

CBSE 12 Biology (57/1/2) Question Paper with Solutions

Time Allowed :3 hours

Maximum Marks :70

Total questions :33

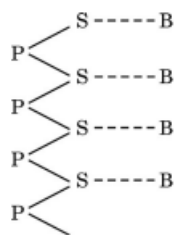
General Instructions

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

1. 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.

2. Select the option that has the correct sequence of events of the human female reproductive cycle:

1. Secretion of FSH
2. Ovulation
3. Growth of corpus luteum

4. Growth of follicle and oogenesis

5. Sudden increase in LH

(A) $i \rightarrow iii \rightarrow v \rightarrow ii \rightarrow iv$

(B) $i \rightarrow iv \rightarrow v \rightarrow ii \rightarrow iii$

(C) $iv \rightarrow i \rightarrow v \rightarrow iii \rightarrow ii$

(D) $v \rightarrow ii \rightarrow iii \rightarrow iv \rightarrow i$

Correct Answer: (B) $i \rightarrow iv \rightarrow v \rightarrow ii \rightarrow iii$

Solution:

The human female reproductive cycle consists of several stages regulated by hormones. The correct sequence of events involves the following steps:

1. Secretion of FSH (Follicle-Stimulating Hormone): - The cycle begins with the secretion of FSH from the anterior pituitary gland. FSH stimulates the growth and maturation of the ovarian follicles in the ovaries, which is the first step in the process.
2. Growth of follicle and oogenesis: - As FSH is secreted, the ovarian follicles start to grow and develop. This is accompanied by the process of oogenesis, where the primary oocyte completes its maturation into a secondary oocyte within the growing follicle.
3. Sudden increase in LH (Luteinizing Hormone): - Just before ovulation, there is a surge in LH, which is triggered by high levels of estrogen produced by the growing follicle. This LH surge is the key trigger for ovulation.
4. Ovulation: - The sudden rise in LH causes the mature follicle to rupture and release the secondary oocyte. This process is called ovulation, which occurs roughly in the middle of the menstrual cycle.
5. Growth of corpus luteum: - After ovulation, the ruptured follicle transforms into the corpus luteum. This structure secretes progesterone, which prepares the uterine lining for a potential pregnancy.

The correct sequence of events is as follows: - Secretion of FSH (i) - Growth of follicle and oogenesis (iv) - Sudden increase in LH (v) - Ovulation (ii) - Growth of corpus luteum (iii)

Thus, the correct sequence is $i \rightarrow iv \rightarrow v \rightarrow ii \rightarrow iii$, which corresponds to option (B).

Quick Tip

The secretion of FSH starts the cycle, leading to follicular growth and oogenesis. The LH surge triggers ovulation, followed by the formation of the corpus luteum.

3. Lactobacillus that sets milk into curd is categorized as:

- (A) Cyanobacteria
- (B) Archaeobacteria
- (C) Chemosynthetic bacteria
- (D) Heterotrophic bacteria

Correct Answer: (D) Heterotrophic bacteria

Solution:

- Lactobacillus is a heterotrophic bacterium that ferments lactose in milk to form lactic acid.
- This process causes milk to coagulate and turn into curd.
- Heterotrophic bacteria rely on organic substances for energy.

Quick Tip

Recall the classification of bacteria: - Cyanobacteria: Photosynthetic. - Chemosynthetic bacteria: Use inorganic substances. - Heterotrophic bacteria: Depend on organic matter.

4. The specific Bt toxin genes which protect the cotton plants against the cotton bollworms are:

- (A) Cry-I Ac and Cry-II Ab
- (B) Cry-I Ab and Cry-I Be
- (C) Cry-II Ac and Cry-I Ab

(D) Cry-II Ab and Cry-I Ab

Correct Answer: (A) Cry-I Ac and Cry-II Ab

Solution:

- Bt toxin genes (Cry-I Ac and Cry-II Ab) are derived from the bacterium *Bacillus thuringiensis*.
- These genes are inserted into cotton plants to produce insecticidal proteins that protect against bollworms.

