# CBSE 12 Biology (57/1/1) 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. In which of the following plants are both male and female flowers born on the same plant, and the mode of pollination can be geitonogamy or xenogamy?**

(A) Papaya

(B) Date Palm

(C) Maize

(D) Spinach

**Correct Answer:** (C) Maize

**Solution:** Plants in which both male and female flowers are borne on the same plant are called monoecious plants. Maize is a monoecious plant. - Geitonogamy occurs when pollen grains are transferred between flowers on the same plant. - Xenogamy occurs when pollen is transferred between flowers of different plants. Maize shows both these modes of pollination.

Quick Tip

Remember: - Papaya and Date Palm are dioecious (separate male and female plants). - Monoecious plants like maize have male and female flowers on the same plant, allowing both geitonogamy and xenogamy.

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**2. Which one of the following hormones is secreted by the human placenta that helps in the maintenance of pregnancy?**

(A) Relaxin

(B) Human Chorionic Gonadotropin

(C) Oxytocin

(D) Human Placental Lactogen

**Correct Answer:** (B) Human Chorionic Gonadotropin

**Solution:** - Human Chorionic Gonadotropin (hCG) is a hormone secreted by the placenta. It supports pregnancy by maintaining the corpus luteum and the production of progesterone during early pregnancy. - Relaxin is produced in the later stages of pregnancy to relax the

pelvic muscles. - Oxytocin is responsible for uterine contractions during labor. - Human Placental Lactogen supports fetal growth and metabolism but does not directly maintain pregnancy.

Quick Tip

Focus on the main hormones and their functions: - hCG: Maintains pregnancy. - Oxytocin: Stimulates labor. - Relaxin: Prepares for delivery. - Placental Lactogen: Aids in metabolism and fetal development.

**3. The periodic abstinence by a couple for family planning should be from:**

(A) Day 5 to 10 of menstrual cycle

(B) Day 13 to 15 of menstrual cycle

(C) Day 10 to 17 of menstrual cycle

(D) Day 16 to 20 of menstrual cycle

**Correct Answer:** (C) Day 10 to 17 of menstrual cycle

**Solution:** - Periodic abstinence involves avoiding sexual intercourse during the fertile period of the menstrual cycle to prevent pregnancy. - The fertile period typically falls around ovulation, which occurs approximately on Day 14 in a 28-day cycle. - To account for variations in ovulation, abstinence is advised from Day 10 to 17 when the chances of fertilization are highest.

Quick Tip

Key concept: - Ovulation occurs around Day 14. - Fertile window = Day 10 to 17 in a 28-day cycle. - Abstinence outside this period has a lower chance of preventing pregnancy.

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**4. Select the *incorrect* match from the following:**

| **Human Karyotype** | **Characters** |
|---|---|
| (A) 45 + XX | Broad palm with characteristic palm crease |
| (B) 44 + XXY | Overall feminine development |
| (C) 44 + XO | Sterile females as ovaries are rudimentary |

(D) 44 + XY Normal male

**Correct Answer:** (B) 44 + XXY

**Solution:** - (A) 45 + XX: Refers to Down Syndrome, characterized by physical features like broad palms and creased palms.

- (B) 44 + XXY: Incorrect. This karyotype corresponds to Klinefelter Syndrome, where males exhibit partial masculine development, not feminine development.

- (C) 44 + XO: Refers to Turner Syndrome, where females are sterile due to rudimentary ovaries.

- (D) 44 + XY: Refers to normal males.

**Quick Tip**

Karyotype tips: - 44 + XO: Turner Syndrome (Sterile females). - 44 + XXY: Klinefelter Syndrome (Affects males, partial masculine development). - 45 + XX/XY: Down Syndrome.

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**5. You know that there are twenty different types of naturally occurring amino acids and four different types of bases in the DNA. A combination of 3 such bases codes for a specific amino acid. If instead there are 96 different amino acids and 12 different bases in the DNA, then the minimum number of combination of bases required to form a codon is:**

(A) 6

(B) 3

(C) 2

(D) 4

**Correct Answer:** (C) 2

**Solution:**

To determine the minimum number of base combinations required to code for 96 different amino acids, we can use the formula for the number of possible combinations:

$$\text{Number of combinations} = (\text{Number of bases})^{\text{Number of bases per codon}}$$

For the given case:

- We know that there are 12 different types of bases in the DNA. - We need to determine how many bases per codon are required to create at least 96 different amino acids.

Let $n$ be the number of bases required per codon. The number of possible codons will be $12^n$, and we want this to be at least 96.

$$12^n \geq 96$$

Now we calculate the powers of 12:

- $12^1 = 12$ - $12^2 = 144$

Thus, $12^2 = 144$ is greater than 96, so the minimum number of bases per codon required is 2.

Therefore, the correct answer is $\boxed{2}$.

- **Option (A):** Incorrect. $12^6$ would give a much larger number than needed.

- **Option (B):** Incorrect. $12^3$ would give more than 96 codons, and 3 bases per codon is not necessary.

- **Option (C):** Correct. The minimum number of bases required is 2, since $12^2 = 144$, which is greater than 96.

- **Option (D):** Incorrect. 4 bases per codon would generate more than enough combinations, but it is not the minimum required.

**Quick Tip**

In general, to find the minimum number of bases per codon needed to code for a certain number of different amino acids, use the formula Number of combinations $=$ $(\text{Number of bases})^{\text{Number of bases per codon}}$ and solve for $n$.

