# CBSE Class 12 2025 Biology Question Paper (57/5/3) With Solutions

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

## SECTION A

**Questions no. 1 to 16 are Multiple Choice Type Questions, carrying 1 mark each. Choose the best option.**

**1. In *E. coli*, a DNA sequence that specifies where RNA polymerase will bind and initiate transcription of a gene is:**

(A) Start codon

(B) Stop codon

(C) Terminator

(D) Promoter

**Correct Answer:** (D) Promoter

**Solution:**

In *E. coli*, the promoter is a specific DNA sequence located upstream of a gene that serves as a binding site for RNA polymerase. It marks the site where transcription should begin. The start codon signals where translation starts, the stop codon marks where translation ends, and the terminator signals the end of transcription, but none of these initiate transcription like the promoter does.

**Quick Tip**

Remember — the **promoter** is the region on DNA where RNA polymerase binds to start transcription.

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**2. Given below are few statements with reference to the major events in the menstrual cycle of a human female:**

1. During the follicular phase, the primary follicles grow to become a Graafian follicle.
2. Gonadotropins FSH and progesterone stimulate follicular development during the follicular phase.
3. LH surge induces rupture of Graafian follicle thereby releasing the corpus luteum.
4. Progesterone released by corpus luteum is essential for maintenance of endometrium.

5. Both LH and progesterone attain a peak level in the middle of the cycle.

**Choose the option with all true statements from the given options:**

(A) (i), (ii) and (iv)

(B) (ii), (iii) and (v)

(C) (ii), (iv) and (v)

(D) (i), (iii) and (iv)

**Correct Answer:** (D) (i), (iii) and (iv)

**Solution:**

Statements (i), (iii), and (iv) are correct:

- (i) During the follicular phase, the primary follicles indeed grow to become a Graafian follicle.
- (iii) LH surge is responsible for inducing rupture of the Graafian follicle, leading to the release of the ovum and formation of the corpus luteum.
- (iv) Progesterone secreted by the corpus luteum is essential for the maintenance of the endometrium.

Statement (ii) is incorrect because progesterone is not involved in follicular development — it acts after ovulation. Statement (v) is incorrect as only LH peaks in the middle of the cycle, while progesterone peaks later in the luteal phase.

**Quick Tip**

Remember — LH surge triggers ovulation and corpus luteum formation; progesterone maintains the endometrium after ovulation.

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**3. The approach used in HGP of identifying all the genes that are expressed as RNA is referred to as:**

(A) SNPs

(B) YACs

(C) ESTs

(D) BACs

**Correct Answer:** (C) ESTs

**Solution:**

Expressed Sequence Tags (ESTs) are short sequences of cDNA generated by sequencing one or both ends of an expressed gene. In the Human Genome Project (HGP), ESTs were used to identify genes that are actively expressed as RNA in a given tissue or cell type.

Quick Tip

**ESTs** are cDNA sequences representing expressed genes — a quick way to identify active genes.

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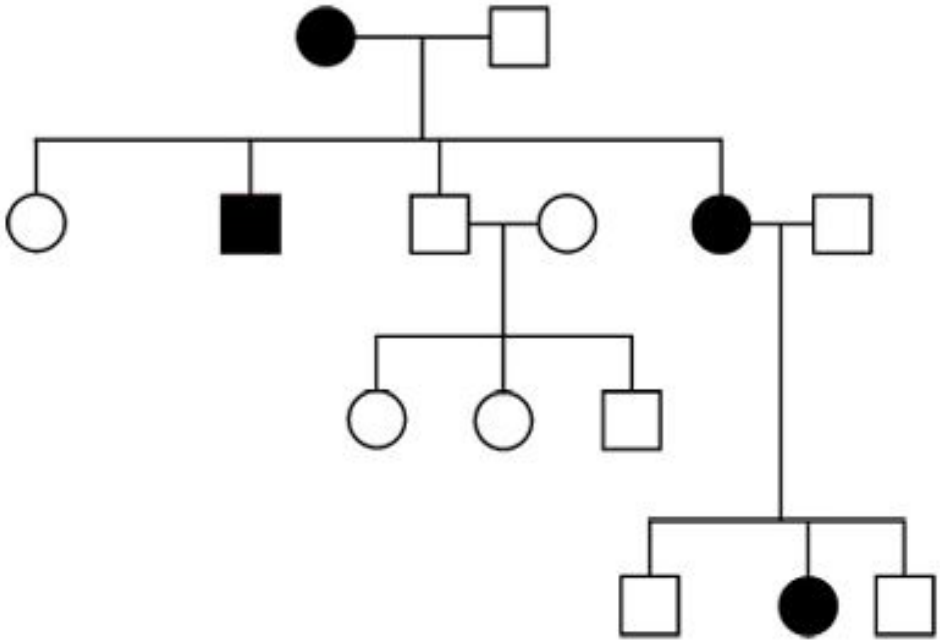
**4. Study the pedigree chart of a family showing the inheritance of myotonic dystrophy:**