Quick Tip

Learn key Bt genes: - Cry-I Ac: Targets bollworms. - Cry-II Ab: Effective against pests in cotton.

5. Listed below are some amino acids and their corresponding mRNA codons:

Amino acid	mRNA codons
Phenylalanine	UUU
Lysine	AAG
Arginine	CGA
Alanine	GCA

Select the DNA sequence that would code for the following polypeptide sequence:

Polypeptide: Alanine – Arginine – Lysine – Phenylalanine

- (A) CGT GCT TTC AAA
- (B) CGT GCT TTC TTT
- (C) CGU GCU UUC AAA
- (D) CGU GCU UUC TTT

Correct Answer: (A) CGT GCT TTC AAA

Solution: To determine the DNA sequence that codes for the given polypeptide sequence, follow these steps:

- mRNA codon for Alanine is GCA, so the DNA coding strand must contain CGT.

- mRNA codon for Arginine is CGA, which corresponds to DNA codon GCT.
- mRNA codon for Lysine is AAG, which corresponds to DNA codon TTC.
- mRNA codon for Phenylalanine is UUU, which corresponds to DNA codon AAA.

Thus, the correct DNA sequence is CGT GCT TTC AAA.

Quick Tip

To solve DNA coding questions, follow these simple steps:

- Remember that DNA coding strand sequences match mRNA (except T instead of U).
- The complementary strand follows base-pairing rules (A-T, G-C).
- Double-check each amino acid's corresponding codon carefully.

6. 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:

- Maize is a monoecious plant where both male and female flowers are present on the same plant.
- Geitonogamy occurs when pollination happens between flowers on the same plant, while xenogamy occurs between flowers on different plants.
- Papaya and Date Palm are dioecious plants, and Spinach is not relevant in this context.

Quick Tip

Remember: - Monoecious plants: Male and female flowers on the same plant. - Dioecious plants: Male and female flowers on separate plants.

7. 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 have been genetically modified to carry human genes that make them susceptible to polio infection.
- They are used to test the safety and effectiveness of the polio vaccine before human trials.

Quick Tip

Transgenic animals are widely used in research: - Mice: Testing vaccines and genetic studies. - Sheep and Goats: Used for producing therapeutic proteins.

8. 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 crucial role in allergic reactions by releasing histamines when exposed to allergens.
- Histamines cause symptoms like inflammation, itching, and increased vascular permeability.

Quick Tip

Key points: - Mast cells release histamine in allergic reactions. - Allergy: Caused by hypersensitivity to specific antigens.

9. 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 intercourse during the fertile window.
- In a 28-day cycle, ovulation usually occurs around day 14. The fertile window is days 10 to 17 when conception chances are high.

Quick Tip

Remember: - Fertile window: Days 10–17 in a 28-day cycle. - Ovulation occurs around day 14.

10. Select the incorrect match from the following:

Characters
Broad palm with characteristic palm crease
Overall feminine development
Sterile females as ovaries are rudimentary
Normal male

(A) 45 + XX

(B) 44 + XXY

(C) 44 + XO

(D) 44 + XY

Correct Answer: (A) 45 + XX

Solution:

- The karyotype 45 + XX does not exist. The correct condition for a broad palm with characteristic palm crease is 47 + XXY (Klinefelter syndrome) or other related conditions.

Quick Tip

Focus on karyotypes: - Turner Syndrome: 45 + XO. - Klinefelter Syndrome: 47 + XXY.

11. Using a DNA template, how many new DNA molecules would be generated after 10 cycles of amplification in PCR?

(A) 512

(B) 1024

(C) 2048

(D) 256

Correct Answer: (B) 1024

Solution:

In Polymerase Chain Reaction (PCR), the DNA amplification follows a process of exponential growth. In each cycle, the amount of DNA doubles. Therefore, after each cycle, the number of DNA molecules increases by a factor of 2.

If we start with one DNA molecule, the number of DNA molecules after n cycles of amplification can be calculated using the formula:

$$\text{Number of DNA molecules} = 2^n$$

where n is the number of cycles.