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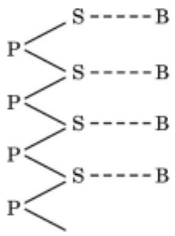
**6. The type of bond represented by the dotted line '——' in a schematic polynucleotide chain is:**



(A) Hydrogen bond

(B) Peptide bond

(C) N-glycosidic linkage

(D) Phosphodiester bond

**Correct Answer:** (C) N-glycosidic linkage

**Solution:** - In a polynucleotide chain, the dotted line ('——') represents the bond between the nitrogenous base (B) and the sugar (S).

- This bond is known as an N-glycosidic linkage. It connects the 1' carbon of the pentose sugar to the nitrogen atom of the nitrogenous base.

- Other bonds in the polynucleotide structure:

- Phosphodiester bond: Links the sugar molecules of adjacent nucleotides. - Hydrogen bond: Occurs between complementary nitrogenous bases in double-stranded DNA.

- Peptide bond: Found in proteins, not in polynucleotides.

Quick Tip

Identify bonds in biomolecules: - N-glycosidic linkage: Between sugar and base in nucleotides. - Phosphodiester bond: Backbone of DNA/RNA. - Hydrogen bond: Holds DNA strands together. - Peptide bond: Found in proteins.

**7. In which of the following conditions/diseases is there a substantial increase in the activity of mast cells observed in the human body?**

(A) Typhoid

(B) Allergy

(C) Ascariasis

(D) AIDS

**Correct Answer:** (B) Allergy

**Solution:** - Mast cells play a key role in allergic reactions. They release histamine and other chemicals during allergic responses, leading to symptoms like itching, swelling, and redness.

- Diseases like typhoid, ascariasis, or AIDS are not related to mast cell activation.

Quick Tip

Remember: - Mast cells = Key players in allergic responses. - Histamine release leads to allergy symptoms like sneezing, rash, and swelling.

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**8. Lactobacillus that sets milk into curd is categorised as:**

(A) Cyanobacteria

(B) Archaebacteria

(C) Chemosynthetic bacteria

(D) Heterotrophic bacteria

**Correct Answer:** (D) Heterotrophic bacteria

**Solution:** - Lactobacillus is a heterotrophic bacterium as it relies on organic substances (milk) for energy. - It converts lactose in milk to lactic acid, setting the milk into curd.

Quick Tip

Bacteria classification: - Heterotrophic bacteria: Depend on organic matter. - Cyanobacteria: Photosynthetic. - Archaebacteria: Survive extreme environments.

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**9. Which one of the following transgenic animals is being used to test the safety of the polio vaccine?**

(A) Sheep

(B) Goat

(C) Pig

(D) Mice

**Correct Answer:** (D) Mice

**Solution:** - Transgenic mice are genetically modified to express human genes. They are widely used for testing the safety and efficacy of vaccines, including the polio vaccine.

Quick Tip

- Transgenic mice = Common in vaccine research due to their genetic similarity and ease of modification.

**10. Restriction Endonuclease – Hind II always cuts DNA molecules at a particular point by recognising a specific sequence of:**

(A) Six base pairs

(B) Four base pairs

(C) Seven base pairs

(D) Three base pairs

**Correct Answer:** (A) Six base pairs

**Solution:** - Hind II recognises specific palindromic sequences in DNA consisting of 6 base pairs and cleaves precisely at this point.

Quick Tip

Restriction enzymes: - Recognise specific palindromic sequences in DNA. - Hind II = Recognises 6 base pairs.

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**11. The improved trait found in the genetically modified transgenic crop – Golden rice is:**

(A) High lysine content

(B) Insect resistant

(C) High protein content

(D) High vitamin-A content

**Correct Answer:** (D) High vitamin-A content

**Solution:** - Golden rice is genetically modified to biosynthesize beta-carotene, a precursor of vitamin A, in the endosperm, addressing vitamin A deficiency.

Quick Tip

Remember: - Golden rice = Enriched with Vitamin A. - Solves vitamin A deficiency-related health issues.

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**12. The rate of formation of new organic matter by consumers, and the biomass**

**available for consumption of herbivores as well as decomposers, are referred to as:**

(A) Gross primary productivity and Net primary productivity

(B) Net primary productivity and Secondary productivity

(C) Secondary productivity and Gross primary productivity

(D) Secondary productivity and Primary productivity

**Correct Answer:** (C) Secondary productivity and Gross primary productivity

**Solution:** - Gross primary productivity (GPP): Total energy captured by autotrophs. - Secondary productivity: Biomass formed by consumers from the organic matter consumed.

Quick Tip

Productivity breakdown: - GPP: Energy captured by producers. - NPP: GPP – Energy used for respiration. - Secondary productivity: Biomass by consumers.

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**13. Assertion (A):** The laws of our country permit legal adoption, and it is as yet, one of the best methods for childless couples looking for parenthood.

**Reason (R):** Emotional, religious, and social factors are no deterrents to the legal adoption of orphaned and destitute children in India.

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

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

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

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

**Correct Answer:** (C) Assertion (A) is true, but Reason (R) is false.

**Solution:** - The laws of India permit legal adoption, making it one of the best options for childless couples. - However, emotional, religious, and social factors often act as deterrents to the adoption of children, especially in conservative settings.

Quick Tip

When solving assertion-reason questions: - Check the truth of each statement individually. - Ensure that the reason explains the assertion directly if both are true.

