands.

Therefore, the reason (R) explains the assertion (A) because it describes the directionality of the DNA strands and how their anti-parallel nature arises due to the 5' to 3' orientation of one strand and the 3' to 5' orientation of the other.

- **Option (A):** Correct. Both the assertion and reason are true, and the reason correctly explains the assertion. - **Option (B):** Incorrect. Both (A) and (R) are true, and the reason does explain the assertion. - **Option (C):** Incorrect. The assertion is true, but the reason is not false. - **Option (D):** Incorrect. Both (A) and (R) are true.

#### Quick Tip

The anti-parallel nature of DNA strands is essential for base pairing and replication. The orientation of the phosphodiester bonds plays a critical role in maintaining the integrity of DNA structure.

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

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

(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:**

- **Assertion (A):** "In molecular diagnosis, single-stranded DNA or RNA tagged with radioactive molecule is called a probe." This is true. In molecular biology and diagnostics, a probe is a single-stranded DNA or RNA molecule that is labeled with a radioactive or fluorescent tag. This allows it to be detected when it binds to its complementary sequence in a sample. Probes are essential for techniques such as Southern blotting, Northern blotting, and in situ hybridization.

- **Reason (R):** "A probe always searches and hybridises with its complementary DNA in a

clone of cells.” This is also true. Probes are designed to bind, or hybridize, with their complementary DNA or RNA sequences. When introduced into a sample, the probe will bind to its complementary sequence, which can be visualized if it is tagged with a detectable marker (like a radioactive or fluorescent tag). The hybridization process is fundamental in various molecular techniques for identifying specific sequences in a mixture or within a clone of cells.

Therefore, the reason (R) correctly explains the assertion (A) because the primary role of a probe is indeed to hybridize with its complementary sequence, facilitating molecular detection and analysis.

- **Option (A):** Correct. Both the assertion and reason are true, and the reason correctly explains the assertion. - **Option (B):** Incorrect. Both (A) and (R) are true, and the reason does explain the assertion. - **Option (C):** Incorrect. The assertion is true, and the reason is not false. - **Option (D):** Incorrect. Both (A) and (R) are true.

#### Quick Tip

Probes are vital tools in molecular diagnostics as they allow the detection of specific DNA or RNA sequences, crucial for gene mapping, disease diagnosis, and genetic research.

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

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

(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:**

- **Assertion (A):** "AIDS is a syndrome caused by HIV." This is **true**. AIDS (Acquired Immunodeficiency Syndrome) is indeed a syndrome caused by HIV (Human Immunodeficiency Virus). HIV attacks and weakens the body's immune system by targeting

CD4 cells (T cells), which are crucial for immune defense. As HIV progresses and the immune system becomes severely compromised, it leads to AIDS, which is characterized by the body's inability to fight off infections and certain cancers.

- **Reason (R):** "HIV is a virus that damages the immune system with DNA as its genetic material." This is **false**. HIV is a virus that damages the immune system, but its genetic material is **RNA**, not DNA. HIV belongs to the retrovirus family, and retroviruses are RNA viruses. When HIV infects a cell, it uses an enzyme called reverse transcriptase to convert its RNA into DNA, which then integrates into the host cell's genome. This process allows the virus to replicate and persist in the host. Thus, HIV has RNA as its genetic material, not DNA.

Because the assertion is true, but the reason is false, the correct answer is option (C).

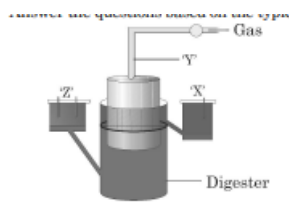
- **Option (A):** Incorrect. The assertion is true, but the reason is false. Therefore, the reason does not explain the assertion. - **Option (B):** Incorrect. While both the assertion and reason are true in isolation, the reason does not explain the assertion accurately. - **Option (C):** Correct. The assertion is true, but the reason is false because HIV carries RNA, not DNA. - **Option (D):** Incorrect. The assertion is true, and the reason is false, so this option is incorrect.

### Quick Tip

HIV is a retrovirus with RNA as its genetic material. It uses reverse transcription to convert its RNA into DNA after infecting a host cell. This is crucial for the replication of the virus.

## SECTION – B

17. Answer the questions based on the typical biogas plant diagram given below:



(a) Identify 'X', 'Y' and 'Z'.

(b) Why is dung preferred for the production of biogas?