**The trait under study is:**

(A) dominant X-linked trait

(B) recessive X-linked trait

(C) autosomal dominant trait

(D) autosomal recessive trait

**Correct Answer:** (C) autosomal dominant trait

**Solution:**

The pedigree shows both males and females affected in every generation, which is a key feature of autosomal dominant inheritance. X-linked traits generally show criss-cross inheritance patterns and recessive traits often skip generations, which isn't seen here.

Quick Tip

Autosomal dominant traits typically appear in every generation and affect both sexes equally.

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**5. The large bean-shaped organ acting as a filter of the blood in humans is:**

(A) Liver

(B) Thymus

(C) Spleen

(D) Heart

**Correct Answer:** (C) Spleen

**Solution:**

The spleen is a large, bean-shaped organ located in the abdominal cavity. It acts as a blood filter by removing old and damaged red blood cells and pathogens. It also plays a role in the immune response.

Quick Tip

The spleen filters blood and helps fight infections by storing white blood cells.

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**6. Select the following statements that are *true* for insect pollinated flowers from the given options.**

1. Majority of these flowers are large, colourful and rich in nectar.
2. Nectars and seeds are usual floral rewards to attract insects for pollination.

3. Pollen grains of these flowers are generally mucilaginous so as to stick to the body of the insects.

4. A foul odour is emitted by some flowers to attract flies and beetles.

**Choose the correct answer:**

(A) (i) and (ii)

(B) (ii) and (iii)

(C) (iii) and (iv)

(D) (i), (iii) and (iv)

**Correct Answer:** (D) (i), (iii) and (iv)

**Solution:**

Statements (i), (iii), and (iv) are true:

- (i) Insect pollinated flowers are often large, colourful, and produce nectar to attract pollinators.
- (iii) Their pollen grains are sticky and mucilaginous, allowing them to adhere to insect bodies.
- (iv) Some flowers emit a foul odour to attract specific pollinators like flies and beetles.

Statement (ii) is incorrect because seeds are not a floral reward; nectar and pollen serve that purpose.

Quick Tip

Insect pollinated flowers are typically showy, fragrant or odorous, and produce sticky pollen to ensure effective pollination.

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**7. Which of the following combinations is a correct example of convergent evolution in Australian marsupials and Placental mammals?**

| | Australian Marsupials | Placental Mammals |
|---|---|---|
| (A) | Tasmanian tiger cat | Lemur |
| (B) | Tasmanian tiger cat | Numbat |
| (C) | Spotted cuscus | Lemur |
| (D) | Spotted cuscus | Numbat |

**Correct Answer:** (B) Tasmanian tiger cat – Numbat

**Solution:**

Convergent evolution refers to the independent evolution of similar traits in different lineages. The Tasmanian tiger cat (marsupial) and Numbat (placental) have evolved similar adaptations independently in different groups.

Quick Tip

Convergent evolution creates analogous structures — similar in function, different in origin.

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**8. "AGGTATCGCAT" is a sequence from the coding strand of a gene. What will be the corresponding sequence of the transcribed mRNA?**

(A) AGGUAUCGCAU

(B) ACCUAUGCGAU

(C) UGGTUTCGCAT

(D) UCCAUAGCGUA

**Correct Answer:** (A) AGGUAUCGCAU

**Solution:**

In mRNA transcription, the coding strand's sequence is copied with the substitution of Uracil (U) for Thymine (T). Thus, "AGGTATCGCAT" becomes "AGGUAUCGCAU" in mRNA.

Quick Tip

In mRNA, adenine pairs with uracil instead of thymine.

**9. Removal of RNA polymerase-III from nucleoplasm of a eukaryotic cell will affect the transcription of which of the following?**

(A) tRNA

(B) hnRNA

(C) mRNA

(D) rRNA

**Correct Answer:** (A) tRNA

**Solution:**

RNA polymerase-III in eukaryotes transcribes tRNA, 5S rRNA, and some snRNA. Removing it would directly impact tRNA synthesis.

Quick Tip

Remember — Polymerase I for rRNA, II for mRNA, and III for tRNA.

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**10. Large scale industrial production of streptokinase for human welfare is done using the microbe:**

(A) *Streptomyces*

(B) *Streptococcus*

(C) *Streptobacilli*

(D) *Streptopneumoniae*

**Correct Answer:** (B) *Streptococcus*

**Solution:**

Streptokinase, used as a clot-buster in myocardial infarction patients, is produced by the bacterium *Streptococcus*.