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**14. Assertion (A):** Linked genes do not show dihybrid $F_2$ ratio 9 : 3 : 3 : 1.

**Reason (R):** Linked genes do not undergo independent assortment.

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

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

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

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

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

**Solution:** - Linked genes are inherited together because they are located on the same chromosome. - They do not follow Mendel's law of independent assortment, which is why the dihybrid $F_2$ ratio 9:3:3:1 is not observed.

Quick Tip

Linked genes: - Found on the same chromosome. - Do not assort independently; hence, they deviate from Mendelian ratios.

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**15. Assertion (A):** Agrobacterium tumefaciens is a pathogen of several monocot plants.

**Reason (R):** It is able to deliver a piece of DNA known as 'T-DNA' to transform normal plant cells into a tumor.

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

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

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

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

**Correct Answer:** (D) Assertion (A) is false, but Reason (R) is true.

**Solution:** - Agrobacterium tumefaciens is primarily a pathogen of dicot plants, not monocots. - However, it does deliver T-DNA into the host plant genome, causing the formation of crown gall tumors.

Quick Tip

Remember: - Agrobacterium tumefaciens infects dicots. - T-DNA transfer is crucial in genetic engineering for plant transformation.

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**16. Assertion (A):** Indian Government has set up an organisation known as GEAC to decide the validity of GM research.

**Reason (R):** Genetic modification of organisms has no effect when such organisms are introduced into the ecosystem.

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

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

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

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

**Correct Answer:** (C) Assertion (A) is true, but Reason (R) is false.

**Solution:** - The Genetic Engineering Appraisal Committee (GEAC) evaluates and monitors genetically modified organisms (GMOs) for research and release. - However, genetic modification can significantly affect ecosystems when GMOs are introduced due to possible crossbreeding or ecological imbalance.

Quick Tip

GEAC: - A regulatory body for GM research in India. - GM organisms can impact ecosystems and must be monitored carefully.

## SECTION – B

**17. Identify A, B, C, and D in the table given below:**

| Terms | Part of the plant it represents |
|---|---|
| Pericarp | $A$ |
| $B$ | Cotyledon in seed of grass family |
| Embryonal axis | $C$ |
| $D$ | Remains of nucellus in a seed |

**Correct Answer:**

$A$: Fruit wall

$B$: Scutellum

$C$: Plumule and radicle

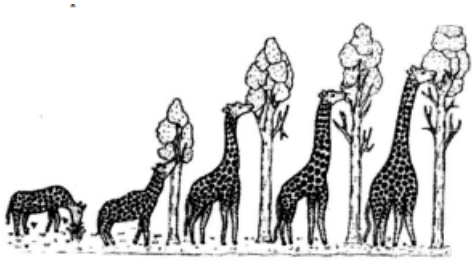
$D$: Perisperm

**Solution:** - Pericarp (A): The fruit wall derived from the ovary wall. - Scutellum (B): A specialized cotyledon found in monocot seeds (grasses). - Embryonal axis (C): Includes the plumule (shoot) and radicle (root). - Remains of nucellus (D): Called the perisperm in mature seeds.

**Quick Tip**

Learn seed structure for both monocots and dicots: - Scutellum = Cotyledon in grasses. - Perisperm = Persistent nucellus.

**18. Observe the picture given below. Name the naturalist and write the explanation given by him that evolution of life forms had occurred on the basis of this example.**



**Correct Answer:**

Naturalist: Jean-Baptiste Lamarck

**Solution:** - Lamarck explained evolution through the theory of Use and Disuse and Inheritance of Acquired Characteristics. - In the image, he suggested that giraffes evolved long necks by stretching to reach tall trees for food. This acquired trait was passed on

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**19. Write the basic steps followed in the Assisted Reproductive Technologies (ART) programme to help childless couples. Why is it also known as test tube baby programme?**

**Solution:** - Basic Steps in ART Programme: 1. Retrieval of eggs from the female and collection of sperm from the male.

2. Fertilization of the egg and sperm outside the body in a laboratory dish (in vitro fertilization).

3. Development of the fertilized egg (embryo) in a controlled environment.

4. Transfer of the embryo into the uterus for implantation and pregnancy.

- Reason for Test Tube Baby Programme: The term “test tube baby” refers to the process of fertilization occurring outside the human body, typically in a laboratory setup, rather than a test tube.

Quick Tip

Remember: - IVF is the main technique in ART. - External fertilization in a lab is why it is called a ”test tube baby” programme.

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**20. (a) A farmer while working on his farm was bitten by a poisonous snake. He was rushed to a nearby health centre where the doctor gave him an injection to save his life.**

**(i)** What did the doctor inject and why?

**(ii)** Name the kind of immunity provided by this injection.

**Solution:**

(i) The doctor injected anti-venom serum. This contains pre-formed antibodies that neutralize the snake venom, providing immediate relief and preventing further damage.

(ii) The immunity provided by this injection is passive immunity, as the antibodies are directly administered rather than being produced by the body.

Quick Tip

Immunity types: - Passive immunity: Pre-formed antibodies, e.g., anti-venom. - Active immunity: Antibodies produced by the body after exposure to antigens.

**20. (b) Why do organic farmers not recommend complete eradication of insect pests? Explain giving reason.**

**Solution:** - Organic farmers discourage complete eradication of insect pests because: 1. Ecological Balance: Insects play a role in the food chain and biodiversity. Their complete eradication can disrupt the balance.