**Solution:**

(a)

- **X:** Inlet for the slurry (dung mixed with water).
- **Y:** Gas outlet for biogas collection.
- **Z:** Outlet for residual slurry (used as manure).

(b) Dung is preferred for biogas production because:

- It contains methanogenic bacteria essential for biogas production.
- It is readily available and provides a continuous supply of organic material for fermentation.

#### Quick Tip

- Biogas plants use dung for its rich content of methanogenic bacteria.
- Byproducts of biogas plants (slurry) can be used as organic manure.

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**18. If the base adenine constitutes 31% of an isolated DNA fragment, then write what will be the expected percentage of the base cytosine in it. Explain how did you arrive at the answer given.**

**Solution:**

DNA follows Chargaff's rule, which states:

- Adenine (A) pairs with Thymine (T), and their percentages are equal.
- Cytosine (C) pairs with Guanine (G), and their percentages are equal.
- If  $A = 31\%$ , then  $T = 31\%$ . Thus,  $A + T = 62\%$ .
- The remaining percentage ( $100\% - 62\% = 38\%$ ) is shared equally between C and G. Therefore,  $C = 19\%$ .

### Quick Tip

- Chargaff's Rule:  $A = T$  and  $C = G$ . If one base percentage is known, you can calculate the others easily.

19. (a) "Farmers prefer apomictic seeds to hybrid seeds." Justify giving two reasons.

OR

(b) Mention one advantage and one disadvantage of amniocentesis.

**Solution (a):**

Farmers prefer apomictic seeds because:

- Apomictic seeds maintain hybrid vigor over generations without the need for repeated hybridization.
- These seeds save time and cost as they do not require manual intervention for propagation.

**Solution (b):**

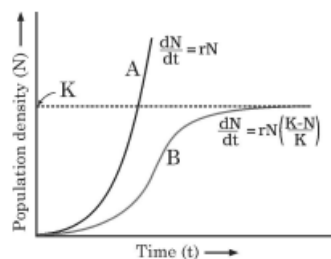
**Advantage:** Amniocentesis helps detect genetic disorders in the fetus, enabling early diagnosis.

**Disadvantage:** The procedure carries a small risk of miscarriage or complications.

### Quick Tip

- Apomictic seeds: Cost-effective and maintain hybrid vigor.
- Amniocentesis: Useful for early diagnosis but involves risks.

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



- (a) State the conditions under which growth curve 'A' and growth curve 'B' plotted in the graph are possible.
- (b) Mention what does 'K' in the graph represent.

**Solution:**

(a)

- Growth curve 'A' represents exponential growth, which occurs when resources are unlimited and environmental constraints are absent.
- Growth curve 'B' represents logistic growth, which occurs when resources are limited, leading to population stabilization at carrying capacity.

(b) 'K' in the graph represents the carrying capacity of the environment, which is the maximum population size that can be sustained indefinitely with available resources.

**Quick Tip**

- Exponential growth: Unlimited resources, no constraints.
- Logistic growth: Limited resources, stabilizes at carrying capacity (K).
- Carrying capacity (K): Maximum sustainable population size.

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**21. 5' – G↓AATTC – 3'**

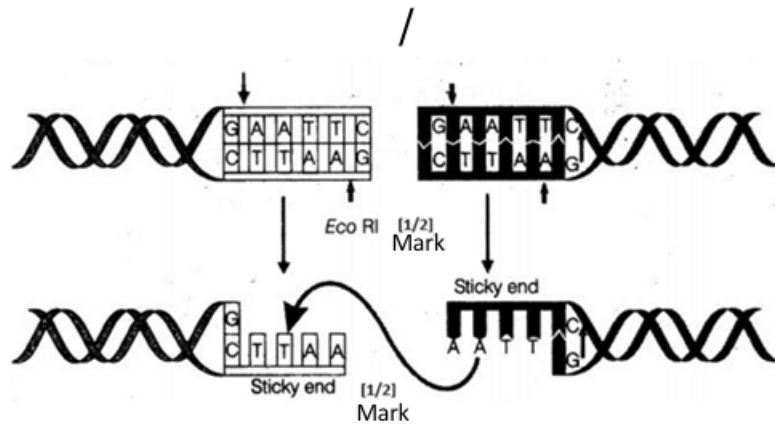
**3' – CTTAA↑G – 5'**

- (a) Name the restriction enzyme that recognizes the given specific sequence of bases. What are such sequences of bases referred to as?
- (b) What are the arrows in the given figure indicating? Write the result obtained thereafter.