Given that the question asks about 10 cycles:

$$\text{Number of DNA molecules after 10 cycles} = 2^{10} = 1024$$

Therefore, after 10 cycles of PCR amplification, the number of DNA molecules generated will be 1024.

- **Option (A):** 512 is incorrect. It represents the number of DNA molecules after 9 cycles ($2^9 = 512$). - **Option (B):** 1024 is the correct answer. After 10 cycles, $2^{10} = 1024$ DNA molecules are generated. - **Option (C):** 2048 is incorrect. It represents the number of DNA molecules after 11 cycles ($2^{11} = 2048$). - **Option (D):** 256 is incorrect. It represents the number of DNA molecules after 8 cycles ($2^8 = 256$).

Quick Tip

In PCR, the number of DNA molecules increases exponentially, and after each cycle, the DNA count doubles. The formula 2^n gives the total number of DNA molecules after n cycles.

12. Read the four statements given below and select the option having two correct statements:

1. A lion eating a deer and a sparrow feeding on grains are ecologically similar in being consumers.

2. Predator starfish *Pisaster* helps in maintaining species diversity of some invertebrates.
3. Predators ultimately lead to extinction of prey species.
4. Production of chemicals nicotine and strychnine by plants are metabolic disorders.

(A) (i) and (iii)

(B) (ii) and (iv)

(C) (i) and (ii)

(D) (iii) and (iv)

Correct Answer: (C) (i) and (ii)

Solution:

- Statement (i) is correct because both the lion (a carnivore) and the sparrow (a herbivore) are consumers in the ecological food chain.
- Statement (ii) is correct as the starfish *Pisaster* acts as a keystone predator, preventing the dominance of certain species and thus maintaining species diversity.
- Statement (iii) is incorrect because predators usually regulate prey populations rather than leading to their extinction.
- Statement (iv) is incorrect as the production of secondary metabolites like nicotine and strychnine in plants are defensive mechanisms, not metabolic disorders.

Quick Tip

When answering ecological questions, consider:

- Consumers can include both herbivores and carnivores.
- Keystone species play a critical role in maintaining ecosystem balance.
- Predators regulate rather than eliminate prey populations.
- Secondary metabolites in plants serve protective functions.

13. 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 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, the statement about T-DNA is correct, as this bacterium transfers T-DNA into plant cells, causing crown gall disease.

Quick Tip

Agrobacterium tumefaciens is widely used in genetic engineering for dicot plants due to its natural ability to transfer genes.

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

Reason (R): Emotional, religious, and social factors are deterrents to the legal adoption of orphaned and destitute children in India.

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

Solution: Legal adoption is indeed permitted by Indian law and encouraged for childless couples. However, emotional and social factors are not absolute deterrents to adoption, as awareness and government initiatives have addressed these concerns.

Quick Tip

Understanding the legal framework of adoption can help eliminate misconceptions regarding social and emotional barriers.

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

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

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

Solution: Linked genes are present on the same chromosome and tend to be inherited together. As a result, they do not assort independently according to Mendel's law of independent assortment, and thus, the expected dihybrid ratio of 9:3:3:1 is not observed.

Quick Tip

Remember, genes located close to each other on the same chromosome tend to be inherited together, leading to deviations from expected Mendelian ratios.

16. Assertion (A): Functional ADA cDNA genes must be inserted in the lymphocytes at the early embryonic stage in gene therapy for ADA deficiency.

Reason (R): Cells in the embryonic stage are immortal, differentiated, and easy to manipulate.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of 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: Adenosine deaminase (ADA) deficiency is treated by introducing functional ADA genes into the lymphocytes of the patient. However, this does not necessarily have to be done at the early embryonic stage; it can also be done later.

The statement that embryonic cells are immortal, differentiated, and easy to manipulate is incorrect. Embryonic cells are actually undifferentiated and have the potential to develop into various cell types, but they are not necessarily easy to manipulate.

Quick Tip

Gene therapy for ADA deficiency typically involves introducing the gene into lymphocytes or bone marrow cells, not necessarily at the embryonic stage.