2. Natural Pest Control: Some pests attract their predators, which naturally control pest populations, reducing the need for chemical interventions.

Quick Tip

Organic farming practices: - Aim for pest management, not eradication. - Preserve ecological balance and avoid disrupting natural predators.

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**21. Study the diagram of a pyramid of biomass given below. Name the two standing crops that could be occupying level 'A' and level 'B' in it. Name this type of pyramid and the ecosystem in which it is found.**

| Level | Description |
|---|---|
| A | PC (Primary Consumer) |
| B | PP (Primary Producer) |

**Solution:** - Level A: Zooplankton (Primary Consumers).

- Level B: Phytoplankton (Primary Producers).

- Type of Pyramid: Inverted Pyramid of Biomass.

- Ecosystem: Found in an aquatic ecosystem.

- In such ecosystems, the biomass of primary producers (phytoplankton) is lower than that of primary consumers (zooplankton) at any given time. This is because phytoplankton

reproduce rapidly and are consumed quickly by zooplankton.

Quick Tip

Pyramids of biomass: - Inverted Pyramid: Common in aquatic ecosystems. - Producers (phytoplankton) have less biomass than consumers due to fast turnover rates.

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## SECTION – C

**22. Explain the mode of action of contraceptive pills taken by human females. Mention the schedule to be followed for an effective outcome.**

**Solution:** - Mode of Action: 1. Contraceptive pills contain synthetic hormones (estrogen and progesterone) that prevent ovulation by inhibiting the secretion of FSH and LH from the pituitary gland. 2. They thicken cervical mucus, making it difficult for sperm to enter the uterus. 3. They alter the endometrial lining, preventing implantation of a fertilized egg. - Schedule for Effective Outcome: - Pills should be taken daily for 21 days starting from the 5th day of the menstrual cycle, followed by a 7-day gap during which withdrawal bleeding occurs.

Quick Tip

Key to effectiveness: - Start pills on the 5th day of the cycle. - Maintain daily intake for 21 days without missing a dose.

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**23. (a) Name and write two characteristics of the type of DNA that forms the basis of DNA fingerprinting technique.**

**Solution:** - Type of DNA: Short Tandem Repeats (STRs) or Variable Number Tandem Repeats (VNTRs). - Characteristics: 1. They are non-coding, repetitive sequences of DNA. 2. They show high polymorphism, making them unique to each individual (except identical twins).

Quick Tip

Focus on VNTRs: - Found in non-coding regions. - Highly variable among individuals, forming the basis for unique identification.

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**23. (b) Mention any two applications of this technique.**

**Solution:** 1. Forensic Science: Used for identification in criminal investigations. 2. Paternity Testing: Determines biological relationships.

Quick Tip

DNA fingerprinting: - Solve crimes (forensics). - Establish paternity or ancestry.

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**24. (a) Explain the significance of the experiment carried out by S.L. Miller. Name the scientists whose hypothesis prompted him to carry out this experiment.**

**Solution:** - Significance of Miller's Experiment: - Demonstrated that organic molecules like amino acids could be synthesized abiotically under conditions resembling early Earth's atmosphere.

- Supported the theory that life originated from simple organic compounds. - Scientists: The experiment was based on the hypothesis of Alexander Oparin and J.B.S. Haldane.

Quick Tip

Remember: - Miller simulated early Earth conditions. - Key outcome: Abiotic synthesis of amino acids.

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**24. (b) How does meteorite analysis favour this hypothesis?**

**Solution:** - Meteorite analysis revealed the presence of simple organic compounds, such as amino acids, on extraterrestrial objects. This suggests that organic molecules can form naturally, supporting the idea of abiotic synthesis.

Quick Tip

Meteorite evidence: - Presence of amino acids supports the theory of abiotic synthesis and the origin of life from organic molecules.

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**25. Identify A, B, C, D, E, and F in the table given below:**

| *Name of Human Disease* | *Causative Organism* | *Symptoms* |
|---|---|---|
| Pneumonia | *Streptococcus* | 'A' |
| Typhoid | 'B' | High fever, weakness, headache, stomach pain |
| Common Cold | Rhino virus | 'C' |
| Ringworm | 'D' | Dry scaly lesions on body parts, redness, itching |
| Ascariasis | *Ascaris* | 'E' |
| 'F' | *Entamoeba histolytica* | Constipation, cramps, stools with mucous and blood clots |

**Correct Answer:**

$A$: Breathing difficulty, cough, and chest pain

$B$: *Salmonella typhi*

$C$: Nasal congestion, sore throat, cough

$D$: *Trichophyton*

$E$: Internal bleeding, muscular pain, anemia

$F$: Amoebiasis

**Solution:** - Pneumonia symptoms: $A$ include breathing difficulty, cough, and chest pain. - Typhoid causative organism: $B$ is *Salmonella typhi*. - Common cold symptoms: $C$ include nasal congestion, sore throat, and cough. - Ringworm causative organism: $D$ is *Trichophyton*. - Ascariasis symptoms: $E$ include internal bleeding, muscular pain, and anemia. - $F$: Disease caused by *Entamoeba histolytica* is Amoebiasis.

Quick Tip

For disease tables: - Learn causative agents and symptoms. - Focus on common examples like typhoid, pneumonia, and ringworm.