**Solution (a):**

The restriction enzyme that recognizes the given sequence is EcoRI. Such sequences are referred to as palindromic sequences, which read the same forward and backward on complementary strands.

**Solution (b):**



The arrows indicate the sites where the restriction enzyme EcoRI cuts the DNA. The result obtained thereafter is the formation of sticky ends, which are single-stranded overhangs that facilitate the joining of DNA fragments during genetic engineering.

#### Quick Tip

Remember: - EcoRI recognizes the sequence 5' – GAATTC – 3'. - Palindromic sequences are the same on complementary strands when read in opposite directions. - Sticky ends are crucial for recombination in genetic engineering.

## SECTION – C

22. (a) How is the grazing food chain different from the detritus food chain?

(b) "The detritus food chain may be connected to the grazing food chain at some levels in an ecosystem." Give an example in support of the statement.

**Solution:**

(a) Differences between grazing food chain and detritus food chain:

- The grazing food chain begins with green plants (producers) and herbivores, while the detritus food chain starts with decomposed organic matter.
- Energy flow in the grazing food chain is based on photosynthesis, whereas in the detritus food chain it depends on detritus breakdown by decomposers.

(b) The detritus food chain is connected to the grazing food chain because decomposers and detritivores recycle nutrients into the soil, which are then absorbed by plants in the grazing food chain. Example: Earthworms (detritivores) break down organic matter, enriching the soil for plant growth.

#### Quick Tip

- Grazing food chain: Starts with producers.
- Detritus food chain: Starts with decomposers.
- Both chains are interconnected through nutrient cycling.

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

**Solution:**

(a) The number of chromosomes in:

- Zygote: 10 chromosomes (formed by fusion of haploid male and female gametes, each with 10 chromosomes).
- Endosperm: 30 chromosomes (formed by the fusion of two polar nuclei and one male gamete, each contributing 10 chromosomes).

(b) Process:

- Zygote Formation (Syngamy): A haploid male gamete fuses with a haploid female egg cell to form a diploid zygote.
- Endosperm Formation (Double Fertilization): One male gamete fuses with two polar nuclei in the embryo sac, forming a triploid (3n) endosperm.

#### Quick Tip

- Zygote: Diploid (2n), formed by syngamy.
- Endosperm: Triploid (3n), formed by double fertilization unique to angiosperms.

**24. (a) Why must a cell be made ‘competent’ in biotechnology experiments? How does calcium ion help in doing so?**

**(b) State the role of ‘biolistic gun’ in biotechnology experiments.**

**Solution:**

(a) A cell must be made ‘competent’ to allow the uptake of foreign DNA in biotechnology experiments. Calcium ions help by:

- Creating pores in the cell membrane.
- Neutralizing the negative charge on DNA and the cell membrane, facilitating DNA entry into the cell.

(b) The ‘biolistic gun’ or gene gun is used to introduce foreign DNA into cells by bombarding them with high-velocity microprojectiles coated with DNA. This method is especially useful for plant cells with rigid cell walls.

**Quick Tip**

- Competence: Calcium ions help cells take up foreign DNA.
- Biolistic gun: Delivers DNA into plant cells using microprojectiles.

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

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

**Solution:**

(a) DNA replication occurs within a replication fork because:

- DNA polymerase can synthesize new strands only in the 5’ to 3’ direction.
- Replication proceeds progressively as the DNA helix unwinds at the fork.

(b) DNA replication is:

- Continuous on the leading strand: Synthesized in the 5’ to 3’ direction towards the replication fork.

- Discontinuous on the lagging strand: Synthesized in fragments (Okazaki fragments) away from the replication fork, which are later joined by DNA ligase.

#### Quick Tip

- DNA replication: Leading strand = Continuous; Lagging strand = Okazaki fragments.
- DNA polymerase synthesizes only in the 5' to 3' direction.

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**26. Expression of different genes for different traits may show dominance, incomplete dominance, or co-dominance. Write about expression of such genes with the help of one example each.**

**Solution:**

(a) Dominance: A dominant allele masks the expression of the recessive allele.

Example: In pea plants, tall (T) is dominant over dwarf (t).

(b) Incomplete Dominance: The heterozygous phenotype is intermediate between the two homozygous phenotypes.