SECTION – B

17. Do you think apomixis can be compared to asexual reproduction? Justify your answer. State the benefits of apomixis to the farmers.

Solution: Apomixis can be compared to asexual reproduction because it leads to the formation of offspring without fertilization. In apomixis, seeds are produced without the fusion of gametes, resulting in progeny that are genetically identical to the parent plant.

Benefits of apomixis to farmers:

- Ensures the production of hybrid seeds without segregation of traits.
- Reduces the cost of hybrid seed production.
- Provides disease-resistant and high-yielding crops.

Quick Tip

Apomixis helps in maintaining hybrid vigor for successive generations, benefiting farmers economically and ensuring uniform crop traits.

18. (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.

1. What did the doctor inject and why?

Solution: The doctor injected **antivenom** to neutralize the snake venom and prevent its harmful effects.

2. Name the kind of immunity provided by this injection.

Solution: The immunity provided is **passive immunity**, as pre-formed antibodies are administered.

Quick Tip

Passive immunity provides immediate protection but is short-lived as the antibodies are not produced by the body itself.

OR

(b) Why do organic farmers not recommend complete eradication of insect pests?

Explain giving reason.

Solution: Organic farmers do not recommend complete eradication of insect pests because:

- Insects play a vital role in maintaining ecological balance.
- Some insects act as natural predators and control pest populations naturally.
- Eradication can disrupt the food chain and lead to the emergence of more resistant pest species.

Quick Tip

Maintaining a balance in pest populations helps reduce dependency on chemical pesticides and promotes sustainable farming.

19. 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.



Solution: The naturalist who provided the explanation for this example is **Jean-Baptiste Lamarck**.

According to Lamarck's theory of evolution, the long necks of giraffes evolved over generations due to the following explanation:

- Giraffes originally had shorter necks and fed on lower vegetation.
- Due to competition and environmental changes, they stretched their necks to reach higher leaves.
- This continuous use of neck muscles led to gradual elongation over generations.
- The acquired trait of a longer neck was passed on to the offspring.

This idea is known as the **Theory of Inheritance of Acquired Characteristics**.

Quick Tip

Lamarck's theory suggested that characteristics acquired during an organism's lifetime could be inherited, but modern genetics has shown that traits are passed through genes, not by use or disuse.

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

Solution: The basic steps followed in the Assisted Reproductive Technologies (ART) programme are:

- **Step 1:** Hormonal stimulation is provided to the female to induce the production of multiple ova.
- **Step 2:** The eggs (ova) are retrieved from the ovaries and fertilized with sperm in a laboratory setting.
- **Step 3:** The fertilized egg (zygote) undergoes early embryonic development in vitro (outside the body).
- **Step 4:** The resulting embryo is then implanted into the uterus for further development.

It is known as the **test tube baby programme** because fertilization and early embryonic development occur outside the female body in a laboratory setting, commonly in a petri dish or test tube.

Quick Tip

Assisted Reproductive Technology (ART) techniques like IVF help couples conceive by fertilizing the egg outside the body, and successful embryos are transferred back into the uterus.

21. A specific plant species was introduced into Australia in 1920 and later it became invasive, spreading over millions of hectares of rangeland.

- (a) **Name the plant that was introduced into Australia and mention the reason for its uncontrollable growth.**

Solution: The plant introduced into Australia was **Opuntia** (commonly known as Prickly Pear Cactus). Its uncontrollable growth was due to the absence of natural predators or pathogens in the Australian ecosystem, leading to its rapid and unchecked spread.

- (b) **State how its spread was eventually brought under control.**

Solution: The spread of **Opuntia** was eventually controlled by introducing a biological control agent, the **Cactoblastis cactorum** moth, whose larvae feed on the cactus and significantly reduced its population.

Quick Tip

Invasive species often thrive in new environments due to a lack of natural predators or competitors. Biological control methods can be an effective solution for their management.

SECTION – C

22. (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.

22. (b) (i) Explain the convention for naming EcoRI.