**26. In a family, the father, the daughter, and the son are colour blind, whereas the mother has normal vision. Do you think the son and daughter have inherited the disease from their father? Work out a cross to justify your answer.**

**Solution:** - Colour blindness is an X-linked recessive disorder. Males inherit the X chromosome from their mother, while females inherit one X chromosome from each parent. - The daughter inherits the $X^c$ chromosome from her father and $X^C$ (normal) from her mother, making her a carrier. The son cannot inherit $X^c$ from the father as he receives only the Y chromosome from him.

Cross:

$$\text{Father } (X^cY) \times \text{Mother } (X^CX^C)$$

$$\text{Gametes: } X^c, Y \text{ (Father) and } X^C, X^C \text{ (Mother)}$$

$$\text{Offspring: } \begin{matrix} \text{Daughter } (X^CX^c) \quad \text{(Carrier)} \\ \text{Son } (X^CY) \quad \text{(Normal).} \end{matrix}$$

- Hence, the son and daughter cannot inherit colour blindness from the father as it is X-linked.

**Quick Tip**

For X-linked inheritance: - Males inherit X-linked traits from mothers. - Fathers pass X-linked traits only to daughters.

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**27. (a) (i) What are transgenic animals?**

**Solution:** - Transgenic animals are those that have had foreign genes deliberately inserted into their genome. These genes are introduced to study gene functions, improve livestock traits, or produce biologically important substances.

**(ii) Name the first transgenic cow and state its importance.**

**Solution:** - The first transgenic cow is Rosie. - Importance: Rosie produced milk enriched with the human protein alpha-lactalbumin, making it nutritionally more balanced for infants.

Quick Tip

Remember: - Transgenic animals = Genetic modification for improved traits or study. - Rosie = First transgenic cow producing enriched milk.

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**27. (b) (i) Explain the convention for naming EcoRI.**

**Solution:** - EcoRI: 1. ”E” = Genus (Escherichia).

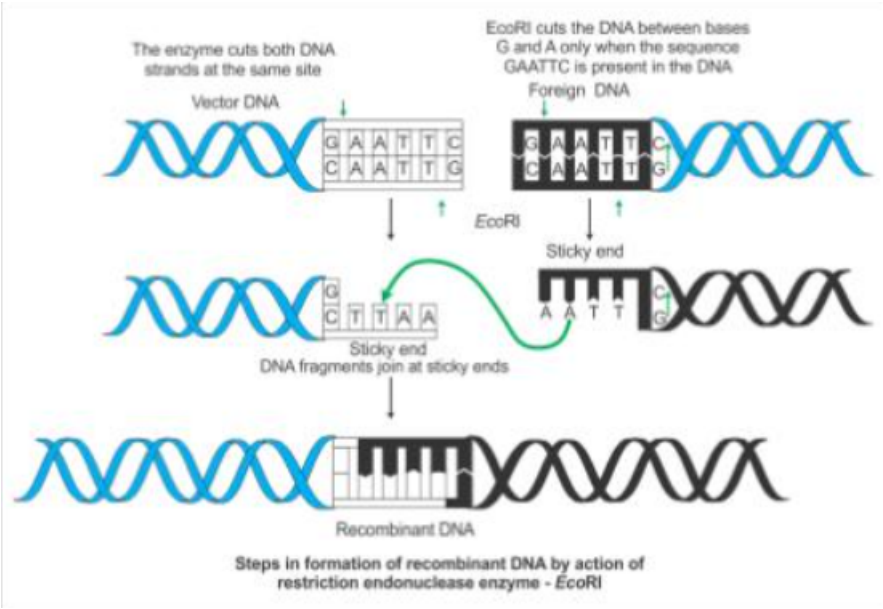
2. ”co” = Species (coli).

3. ”R” = Strain (RY13).

4. ”I” = First identified enzyme from this strain.

**(ii) With the help of an illustration only, show the action of EcoRI on a DNA polynucleotide.**

**Solution:**



Steps in formation of recombinant DNA by action of restriction endonuclease enzyme - *EcoRI*

5’-GAATTC-3’ (Cleavage Site)

EcoRI cuts between G/AATTC, resulting in sticky ends.

Quick Tip

Learn enzyme conventions: - Genus + Species + Strain + Number (e.g., EcoRI = Escherichia coli RY13, 1st enzyme). - Remember: EcoRI creates sticky ends.

**28. (a) Explain how it is ensured that the orchid *Ophrys* is pollinated by a specific species of bee.**

**Solution:** - The orchid *Ophrys* ensures pollination by mimicking the appearance and scent of a female bee. Male bees, attracted to the orchid, attempt to mate with it (pseudocopulation) and inadvertently carry pollen to other flowers.

**(b) Describe co-evolution with the help of this example.**

**Solution:** - Co-evolution is the process where two or more species influence each other's evolution. In the case of *Ophrys* and its specific bee species, the orchid evolved to mimic the female bee, while the bee adapted to the orchid's mimicry.

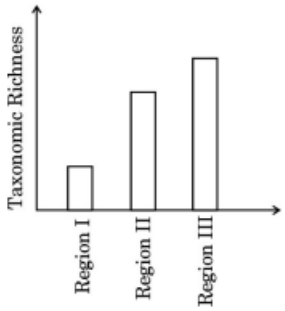
Quick Tip

Key concepts: - Ophrys: Mimics female bee to ensure pollination. - Co-evolution = Mutual influence in evolution (e.g., plant-pollinator relationships).