Example: In snapdragons, crossing a red flower (RR) with a white flower (rr) produces pink flowers (Rr).

(c) Co-dominance: Both alleles are expressed simultaneously in the heterozygote.

Example: In human blood groups, the AB blood type shows co-dominance, as both A and B alleles are expressed.

#### Quick Tip

- Dominance: One allele masks the other (e.g., Tall pea plants).
- Incomplete Dominance: Intermediate phenotype (e.g., Pink snapdragons).
- Co-dominance: Both alleles expressed (e.g., AB blood group).

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

**OR**

**(b) (i) What does an ecological pyramid represent?**

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

**Solution (a):**

Tropical regions harbour more species than temperate regions due to:

- **Stable Climate:** Tropical regions have a consistent climate, allowing year-round reproduction and growth.
- **Longer Evolutionary Time:** These regions have remained undisturbed for millions of years, promoting species diversification.
- **High Productivity:** High temperature and sunlight lead to greater plant growth, which supports more species.

**Solution (b):**

(i) An ecological pyramid represents the trophic structure and function of an ecosystem, illustrating the flow of energy, biomass, or number of organisms across different trophic levels.

(ii)

- **Upright Pyramid:** The energy pyramid is always upright as energy decreases with each trophic level. Example: Grassland ecosystem.
- **Inverted Pyramid:** The biomass pyramid in aquatic ecosystems is inverted as the biomass of phytoplankton (producers) is smaller than that of zooplankton (primary consumers).

#### Quick Tip

- Tropical regions: High species diversity due to stable climate, long evolutionary time, and high productivity.
- Ecological pyramids: Energy is always upright; biomass may be inverted in aquatic systems.

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**28. Identify a, b, c, d, e, and f in the table given below:**

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

**Solution:**

The completed table is as follows:

Sl. No.	Organism	Bioactive Molecule	Use
1	<i>Monascus purpureus</i>	Statins	Lowers blood cholesterol
2	<i>Streptomyces</i>	Streptomycin	Antibiotic
3	<i>Trichoderma polysporum</i>	Cyclosporin A	Immunosuppressant

**Quick Tip**

- *Monascus purpureus* produces statins that lower blood cholesterol.
- *Streptomyces* is a source of antibiotics like streptomycin.
- Cyclosporin A from *Trichoderma polysporum* is used as an immunosuppressant.

**SECTION – D**

**29. Read the following passage and answer the questions that follow:**

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

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

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

**OR**

**(b) Explain the events which occur within a female *Anopheles* mosquito after it has sucked blood from a malaria patient.**

**(c) Name a species of mosquito other than female *Anopheles* and the disease for which it carries the pathogen.**

**Solution:**

(a)

- (i) In humans, *Plasmodium* enters in the form of sporozoites, which are injected by the female *Anopheles* mosquito during a bite.
- (ii) In the female *Anopheles* body, *Plasmodium* enters in the form of gametocytes, which are taken up with the blood meal from an infected person.

(b) The symptoms of malaria do not appear immediately after the bite because the parasite undergoes an incubation period inside the human liver and blood cells. Symptoms appear 10–14 days later when the parasite multiplies and ruptures red blood cells, releasing toxins. This results in fever, chills, and sweating.

**OR**

In the female *Anopheles* mosquito, after sucking blood from an infected person:

- The gametocytes of *Plasmodium* develop into sporozoites in the mosquito's gut.
- The sporozoites migrate to the salivary glands of the mosquito, making it ready to infect another human during its next bite.

(c) A mosquito species other than *Anopheles* is *Aedes aegypti*, which carries the pathogen for dengue fever.