Quick Tip

Streptokinase dissolves blood clots — produced by *Streptococcus*.

**11. Isolation of DNA from a plant cell can be achieved by using:**

(A) Chitinase

(B) Lysozyme

(C) Cellulase

(D) Pectinase

**Correct Answer:** (C) Cellulase

**Solution:**

Cellulase breaks down cellulose in plant cell walls, facilitating the isolation of DNA from plant cells.

**Quick Tip**

For plant DNA extraction — Cellulase digests the cellulose cell wall.

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**12. In a pea plant (*Pisum sativum*), green pod colour is dominant over yellow pod colour. The expected ratio of the phenotypes of the offsprings ($F_1$) in a cross between parents with heterozygous green pod colour and homozygous yellow pod will be:**

(A) 1 : 1

(B) 2 : 1

(C) 3 : 1

(D) 4 : 1

**Correct Answer:** (A) 1 : 1

**Solution:**

Cross: $Gg \times gg$

| Gametes | Offspring |
|---|---|
| G | Gg (Green) |
| g | gg (Yellow) |

Phenotypic ratio = 1 Green : 1 Yellow

**Quick Tip**

A cross between heterozygous dominant and homozygous recessive always gives a 1:1 phenotypic ratio.

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**For Questions number 13 to 16, two statements are given — one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below:**

**(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.**

**13. Assertion (A):** Biogas plants are more often built in rural areas.

**Reason (R):** The excreta or gobar of cattle is rich in Methanobacterium.

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

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

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

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

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

**Solution:**

Biogas plants are commonly built in rural areas because cattle dung (gobar), abundantly available in villages, serves as a rich substrate for Methanobacterium, which produces methane gas used as biogas. The Reason correctly explains the Assertion.

**Quick Tip**

Methanobacterium thrives in gobar producing biogas — hence rural biogas plants.

**14. Assertion (A):** Mode of action of pills and implants/injectables is similar.

**Reason (R):** The effective period of pills is much longer as compared to implants/injectables.

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

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

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

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

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

**Solution:**

Both pills and implants/injectables work by releasing hormones to prevent ovulation, hence their mode of action is similar. However, pills need to be taken daily while implants/injectables have a much longer effective period — so the Reason is false.

Quick Tip

Pills are short-acting, implants/injectables offer long-term contraception.

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**15. Assertion (A):** To generate only a part of the plant from a cell is totipotency.

**Reason (R):** Suitable special nutrient media and sterile conditions are required in *in vitro* conditions for the division of cells in explants.

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

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

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

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

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

**Solution:**

Totipotency is the ability of a plant cell to regenerate into a complete plant, not just a part. So, the Assertion is false. However, division of plant cells in explants requires sterile, nutrient-rich media under *in vitro* conditions — making the Reason true.

Quick Tip

Totipotency means forming a whole plant, not just a part.

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**16. Assertion (A):** Gene pairs present on the same chromosome may be tightly linked or loosely linked.

**Reason (R):** Frequency of recombination between gene pairs on different chromosomes as a measure of the distance between genes can be used for 'mapping' their position on the chromosomes.

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

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

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

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

**Correct Answer:** (B) Both (A) and (R) are true, but (R) is not the correct explanation of (A).

**Solution:**

Gene pairs on the same chromosome can be tightly or loosely linked based on their recombination frequency — making Assertion true. Recombination frequency is indeed used for gene mapping, but between genes on the same chromosome, not different chromosomes. So, Reason is misphrased, making option (B) correct.

Quick Tip

Gene mapping applies to same chromosome gene pairs using recombination frequency.

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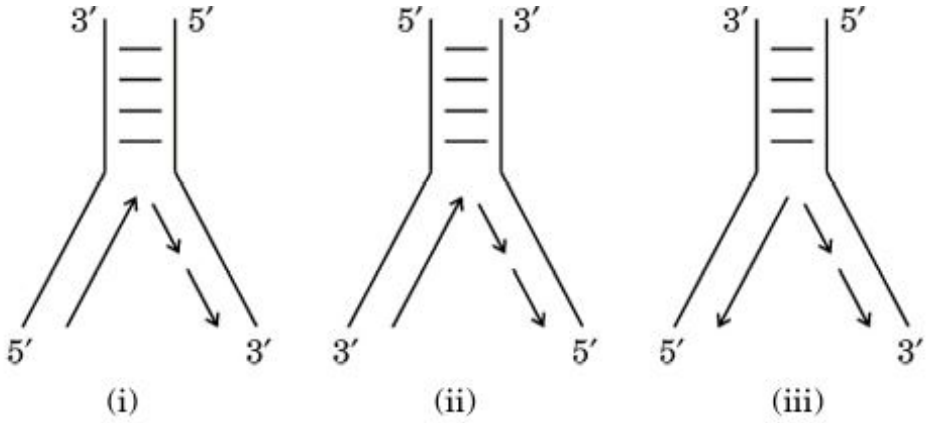
## SECTION B

**17. Given below are the diagrammatic representations of the replicating fork of DNA in *E. coli*. Study the diagrams and answer the questions that follow.**




**(a)** Which one of the three diagrams (i), (ii) or (iii) is the correct representation of the replicating fork of DNA replication? Explain your answer.