## SECTION – D

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

**Isn't it incredible that India's land area is only 2.4 percent of the world's total land area whereas its share of the global species diversity is an impressive 8-1 percent! However, in these estimates of species, prokaryotes do not figure anywhere. Biologists are always keen on collecting data with respect to species diversity observed in different regions of the world. The data collected based on the survey conducted for species richness of groups of mammals in three different regions of the world is shown in the bar graph below.**




**(a) Why is the species richness maximum in Region III in the bar graph?**

**Solution:** - Region III has maximum species richness due to: 1. Favourable climatic conditions such as tropical climate with high rainfall and temperature. 2. High resource availability and ecological niches supporting a large number of species.

Quick Tip

Species richness depends on: - Climatic conditions (tropical regions have higher richness). - Resource availability and niche diversity.

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**(b) Why is the species richness minimum in Region I in the bar graph?**

**Solution:** - Region I has minimum species richness because: 1. It likely represents a cold or arid climate, which is less suitable for supporting diverse life forms. 2. Limited resource availability and harsh environmental conditions restrict the number of species.

Quick Tip

Extreme climates (cold or arid) limit species richness due to low resources and survival challenges.

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**(c) Plants and animals do not have uniform diversity in the world but show rather uneven distribution. Mention what this kind of diversity is referred to as.**

**Solution:** - This uneven distribution of species diversity is referred to as Beta Diversity. It reflects the variation in species composition between different ecosystems or regions.

Quick Tip

Remember: - Alpha diversity: Within a specific habitat. - Beta diversity: Between different habitats. - Gamma diversity: Across large geographic scales.

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**(d) Why is it that prokaryotes do not have an estimated number of their species diversity as seen in plants and animals? Explain.**

**Solution:** 1. Prokaryotes lack morphological diversity, making species identification challenging. 2. Many prokaryotic species cannot be cultured in laboratories, limiting data collection. 3. Molecular techniques like DNA sequencing are required to identify them, which is time-consuming and resource-intensive.

Quick Tip

Challenges in estimating prokaryotic diversity: - Lack of culture techniques for most species. - Dependence on advanced molecular methods for identification.

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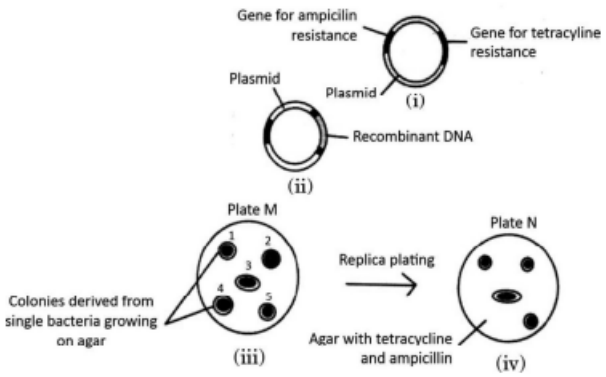
**30. Study the diagram given below that shows the steps involved in the procedure of selecting transformed bacteria and answer the questions that follow:**




**(a) Identify the colony that has got transformed. Justify your answer.**

**Solution:** - The transformed colony is the one that grows on Plate M (with ampicillin) but does not grow on Plate N (with both ampicillin and tetracycline). - Justification: The recombinant DNA disrupts the tetracycline resistance gene, making the bacteria sensitive to

tetracycline, but retains ampicillin resistance, allowing growth on Plate M.

Quick Tip

In transformation experiments: - Disrupted resistance gene = Loss of resistance. - Growth indicates retained resistance (e.g., ampicillin resistance).

**(b) What are the sites in a plasmid called where ampicillin and tetracycline resistance genes are inserted? State their role in genetic engineering.**

**Solution:** - The sites are called selectable marker sites. - Role: These genes help in identifying and selecting transformed cells: - Ampicillin resistance gene ensures growth on ampicillin-containing media. - Tetracycline resistance gene helps distinguish recombinant bacteria (tetracycline-sensitive) from non-recombinant ones.

Quick Tip

Selectable markers: - Aid in distinguishing transformed cells by their growth or lack thereof on specific media.

**(c) Name two enzymes playing an important role in genetic engineering.**

**Solution:** 1. Restriction endonucleases: Cut DNA at specific sequences. 2. DNA ligase: Joins DNA fragments to form recombinant DNA.

**OR**

**(c) State the role of $\beta$-galactosidase in insertional inactivation.**

**Solution:** - Insertional inactivation of the $\beta$-galactosidase gene prevents the production of the enzyme, resulting in white colonies (instead of blue) on media with X-gal. This helps identify recombinant bacteria.

Quick Tip

- Restriction enzymes cut, and DNA ligase joins DNA. - $\beta$-galactosidase inactivation indicates recombinant colonies (white on X-gal media).

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a

## SECTION – E

**31. (a) (i) Explain the development of male gametophyte in an angiosperm.**

**Solution:** - The male gametophyte in angiosperms develops within the pollen grain: 1. Microspore Formation: Each microspore undergoes mitotic division to form a small generative cell and a larger vegetative cell. 2. Mature Pollen Grain: The generative cell divides mitotically to produce two male gametes, resulting in a three-celled structure (two male gametes + one vegetative cell).

**(ii) Draw a labelled diagram of a three-celled male gametophyte.**

**Solution:** Include a diagram with labels: 1. Vegetative cell (large). 2. Two male gametes (small).

Quick Tip

Male gametophyte stages: - Microspore $\rightarrow$ Vegetative + Generative cells $\rightarrow$ Mature pollen grain (three-celled).