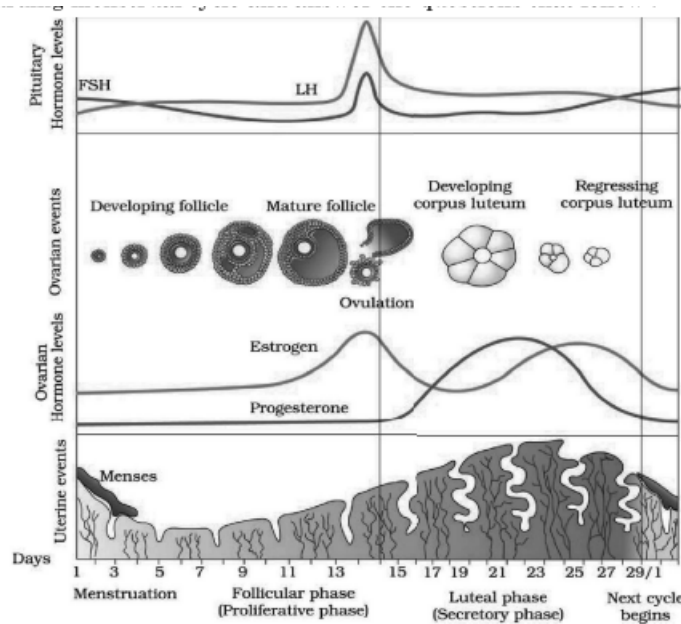
#### Quick Tip

- *Plasmodium* stages: Sporozoites enter humans; gametocytes enter mosquitoes.
- *Aedes aegypti*: Carries pathogens for dengue and chikungunya. - Malaria symptoms appear after the incubation period (10–14 days).

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**30. In a human female, the reproductive phase starts on the onset of puberty and ceases around the middle age of the female. Study the graph given below regarding the**

**menstrual cycle and answer the questions that follow:**



- (a) Name the hormones and their source organ, which are responsible for the menstrual cycle at puberty.
- (b) For successful pregnancy, at what phase of the menstrual cycle can an early embryo (up to 3 blastomeres) be implanted in the uterus (IUT) of a human female who has opted for Assisted Reproductive Technology (ART)? Support your answer with a reason.
- (c) Name the hormone and its source organ responsible for the events occurring during the proliferative phase of the menstrual cycle. Explain the event.

**OR**

- (c) In a normal human female, why does menstruation occur only if the released ovum is not fertilised? Explain.

**Solution:**

- (a) The hormones responsible for the menstrual cycle at puberty are:

- **FSH (Follicle Stimulating Hormone):** Secreted by the anterior pituitary gland, stimulates follicle development.
- **LH (Luteinizing Hormone):** Secreted by the anterior pituitary gland, triggers ovulation and corpus luteum formation.
- **Estrogen and Progesterone:** Secreted by the ovaries, regulate the uterine lining during the cycle.

(b) Implantation should occur during the secretory phase (days 15-28) of the menstrual cycle. During this phase, the uterine lining (endometrium) is thick and vascularized due to the action of progesterone, creating a suitable environment for embryo implantation.

(c) The hormone responsible for the proliferative phase is Estrogen, secreted by the developing ovarian follicles. It stimulates the regeneration and thickening of the uterine lining (endometrium) after menstruation.

**OR**

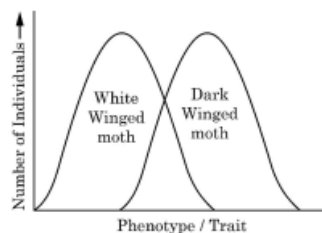
If the released ovum is not fertilized, the corpus luteum degenerates, leading to a drop in progesterone levels. This causes the uterine lining (endometrium) to break down and shed, resulting in menstruation.

#### Quick Tip

- Menstrual cycle phases: Menses, Proliferative, Secretory. - Implantation occurs in the secretory phase due to high progesterone levels. - Progesterone = Maintains endometrium; Estrogen = Builds endometrium.

## SECTION – E

31.



(a)

1. Natural selection operates in different ways in nature. Identify the type of natural selection depicted in the graph above.
2. In England after industrialisation, the population of dark-winged moths was more favoured than white-winged moths. Explain.

**3. Anthropogenic action can enhance the rate of evolution. Explain with the help of an example.**

**OR**

**(b)**

**1. Why did Hershey and Chase use  $^{35}\text{S}$  and  $^{32}\text{P}$  in their experiment? Explain.**

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

**3. Write the conclusion they arrived at the end of their experiment.**

**Solution (a):**

(i) The type of natural selection depicted is directional selection, as one extreme phenotype (dark-winged moth) is favoured over the other (white-winged moth).

(ii) After industrialisation, soot darkened tree trunks. Dark-winged moths were camouflaged and escaped predation, while white-winged moths were easily spotted by predators. This is an example of natural selection.

(iii) Anthropogenic actions like pesticide usage or antibiotic resistance drive evolution.

Example: Overuse of antibiotics has led to the evolution of drug-resistant bacteria.

**Solution (b):**

(i) Hershey and Chase used  $^{35}\text{S}$  to label protein and  $^{32}\text{P}$  to label DNA to distinguish which molecule entered bacterial cells during viral infection.