**(b)** Name the enzyme used in *E. coli* to join the newly synthesised fragments of DNA.

**Solution:**

**(a) Step 1:** The correct diagram is (ii).

**Step 2:** DNA replication occurs in the 5 to 3 direction. At the replication fork, one strand (leading strand) is synthesized continuously, while the other (lagging strand) is synthesized discontinuously in short fragments.

**Step 3:** In diagram (ii), both forks show correct orientation: the leading strand is synthesized towards the fork and the lagging strand away from it, consistent with the antiparallel nature of DNA and enzymatic action of DNA polymerase.

**(b) Step 1:** The enzyme used is **DNA ligase**.

**Step 2:** DNA ligase joins Okazaki fragments on the lagging strand by catalyzing the formation of phosphodiester bonds.

Quick Tip

In DNA replication, DNA polymerase adds nucleotides only in the 5 to 3 direction. DNA ligase seals nicks between Okazaki fragments on the lagging strand.

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**18. The basic scheme of the essential steps involved in the process of recombinant DNA technology is summarised below in the form of a flow diagram. Study the given flow diagram and answer the questions that follow:**

**Step-1** Plasmid DNA (cut using Restriction Enzyme EcoR I) + Foreign DNA (cut using Restriction Enzyme EcoR I)

↓

DNA ligase

↓

**Step-2** Recombinant DNA molecule

↓

**Step-3** Transfer of recombinant DNA molecule to the host cell

↓

**Step-4** Replication of recombinant DNA molecule in the host cell

**(a)** Name the specific enzyme that might have been used to make the multiple copies of foreign DNA before undergoing Step-1 of the process.

**(b)** How does the use of restriction enzyme EcoR I in Step-1 facilitate the action of DNA ligase to form the recombinant DNA molecule? Explain.

**(c)** Name the most commonly used host in the above process.

**Solution:**

**Step 1: (a)** The enzyme used to make multiple copies of foreign DNA is **DNA polymerase**, specifically **Taq polymerase** during the PCR (Polymerase Chain Reaction) process.

**Step 2: (b)** EcoR I creates sticky ends (overhanging sequences) in both plasmid and foreign DNA.

- These sticky ends are complementary, allowing the foreign DNA to bind with the plasmid DNA.
- DNA ligase then joins the sugar-phosphate backbones, forming a stable recombinant DNA molecule.

**Step 3: (c)** The most commonly used host is ***Escherichia coli*** (E. coli).

**Quick Tip**

PCR uses DNA polymerase to amplify DNA. EcoR I generates sticky ends, and DNA ligase seals the DNA strands. E. coli is the standard host in rDNA technology.

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

**(A) Explain how the interaction between a fig tree and its tight one-to-one relationship with the pollinator species of wasp is one of the best examples of mutualism.**

**OR**

**(B) Correctly depict (also indicate the trophic level) and describe the ecological pyramid of number with 32 birds dependent on 20 insects feeding on one banyan tree.**

**Solution:**

**(A) Step 1:** Mutualism is an interaction where both species benefit from each other.

**Step 2:** In the case of fig tree and wasp:

- The fig tree is pollinated only by its specific species of wasp.
- The wasp lays eggs inside the fig fruits.
- The fig provides shelter and nourishment for the larvae.
- Both species are dependent on each other for survival and reproduction.

**Step 3:** This is a classic example of co-evolved mutualism.

**OR**

**(B) Step 1:** The ecological pyramid of number represents the number of organisms at each trophic level. In this case, the pyramid is upright.

**Step 2:** Representation of the pyramid:

| Trophic Level | Organisms and Number |
|---|---|
| Trophic Level 3 (Secondary Consumers) | Birds – 32 |
| Trophic Level 2 (Primary Consumers) | Insects – 20 |
| Trophic Level 1 (Producers) | One Banyan Tree – 1 |

**Step 3:**

- The number of organisms decreases from producers to top consumers.

- A single banyan tree supports many insects, which in turn are preyed upon by more birds.

Thus, this pyramid shows how energy flow supports different populations.

**Quick Tip**

Mutualism involves reciprocal benefit. The fig-wasp relationship is highly specific. Ecological pyramids of number can be upright or inverted depending on the ecosystem.