**OR**

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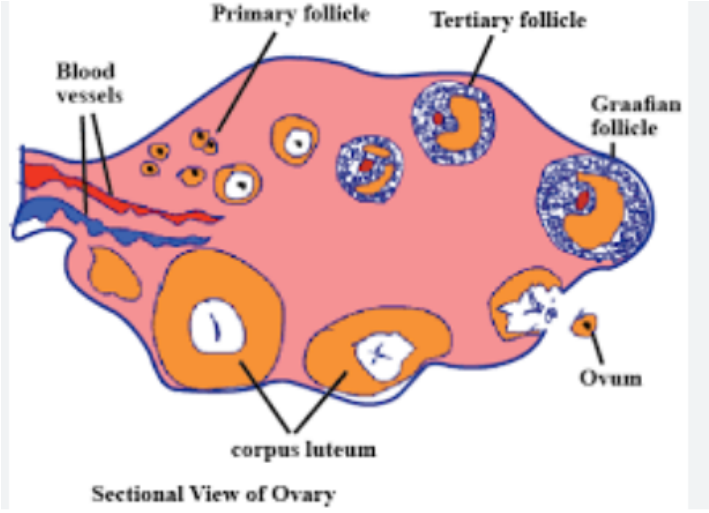
**(b) (i) Draw a diagrammatic sectional view of ovary of human female and label the following:**

- Blood vessels
- Primary follicle
- Tertiary follicle
- Ovum

**Solution:** Include a diagram showing: - Blood vessels in the medulla. - Primary follicle in the cortex. - Tertiary follicle with an antrum. - Ovum released from the mature Graafian follicle.




**(ii) At which stage of life are primary follicles formed in a human female?**

**Solution:** - Primary follicles are formed during the fetal stage of development in a female.

**(iii) Explain the events (both hormonal and structural) that occur at the time of ovulation till the onset of the next menstrual cycle.**

**Solution:** 1. At Ovulation:

- Surge in LH (Luteinizing Hormone) leads to the rupture of the Graafian follicle and release of the ovum.

2. Post-Ovulation: - The ruptured follicle transforms into the corpus luteum, which secretes progesterone.

- Progesterone prepares the endometrium for implantation.

3. If Fertilization Does Not Occur:

- The corpus luteum degenerates, leading to a drop in progesterone levels. - The endometrium breaks down, resulting in menstruation.

**Quick Tip**

Ovulation key points: - Triggered by LH surge. - Corpus luteum secretes progesterone. - Lack of fertilization $\rightarrow$ Endometrial breakdown (menstruation).

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**32. (a) Stability, as one of the properties of genetic material, was very evident in one of the very early experiments in genetics. Name the scientist and describe his experiment. State the conclusion he arrived at.**

**Solution:** - Scientist: Frederick Griffith.

- Experiment:

1. He worked on *Streptococcus pneumoniae* (S strain = virulent, R strain = non-virulent).

2. Heat-killed S strain mixed with live R strain transformed R into a virulent S strain.

- Conclusion:

- A "transforming principle" (later identified as DNA) is responsible for genetic stability and transfer of traits.

Quick Tip

Griffith's experiment:

- Showed genetic material is stable and transferable.

- Led to the discovery of DNA as the genetic material.

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**OR**

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**(b) A tall pea plant bearing violet flowers with unknown genotype is given. Find the genotype by working out different crosses by selfing the plants. Write the genotypic and phenotypic ratios of each cross shown by you.**

**Solution:** 1. Case 1: Homozygous (TTVV): - Cross: $TTVV \times TTVV$ - Genotypic ratio: 100- Phenotypic ratio: 1002. Case 2: Heterozygous (TtVv): - Cross: $TtVv \times TtVv$ - Genotypic ratio: 1:2:1 (TT:Tt:tt) for height, 1:2:1 (VV:Vv:vv) for color. - Phenotypic ratio: 9:3:3:1 (Tall violet: Tall white: Dwarf violet: Dwarf white).

Quick Tip

- Use Punnett squares for dihybrid crosses. - Remember 9:3:3:1 ratio for heterozygous parents in F2 generation.

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**33. (a)**

**(i) Name and explain the property present in normal cells but lost in cancer cells.**

The property present in normal cells but lost in cancer cells is **contact inhibition**. - Contact inhibition refers to the process where normal cells stop dividing when they come into contact with neighboring cells. This mechanism ensures that cells grow in an organized manner and maintain proper tissue structure. It prevents overgrowth and helps to regulate tissue size. - In **cancer cells**, this property is lost, and they continue to divide uncontrollably, even when they come into contact with other cells. This uncontrolled division results in tumor formation and cancer progression.

**(ii) All normal human cells have genes that may become cancerous under certain conditions. Name them and explain how.**

The genes that may become cancerous under certain conditions are **oncogenes** and **tumor suppressor genes**.

1. Oncogenes: - Oncogenes are mutated forms of normal genes called proto-oncogenes. Proto-oncogenes normally promote cell growth and division. However, when mutated or overexpressed, they become **oncogenes**, leading to uncontrolled cell division and potentially causing cancer. - Example: The *Ras* gene, when mutated, continuously signals the cell to divide, even when not needed, leading to uncontrolled cell proliferation.