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

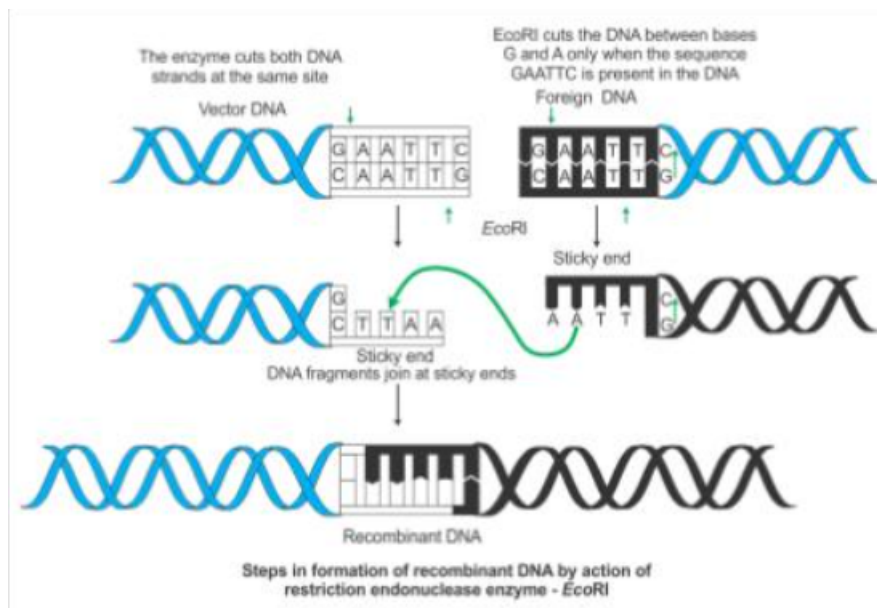
2. "co" = Species (coli).

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:



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.

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

<i>Name of Human Disease</i>	<i>Causative Organism</i>	<i>Symptoms</i>
Pneumonia	<i>Streptococcus</i>	'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	<i>Ascaris</i>	'E'
'F'	<i>Entamoeba histolytica</i>	Constipation, cramps, stools with mucous and blood clots

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.

24. 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.

25. (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.

25. (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.

26. Given below is a picture that shows the magnified blood smear of a patient under a microscope.



(a) Name the disease the blood smear is indicative of. Write the symptoms of the disease and its cause.

Solution: The blood smear is indicative of **Sickle Cell Anemia**. It is caused by a mutation in the gene that codes for the beta chain of hemoglobin, leading to the production of abnormal hemoglobin S (HbS).

Symptoms:

- Severe anemia and fatigue
- Pain episodes (sickle cell crisis)
- Swelling in hands and feet
- Frequent infections
- Delayed growth and vision problems

Quick Tip

Sickle cell anemia is caused by a single point mutation in the HBB gene, leading to the replacement of glutamic acid with valine at the sixth position of the beta-globin chain.

(b) Explain the inheritance pattern of the disease with the help of a suitable cross.

Solution: Sickle cell anemia follows an **autosomal recessive inheritance** pattern. Individuals with one defective allele (HbA/HbS) are carriers, while those with two defective alleles (HbS/HbS) suffer from the disease.

Genetic cross:

Parent 1 (Carrier) : HbA/HbS × Parent 2 (Carrier) : HbA/HbS

Gametes: HbA, HbS and HbA, HbS

Offspring: HbA/HbA (Normal), HbA/HbS (Carrier), HbS/HbS (Affected)

The ratio of offspring will be:

- 25% Normal (HbA/HbA)
- 50% Carriers (HbA/HbS)
- 25% Affected (HbS/HbS)

Quick Tip

Sickle cell anemia is inherited in an autosomal recessive manner, meaning both parents must be carriers for the child to inherit the disease.

27. (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.

27. (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.

28.

(a) **State what is primary productivity and mention its units.**

Solution: Primary productivity refers to the rate at which organic matter is produced by plants (producers) through photosynthesis in an ecosystem. It is expressed in terms of energy or biomass.

Units: Primary productivity is measured in **kcal/m²/year** (energy) or **g/m²/year** (biomass).