(ii)

- Blending: Removed phage particles attached to the bacterial surface.
- Centrifugation: Separated heavier infected bacterial cells from lighter viral components.

(iii) The conclusion was that DNA is the genetic material, as only  $^{32}\text{P}$  (DNA) was found inside the bacterial cells.

#### Quick Tip

- Natural selection: Directional selection favours one phenotype.
- Industrial melanism: Dark-winged moths camouflaged better on soot-covered trees.
- Hershey-Chase: DNA, not protein, is the genetic material.

32. (a) (i) Describe the events of spermatogenesis with the help of a schematic diagram.  
(ii) Explain the role of hormones in spermatogenesis.

OR

(b) (i) Show the development of megaspore mother cell up to the formation of mature embryo sac in flowering plants with the help of labelled diagrams only.

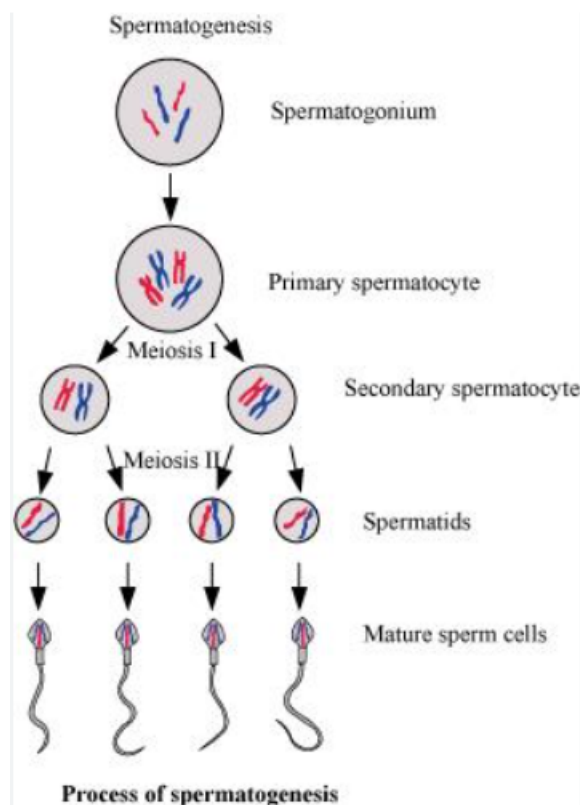
(ii) How does geitonogamy differ from xenogamy?

(iii) Name the type of flowers that are invariably autogamous.

**Solution (a):**

(i) **Events of Spermatogenesis:**

- **Multiplication Phase:** Spermatogonia (diploid cells) divide mitotically to form primary spermatocytes.
- **Growth Phase:** Primary spermatocytes grow in size.
- **Maturation Phase:** Primary spermatocytes undergo meiosis I to form secondary spermatocytes (haploid), which further undergo meiosis II to form spermatids.
- **Differentiation Phase:** Spermatids differentiate into mature spermatozoa (sperms).

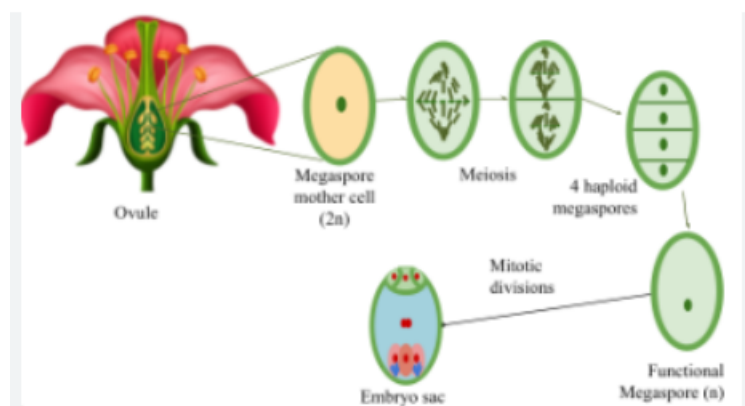


(ii) **Role of Hormones in Spermatogenesis:**

- **FSH (Follicle-Stimulating Hormone):** Stimulates spermatogonia to undergo mitosis and supports Sertoli cells.
- **LH (Luteinizing Hormone):** Stimulates Leydig cells to secrete testosterone.
- **Testosterone:** Regulates spermatogenesis and promotes the differentiation of spermatids into spermatozoa.