2. Tumor Suppressor Genes: - Tumor suppressor genes are responsible for inhibiting cell growth and promoting the repair of damaged DNA or apoptosis (programmed cell death). If these genes are mutated or inactivated, cells can bypass growth control mechanisms and continue to divide. - Example: The *p53* gene is a critical tumor suppressor gene. When it is mutated, it fails to prevent the division of cells with damaged DNA, which can lead to cancer development.

**(iii) State the role of the following techniques in the detection and diagnosis of cancer:**

1. Biopsy and Histopathology: - A **biopsy** involves removing a small sample of tissue from a suspected tumor or abnormal growth. The tissue is then examined under a microscope through **histopathology**. - The role of biopsy and histopathology is essential for diagnosing cancer. They help identify the presence of cancerous cells, determine the type of cancer, and assess its stage and grade. This also provides critical information on the malignancy of the tumor and helps plan appropriate treatment options.

2. Magnetic Resonance Imaging (MRI): - **MRI** is a non-invasive imaging technique that uses magnetic fields and radio waves to produce detailed images of the inside of the body. It is especially useful in detecting soft tissue abnormalities such as brain, spinal cord, and breast cancers. - The role of MRI in cancer diagnosis includes identifying and locating tumors, determining their size, and assessing whether cancer has spread to other parts of the body (metastasis). It is also used to monitor treatment progress and plan surgeries or radiation therapy.

**Quick Tip**

Cancer cells lack the property of contact inhibition, leading to uncontrolled growth. Biopsy and MRI are key tools for accurate diagnosis, with biopsy providing tissue-level confirmation of cancer and MRI helping to visualize and assess the extent of cancer in the body.

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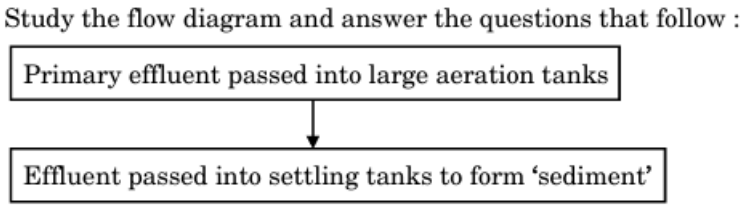
**OR**

**(b)**

**Large quantities of sewage are generated every day in cities as well as in towns and are treated in Sewage Treatment Plants (STPs) to make them less polluting. Given below is the flow diagram of stages of STP.**

**Study the flow diagram and answer the questions that follow:**




**(i)**

1. **Why is primary effluent passed into large aeration tanks?**

   Primary effluent is passed into large aeration tanks to increase the oxygen supply to the effluent. This helps in the growth of aerobic microorganisms that break down the organic matter in the sewage, converting it into simpler substances. The process of

aeration encourages the growth of these microorganisms, which helps in reducing the biochemical oxygen demand (BOD) of the water, making it less polluting.

2. **What is the 'sediment' formed referred to? Mention its significance.**
   The sediment formed is called **sludge**. It consists of organic and inorganic matter that settles at the bottom of the settling tank. The significance of sludge is that it contains a high concentration of organic matter, which can be further processed to extract biogas or treated for use as fertilizer. Proper disposal of sludge is crucial for preventing environmental pollution.

3. **Explain the final step in the settling tank before the treated effluent is released into water bodies.**
   The final step involves the treatment of the effluent in the settling tank, where the remaining suspended particles, including microorganisms, are allowed to settle down. This is followed by the removal of the clear water (supernatant), which is relatively free from pollutants. This treated water is then released into water bodies. Further treatment may be performed, depending on the quality of the effluent.

**(ii) Name any two organisms commonly used as biofertilizers, belonging to different kingdoms. Write how each one acts as a biofertilizer.**

- **Rhizobium (Kingdom: Bacteria)**:
  Rhizobium is a nitrogen-fixing bacterium that forms a symbiotic relationship with leguminous plants. It helps in fixing atmospheric nitrogen into a form that the plants can use for growth, thereby acting as a natural fertilizer.

- **Azotobacter (Kingdom: Bacteria)**:
  Azotobacter is a free-living nitrogen-fixing bacterium found in soil. It helps in fixing nitrogen from the atmosphere and making it available to plants, improving soil fertility. Unlike Rhizobium, Azotobacter does not form symbiotic relationships with plants but independently fixes nitrogen.

Quick Tip

Biofertilizers like *Rhizobium* and *Azotobacter* are eco-friendly alternatives to chemical fertilizers, promoting sustainable agricultural practices.

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**OR**

(b)(i) **Construct a transcription unit with a coding strand given below with proper labelling:**

**Solution:** The transcription unit includes:

- **Promoter:** Located upstream of the transcription start site.
- **Coding region:** Contains the sequence to be transcribed.
- **Terminator:** Signals the end of transcription.

5' Promoter — Coding Region (5' to 3') — Terminator 3'

(b)(ii) **When does a coding strand become a template strand?**

**Solution:** The coding strand does **not** become the template strand. Instead, the complementary strand (non-coding strand) acts as the template strand during transcription.

(b)(iii) **Why does a double-helix DNA molecule transcribe into a single-stranded RNA molecule?**

**Solution:** Transcription produces a single-stranded RNA because:

- RNA polymerase synthesizes RNA complementary to only one strand (the template strand).
- The resulting RNA strand does not pair with the DNA template, ensuring a single-stranded molecule for translation.

Quick Tip

Transcription involves RNA polymerase reading only the template strand, leading to the formation of single-stranded RNA.