(b) **Some ecologists observed that primary productivity of a place in Rajasthan was low as compared to a particular place in Kerala. Explain why.**

Solution: The primary productivity in Rajasthan is lower than in Kerala due to differences in climatic and environmental conditions:

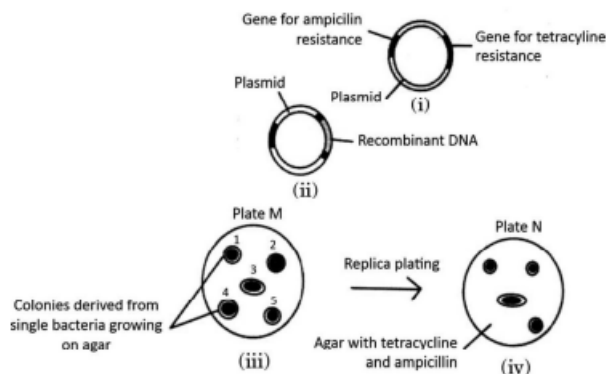
- **Rajasthan:** Being a desert region, it has limited water availability, high temperatures, and low vegetation cover, all of which reduce primary productivity.
- **Kerala:** It has a tropical climate with abundant rainfall, fertile soil, and dense vegetation, which enhance primary productivity.

Quick Tip

Primary productivity depends on factors like climate, water availability, soil fertility, and vegetation type. Tropical regions typically show higher productivity due to favorable environmental conditions.

SECTION – D

29. 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 β -galactosidase in insertional inactivation.

Solution: - Insertional inactivation of the β -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.

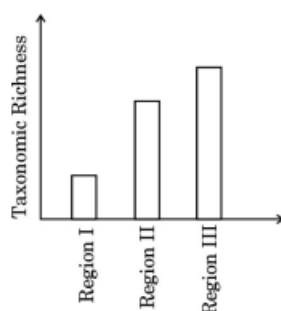
Quick Tip

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

30. 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.

(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.

(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.

(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.

SECTION – E

31. (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.

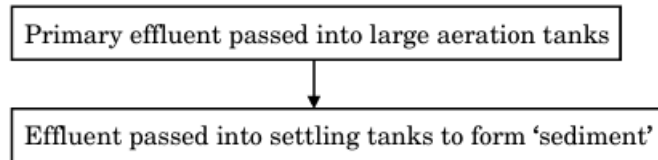
OR

(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:

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.

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.

32.

- (a) **Many patterns of inheritance deviate considerably from the pattern of inheritance as explained by Mendel. List any four such inheritance patterns and explain any three with the help of an example each.**

Solution: Four patterns of inheritance that deviate from Mendelian genetics are:

- **Incomplete dominance:** Neither allele is completely dominant, resulting in an intermediate phenotype. Example: In snapdragons, red (RR) and white (rr) flowers produce pink (Rr) flowers in the heterozygous condition.
- **Codominance:** Both alleles are equally expressed in the heterozygous condition. Example: Blood group AB in humans, where both I^A and I^B alleles are expressed.
- **Multiple alleles:** A gene has more than two alleles. Example: ABO blood group in humans, controlled by three alleles (I^A, I^B, i).
- **Polygenic inheritance:** Traits are controlled by multiple genes. Example: Human skin color, which is determined by several gene pairs.

Explanation:

- **Incomplete dominance:** The pink color in snapdragons arises as the red allele cannot completely mask the effect of the white allele.
- **Codominance:** In blood group AB, both I^A and I^B alleles are expressed, showing traits of both A and B blood groups.

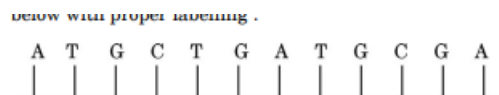
- **Multiple alleles:** The ABO blood group system shows that more than two alleles can govern a trait, where I^A and I^B are codominant, and i is recessive.

Quick Tip

Mendelian inheritance explains basic patterns, but deviations like incomplete dominance and codominance occur due to variations in allele interactions.