**Solution (b):**

(i) **Development of Megaspore Mother Cell:**



(ii) **Difference Between Geitonogamy and Xenogamy:**

- **Geitonogamy:** Transfer of pollen grains from the anther of one flower to the stigma of another flower on the same plant.
- **Xenogamy:** Transfer of pollen grains from the anther of one flower to the stigma of a flower on a different plant.

(iii) Flowers that are invariably autogamous are **cleistogamous flowers**.

**Quick Tip**

- Spermatogenesis: FSH, LH, and testosterone regulate the process.
- Embryo sac formation: Involves megasporogenesis and megagametogenesis.
- Cleistogamous flowers: Always self-pollinate due to closed structure.

33. (a)

1. Draw a schematic diagram of the cloning vector pBR 322 and label (1) Bam HI site (2) gene for ampicillin resistance (3) 'ori' (4) 'rop' gene.
2. State the role of 'rop' gene.
3. A cloning vector does not have a selectable marker. How will it affect the process of cloning?
4. Why is insertional inactivation preferred over the use of selectable markers in cloning vectors?

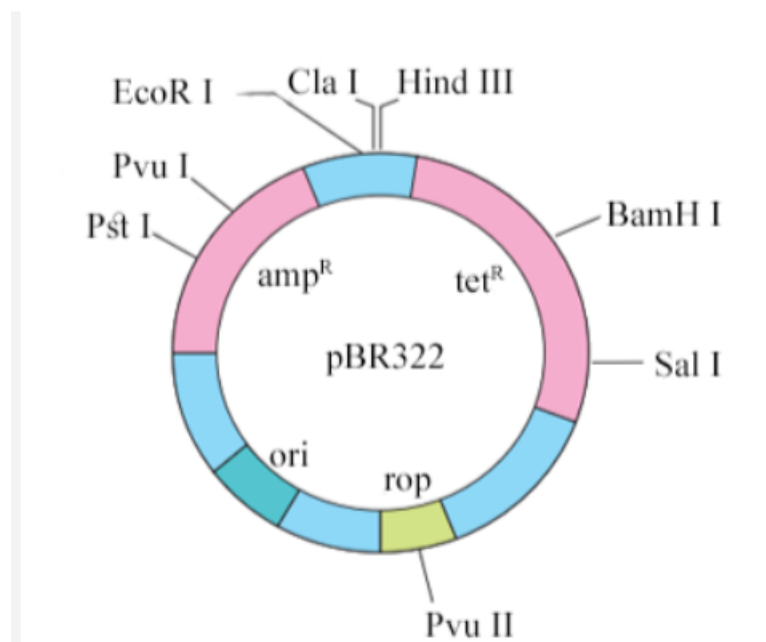
OR

(b)

1. Name the nematode (scientific name) that infects the roots of tobacco plant and reduces its yield.
2. Name the vector that is used to introduce nematode-specific genes into the host plant (tobacco).
3. How do sense and anti-sense RNAs function?
4. Why could the parasite not survive in a transgenic tobacco plant?

Solution (a):

(i) A schematic diagram of the cloning vector pBR 322 is shown below:



- (ii) The 'rop' gene in pBR 322 encodes proteins involved in maintaining the copy number of the plasmid.
- (iii) If a cloning vector does not have a selectable marker, it would be difficult to differentiate between transformed and non-transformed cells, complicating the identification of successful clones.
- (iv) Insertional inactivation is preferred because it allows direct identification of recombinant colonies. It inactivates a selectable marker gene (e.g., antibiotic resistance), so only recombinant cells are easily identified.

**Solution (b):**

- (i) The nematode that infects the roots of tobacco plants is *Meloidogyne incognita*.
- (ii) The vector used to introduce nematode-specific genes into the host plant is *Agrobacterium tumefaciens*.
- (iii) Sense and anti-sense RNAs are complementary RNA strands. When expressed together, they form a double-stranded RNA that silences the target nematode gene through RNA interference (RNAi).
- (iv) The parasite could not survive in the transgenic tobacco plant because the RNAi mechanism silences the nematode-specific genes, preventing its growth and reproduction.

**Quick Tip**

- Cloning vectors: pBR 322 has ori (replication origin), selectable markers, and restriction sites.
- RNAi: Silences specific genes by degrading their mRNA using double-stranded RNA.
- *Agrobacterium tumefaciens* is commonly used for plant genetic transformation.