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

**(A) Explain what is meant by the term amniocentesis. How is this technique misused in India?**

**OR**

**(B) Name any two VDs which might occur in a human female. State any two complications in a female if it is left untreated.**

**Solution:**

**(A) Step 1:** Amniocentesis is a prenatal diagnostic technique used to detect chromosomal abnormalities in the fetus.

**Step 2:** A small amount of amniotic fluid is withdrawn from the amniotic sac surrounding the fetus using a syringe under ultrasound guidance. **Step 3:** Misuse in India:

- The technique is often misused for sex determination.
- This leads to female foeticide, contributing to an imbalanced sex ratio.

**OR**

**(B) Step 1:** Two common venereal diseases (VDs) in females are:

- Gonorrhoea
- Syphilis

**Step 2:** If left untreated, complications may include:

- Pelvic inflammatory disease (PID), which can lead to infertility.
- Ectopic pregnancy or damage to reproductive organs.

**Quick Tip**

Amniocentesis is for fetal diagnosis but misused for sex determination. VDs like gonorrhoea and syphilis can cause infertility and reproductive damage.

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

**(A) Give an account of the generalised structure of an antibody molecule produced by B-lymphocytes in response to the pathogen.**

**OR**

**(B) Other than public awareness and counselling, enlist four measures taken up by NACO, WHO and other NGOs to prevent the spread of HIV infection in the society.**

**Solution:**

**(A) Step 1:** An antibody is a Y-shaped glycoprotein made by B-lymphocytes in response to an antigen.

**Step 2:** Structure of an antibody molecule:

- Composed of four polypeptide chains — two identical light (L) chains and two identical heavy (H) chains.
- Chains are held together by disulfide bonds.
- Each chain has a variable region and a constant region.
- The variable region forms the antigen-binding site — specific to each antigen.
- The constant region determines the antibody class (IgA, IgG, etc.).

**Step 3:** The specificity of the antibody is due to the antigen-binding sites present on the variable regions of the light and heavy chains.

**OR**

**(B) Step 1:** Public awareness and counselling are essential to prevent HIV spread. In addition to these, the following measures are taken:

- Ensuring safe blood transfusion by proper screening.
- Use of disposable syringes and needles.
- Promoting safe sex practices (e.g., use of condoms).
- Providing antiretroviral therapy (ART) to infected individuals.

**Step 2:** Organizations like NACO and WHO also promote voluntary testing and confidentiality to reduce stigma and improve early diagnosis.

**Quick Tip**

Antibodies are specific to antigens and made of two heavy and two light chains. HIV prevention includes awareness, safe sex, safe blood, and ART programs.

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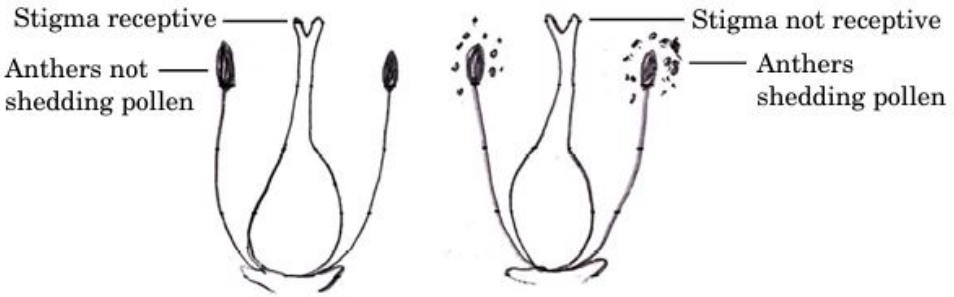
## SECTION C

**22. Many of the flowering plants producing hermaphrodite flowers have developed many devices to discourage self-pollination and to encourage cross-pollination. Given below is a picture of one such outbreeding device in a flowering plant. Study the picture and answer the questions that follow:**




Flowers present on different plants of same species

(a) Explain how the given type of pollination is advantageous to the plant.

(b) Can this flowering plant show geitonogamy? Justify your answer.

**Solution:**

(a) In the given type, stigma becomes receptive when anthers are not shedding pollen and vice versa. This prevents self-pollination and promotes cross-pollination, which enhances genetic variation and adaptability.

(b) Yes, the plant can show geitonogamy because the flowers are on the same plant. Though genetically it resembles self-pollination, it functionally involves different flowers.

Quick Tip

Dichogamy and herkogamy are common mechanisms to promote cross-pollination in hermaphrodite plants.

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**23. Enlist three advantages of genetically modified plants.**

**Solution:**

- Genetically modified (GM) plants show increased resistance to pests, reducing pesticide use.
- They offer higher yield and improved nutritional content.
- GM plants can tolerate abiotic stresses like drought, salinity, and extreme temperatures.