OR

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Solution: The transcription unit includes:

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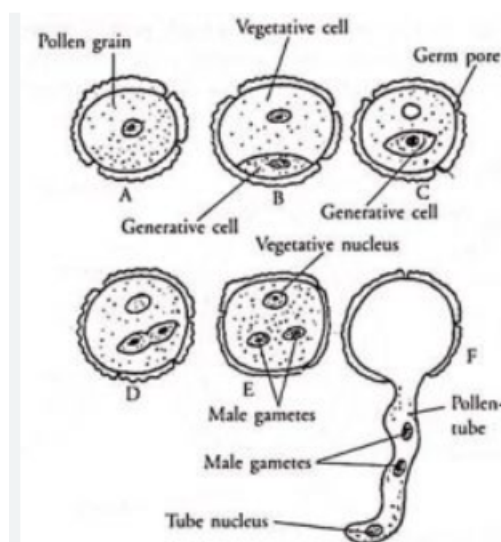
33.

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

Solution: The development of male gametophyte in an angiosperm occurs as follows:

- The pollen grain (microspore) represents the male gametophyte.
- Inside the pollen grain, the nucleus divides mitotically to form two cells:
 - A larger **vegetative cell** (tube cell) that controls pollen tube growth.
 - A smaller **generative cell** that divides mitotically to form two male gametes.
- At the three-celled stage, the pollen grain is ready for fertilization.

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



Solution: The diagram should show:

- The vegetative cell (tube cell) and nucleus.
- Two male gametes formed from the generative cell.
- The pollen grain's outer structure.

Quick Tip

The male gametophyte develops within the pollen grain and reaches maturity as a three-celled structure with one vegetative cell and two male gametes.

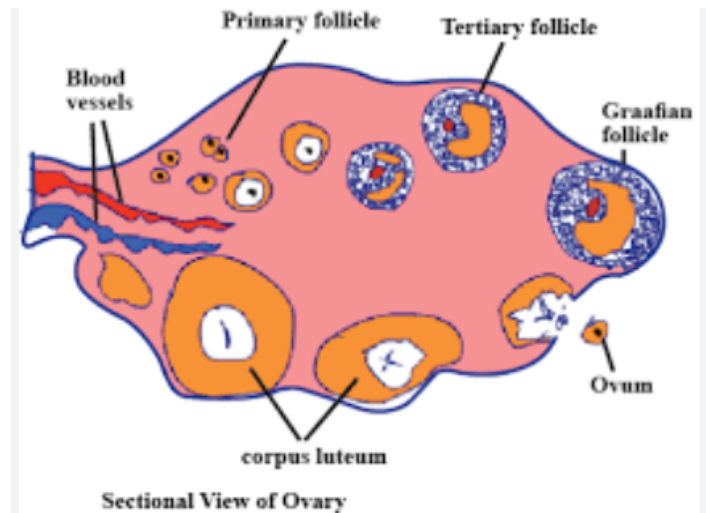
OR

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

- Blood vessels
- Primary follicle
- Tertiary follicle
- Ovum

Solution: The diagram should include:

- The outer ovarian wall.
- Multiple follicles at different developmental stages, including primary and tertiary follicles.
- The ovum within the mature Graafian follicle.
- Blood vessels supporting the ovary.



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

Solution: Primary follicles are formed during the **fetal stage** in the ovary of a developing female fetus.

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

Solution: The events include:

- **Ovulation:**

- Triggered by a surge in luteinizing hormone (LH) around the 14th day of the menstrual cycle.
- The mature Graafian follicle ruptures, releasing the ovum.

- **Post-ovulation:**

- The ruptured follicle transforms into the corpus luteum, secreting progesterone.
- Progesterone maintains the uterine lining for potential implantation.

- **If fertilization does not occur:**

- The corpus luteum degenerates, leading to a drop in progesterone levels.
- The uterine lining is shed, resulting in menstruation.

Quick Tip

The menstrual cycle is regulated by hormonal interplay (FSH, LH, estrogen, and progesterone). Ovulation marks the midpoint of the cycle, driven by an LH surge.