Quick Tip

Remember — GM plants improve productivity, pest resistance, and stress tolerance.

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**24. Explain the neuroendocrine mechanism involved in the process of parturition in a human female leading to the expulsion of the baby out of the uterus through the birth canal.**

**Solution:**

**Step 1:** Parturition is the process of childbirth, initiated by a complex neuroendocrine mechanism.

**Step 2:**

- Signals from the fully developed foetus and placenta trigger mild uterine contractions.
- These contractions are sensed by the maternal hypothalamus, which signals the posterior pituitary to release **oxytocin**.
- Oxytocin causes stronger uterine contractions (positive feedback mechanism).
- These contractions further stimulate oxytocin release, intensifying the process.
- Eventually, this leads to expulsion of the baby through the birth canal.

Quick Tip

Oxytocin plays a major role in parturition through a positive feedback loop, leading to stronger and more frequent uterine contractions.

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**25. Name one commonly occurring genetic disorder in humans which is caused due to monosomy (one chromosome less than the normal number of chromosomes) of sex chromosome. Give its two symptoms.**

**Solution:**

**Step 1:** The genetic disorder caused by monosomy of a sex chromosome is called **Turner's syndrome**. It occurs due to the presence of only one X chromosome (45, $X_O$).

**Step 2:** Two symptoms of Turner's syndrome are:

- Underdeveloped secondary sexual characters.
- Short stature and webbed neck.

Quick Tip

Turner's syndrome occurs in females due to absence of one X chromosome — look for features like short stature, infertility, and webbed neck.

**26. Explain how the loss of habitat and fragmentation drives plants and animals to extinction with the help of an example of habitat loss in the Tropical Rain Forest. Also write the effect of fragmentation of a habitat on the population decline.**

**Solution:**

- Habitat loss and fragmentation reduce the available area for wildlife, restricting food, shelter and breeding grounds.
- Fragmentation divides populations into small, isolated groups, leading to inbreeding and reduced genetic diversity.
- An example is the clearing of Tropical Rain Forests for agriculture and settlements, which leads to species extinction.
- Fragmentation causes edge effects, making populations more vulnerable to predators and environmental changes.

Quick Tip

Remember — fragmentation reduces population size and gene flow, increasing extinction risks.

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**27. (a) Write the full form of BOD.**

**Solution:**

- The full form of BOD is **Biochemical Oxygen Demand**.

Quick Tip

Remember — BOD stands for Biochemical Oxygen Demand, an important indicator of water pollution.

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**(b) Define BOD. Explain how it is a measure of the organic matter present in the water body.**

**Solution:**

- Biochemical Oxygen Demand (BOD) is the amount of dissolved oxygen required by aerobic microorganisms to break down organic matter in a given volume of water over a specified period.
- It indicates the level of organic pollution in water.
- Higher BOD values mean more organic matter is present, which requires more oxygen for decomposition, indicating higher pollution.
- It is a crucial parameter in assessing the health and quality of water bodies.

Quick Tip

Remember — Higher BOD means more organic waste in water, lowering its quality.

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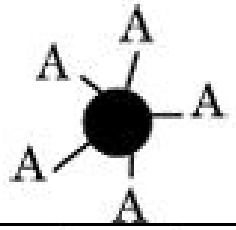
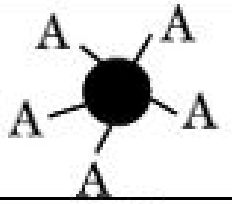
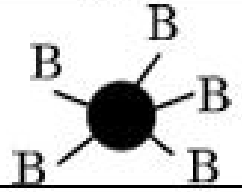
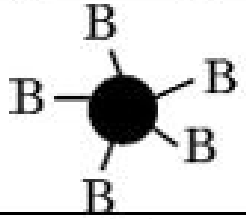
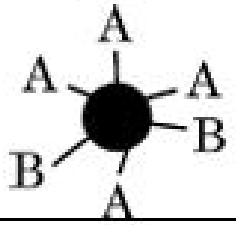
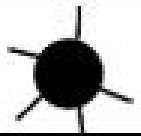
**28.**

| Genotype | RBC | Phenotype |
|---|---|---|
| $I^AI^A$ |  | A |
| $I^Ai$ |  | A |
| $I^BI^B$ |  | B |
| $I^Bi$ |  | B |
| $I^AI^B$ |  | AB |
| ii |  | O |

**Study the diagram above and answer the following questions:**

(a) How many alleles are involved in blood grouping?

(b) A person having 'AB' blood group has both dominant alleles. What is this inheritance type called?

(c) A man with 'A' blood group marries a woman with 'B' blood group. Can they have a child with 'O' blood group? Explain with the help of a cross.

**Solution:**

(a) Three alleles are involved in blood grouping: $I^A$, $I^B$, and $i$.

(b) This inheritance is called codominance because both $I^A$ and $I^B$ alleles express themselves equally in the phenotype.

(c) Yes, they can have a child with 'O' blood group if both the parents are heterozygous, i.e., the man has genotype $I^Ai$ and the woman has genotype $I^Bi$.

**Cross:**

| | $I^B$ | $i$ |
|---|---|---|
| $I^A$ | $I^AI^B$ (AB) | $I^Ai$ (A) |
| $i$ | $I^Bi$ (B) | $ii$ (O) |

**Quick Tip**

Blood group inheritance involves multiple alleles and codominance. Use Punnett squares to predict possible genotypes.

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## SECTION D

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

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

Highly conserved proteins such as Haemoglobin and Cytochrome-C provide the best biochemical evidences to trace evolutionary relationships between different groups. Cytochrome-C is formed of 104 amino acids. Cytochrome-C is the respiratory pigment present in all eukaryotic cells. It has evolved at a constant rate during evolution. In chimpanzees and humans, Cytochrome-C genes are identical. The given data shows the evolution of the Cytochrome-C gene in different mammals from kangaroos, cows, rodents to humans:

| Groups | Nucleotide substitution in the gene of Cytochrome-C | Millions of years ago |
|---|---|---|
| Human/Kangaroo | 100 | 125 mya |
| Human/Cow | 75 | 120 mya |
| Human/Rodent | 60 | 75 mya |

(a) Select the correct option for the time of separation of two groups and the number of nucleotide substitutions in the gene of Cytochrome-C:

| Options | Time of separation of two groups during evolution | Number of nucleotide substit |
|---|---|---|
| (i) | Lesser | Greater |
| (ii) | Greater | Lesser |
| (iii) | Greater | Greater |

(b) What do you infer about the type of evolution (convergent or divergent) for the given pair of groups and why?

(i) Human and Kangaroo

(ii) Human and Rodent

(c) (i) Define convergent evolution.

**OR**

(ii) Define divergent evolution.

**Solution:**

(a) The correct option is **(iii) — Greater** the time of separation, **greater** the number of nucleotide substitutions. This reflects the accumulation of genetic changes over evolutionary time.

(b) (i) Human and Kangaroo: **Divergent evolution**, as both groups evolved from a common ancestor but underwent different evolutionary changes over time.

(ii) Human and Rodent: **Divergent evolution**, as they also share a common ancestor but diverged due to different selective pressures and environments.

(c) (ii) **Divergent evolution** is the process by which two or more related species become more dissimilar over time, usually in response to different environmental pressures or ecological niches.

**Quick Tip**

Greater nucleotide substitutions in conserved genes like Cytochrome-C typically indicate a longer evolutionary separation between species.

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

In 2021, 5.3 percent of 15 to 16-year-olds worldwide (13.5 million individuals) had used *Cannabis* in the past year according to UNODC. The adolescent brain is still developing and drug use can have long-term negative effects. Early drug use initiation can lead to faster development of dependence than in adults and other problems in adulthood. Parts of the Amazon Basin are at the intersection of multiple forms of organised crimes that are accelerating devastation, with severe implications for the security, health and well-being of the population across the region. The direct impact of coca cultivation on deforestation is minimal, but indirectly it acts as a catalyst for "Narco-deforestation". The laundering of drug trafficking profits into land speculation etc. is posing a growing danger to the world's largest rainforest.

(a) Which age group or period of growth people are more vulnerable to drug abuse?

(b) **Explain the negative impact of coca cultivation on the world's largest rainforest.**

(c) (i) From which part of the plant are cannabinoids mainly obtained? Mention any one negative effect of this drug on adolescents.

**OR**

(ii) State the scientific name of the plant from which coca alkaloids are derived and state one negative impact of use of excessive dosage of cocaine.

**Solution:**

(a) People in the **adolescent age group (15–16 years)** are more vulnerable to drug abuse due to ongoing brain development and susceptibility to peer pressure.

(b) Coca cultivation indirectly accelerates **"Narco-deforestation"** by laundering drug profits into land speculation, increasing deforestation rates and endangering the ecological balance of the Amazon rainforest.

(c) (i) Cannabinoids are mainly obtained from the **resin of the flowering tops and leaves** of the *Cannabis* plant.

- Negative effect: It can lead to **impaired cognitive development, memory loss and addiction in adolescents.**

**OR**

(ii) The scientific name of the plant is *Erythroxylum coca*.

- Excessive use of cocaine can cause **hallucinations, severe mental instability and cardiac failure.**

Quick Tip

Remember — adolescents are highly vulnerable to drug abuse, and coca cultivation indirectly worsens deforestation by fuelling illegal land speculation.

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## SECTION E

**31. Answer the following questions:**

(a) (i) Describe the population growth curve applicable in a population of any species in nature that has unlimited resources at its disposal.

(ii) Explain the equation of this growth curve.

(iii) Name the growth curve and depict a graphical plot for this type of population growth.

**OR**

(b) (i) Explain the conclusion drawn by Alexander von Humboldt during his extensive explorations in the wilderness of South American jungles.

(ii) Give the equation of the Species-Area relationship.

(iii) Draw a graphical representation of the relation between species richness and area for a wide variety of taxa such as birds, bats, etc.

**Solution:**

(a) (i) When unlimited resources are available, populations exhibit **exponential growth**. The population size increases rapidly without any environmental resistance.

(ii) The equation for exponential growth is:

$$\frac{dN}{dt} = rN$$

where:

- $N$ = population size
- $r$ = intrinsic rate of natural increase
- $\frac{dN}{dt}$ = change in population size per unit time

(iii) The growth curve is called the **J-shaped curve**. It shows rapid increase initially and continues rising steeply without a plateau.

(b) (i) Alexander von Humboldt observed that within a region, species richness increases with increasing area but only up to a certain limit.

(ii) The Species-Area relationship equation is:

$$\log S = \log C + Z \log A$$

where:

- $S$ = species richness
- $A$ = area
- $C$ and $Z$ = constants

(iii) **Graphical Representation:**

Quick Tip

Exponential (J-shaped) growth occurs only under ideal conditions. In nature, due to limited resources, most populations follow logistic (S-shaped) growth patterns.

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**32. Answer the following questions:**

(a) **Explain how the process of RNA interference technology is used effectively to prevent infestation of the roots of tobacco plant by the nematode *Meloidogyne incognita*.**

**OR**

(b) **Explain how more than a billion copies of a fragment of DNA are formed using the technique of PCR.**

**Solution:**

(a) **RNA interference (RNAi) Technology:**

- In this method, **specific genes responsible for nematode infestation are silenced**.
- The nematode *Meloidogyne incognita* affects tobacco plant roots.
- To counter this, a DNA sequence producing both sense and antisense RNA strands for the nematode's essential genes is introduced into the plant using **Agrobacterium vectors**.
- These complementary RNA strands form **double-stranded RNA (dsRNA)** inside the host plant cells.
- The dsRNA triggers the RNA interference (RNAi) mechanism, degrading the nematode's specific mRNA.
- As a result, the target gene is silenced, protecting tobacco plants from nematode attack.

(b) **Polymerase Chain Reaction (PCR) Process:**

- PCR is a technique to amplify a specific segment of DNA.
- The process involves multiple cycles of:

- **Denaturation:** Double-stranded DNA is heated to separate into single strands.
- **Annealing:** Primers bind to the specific target sequences.
- **Extension:** DNA polymerase extends primers to synthesize new DNA strands.

- Each cycle doubles the DNA quantity.
- Repeating this process for around **30 cycles results in over a billion copies** of the desired DNA fragment.

**Quick Tip**

RNA interference uses double-stranded RNA to silence genes, while PCR uses repeated cycles of heating and cooling to exponentially amplify DNA fragments.

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**33. Answer the following questions:**

(a) (i) Explain the structure of a typical monocotyledonous embryo of a flowering plant.

(ii) How are multiple embryos formed in a citrus fruit? What is the mechanism known as?

**OR**

(b) (i) Name and explain the structural organisation of the male sex accessory ducts in the human male reproductive system.

(ii) Describe the role of gonadotropin FSH in the regulation of spermatogenesis.

**Solution:**

(a) (i) **Structure of Monocotyledonous Embryo:**

- It consists of a single large cotyledon called **scutellum** placed laterally.
- There's a short axis with a plumule (embryonic shoot) and radicle (embryonic root) enclosed within protective sheaths called **coleoptile** and **coleorhiza**, respectively.

(ii) **Multiple embryos in citrus fruits:**

- Multiple embryos arise when nucellar cells surrounding the embryo sac start dividing and develop into embryos.

– This phenomenon is known as **Polyembryony**.

(b) (i) **Male Accessory Ducts:**

– Includes **rete testis**, **vasa efferentia**, **epididymis**, and **vas deferens**.

– They transport, store, and aid maturation of sperm.

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

– FSH acts on **Sertoli cells** to stimulate secretion of factors aiding spermatogenesis.

– Supports nourishment and maturation of developing sperms.

**Quick Tip**

Polyembryony is a form of asexual reproduction in plants where multiple embryos develop from a single fertilized ovule.

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