CBSE Class 12 2025 Biology Question Paper (57/5/1) 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. The histone core in a nucleosome of chromatin thread is a/an:

(A) Pentamer

(B) Hexamer

(C) Heptamer

(D) Octamer

Correct Answer: (D) Octamer

Solution:

The nucleosome core particle consists of a histone octamer, which is made up of two copies each of the core histone proteins H2A, H2B, H3, and H4. This octamer forms the core around which DNA is wrapped.

Quick Tip

The histone core of a nucleosome is an octamer containing 2 copies each of H2A, H2B, H3, and H4.

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2. Given below are few statements with reference to the uterus in the female reproductive system:

1. The myometrium exhibits strong contractions during the delivery of the baby.
2. The uterus opens into the cervix through a narrow opening called vagina.
3. The cavity of the cervix and the vagina forms the birth canal.
4. The outermost layer of uterus is a thin membranous perimetrium.
5. The uterus is supported by tendons attached to the pelvic wall.

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:

(i) is correct: The myometrium, the muscular layer of the uterus, contracts during childbirth.

(ii) is incorrect: The uterus opens into the cervix, which further leads into the vagina, not directly.

(iii) is correct: The cervix and vagina together form the birth canal.

(iv) is correct: The perimetrium is indeed the outermost thin membranous layer.

(v) is incorrect: The uterus is supported by ligaments, not tendons.

Quick Tip

The uterus connects to the cervix, has a muscular layer (myometrium) for contractions, and is covered by a thin layer called the perimetrium.

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3. During the process of transcription, after binding to a promoter, RNA polymerase catalyses and makes the bases in the template strand of DNA available for base pairing, with the bases of:

(A) Deoxyribonucleotide triphosphate

(B) Deoxyribonucleoside triphosphate

(C) Ribonucleotide triphosphate

(D) Ribonucleoside triphosphate

Correct Answer: (C) Ribonucleotide triphosphate

Solution:

During transcription, RNA polymerase synthesizes RNA by pairing ribonucleotide triphosphates (ATP, GTP, CTP, UTP) with the DNA template strand. These ribonucleotides provide both the base and the energy (via phosphate groups) for RNA chain elongation.

Quick Tip

Transcription uses ribonucleotide triphosphates as substrates for RNA synthesis.

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4. Which of the following is *not* an example of aneuploidy?

(A) Turner's syndrome

(B) Down's syndrome

(C) Phenylketonuria

(D) Klinefelter's syndrome

Correct Answer: (C) Phenylketonuria

Solution:

Aneuploidy refers to the presence of an abnormal number of chromosomes. Turner's, Down's, and Klinefelter's syndromes are caused by chromosomal number abnormalities. Phenylketonuria, however, is a metabolic disorder caused by a mutation in a single gene and not by aneuploidy.

Quick Tip

Phenylketonuria is a genetic disorder, not a chromosomal abnormality.

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5. Colostrum secreted by the mother's mammary glands in a human female during the initial days of lactation is rich in antibody:

(A) IgE

(B) IgD

(C) IgA

(D) IgG

Correct Answer: (C) IgA

Solution:

Colostrum, the first milk produced after childbirth, is rich in immunoglobulin A (IgA). IgA provides passive immunity to the newborn by protecting the mucosal surfaces from pathogens.

Quick Tip

IgA in colostrum gives the newborn protection against infections through mucosal immunity.

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6. Select the statements that are true for pollination mechanism in flowering plants from the given options:

1. In *Vallisneria*, the female flowers are pollinated by pollen grains inside the water.
2. In *Zostera*, pollen grains are released on the surface of water.
3. In most of the water-pollinated species, pollen grains are covered by a mucilaginous coating.
4. Pollination by water is quite rare and limited to about 30 genera.

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:

(i) True: In *Vallisneria*, pollination occurs underwater.

(ii) False: In *Zostera*, pollen grains are also released underwater, not on the surface.

(iii) True: Mucilaginous coating protects pollen in water-pollinated species.

(iv) True: Water pollination is rare and restricted to about 30 genera.

Quick Tip

Water pollination is uncommon and involves adaptations like mucilage-covered pollen grains.

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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)	Lemur	Spotted cuscus
(B)	Tasmanian tiger cat	Anteater
(C)	Bobcat	Lemur
(D)	Numbat	Anteater

Correct Answer: (D) Numbat – Anteater

Solution:

Convergent evolution is the phenomenon where unrelated organisms evolve similar traits due to similar environmental pressures. The numbat (a marsupial) and the anteater (a placental mammal) are an example of convergent evolution as both have evolved to feed on ants and termites despite being from different lineages.

Quick Tip

Convergent evolution leads to similar adaptations in unrelated groups, such as the numbat and anteater.

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8. Isolation of DNA from a fungal cell can be achieved by using:

(A) Cellulase

(B) Chitinase

(C) Lysozyme

(D) Protease

Correct Answer: (B) Chitinase

Solution:

Fungal cell walls are composed of chitin. Therefore, chitinase enzyme is used to break down the fungal cell wall during DNA isolation.

Quick Tip

Chitinase is used to break chitin-rich fungal cell walls during DNA isolation.

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9. During a monohybrid cross involving a tall pea plant with a dwarf pea plant, the offspring populations were tall and dwarf in equal ratio. Find out the genotype of parent pea plants.

(A) Tt × tt

(B) TT × Tt

(C) tt × tt

(D) Tt × Tt

Correct Answer: (A) Tt × tt

Solution:

A Tt (heterozygous tall) crossed with tt (homozygous dwarf) gives a 1:1 ratio of tall (Tt) and dwarf (tt) offspring. This matches the given phenotype ratio.

Quick Tip

A 1:1 tall to dwarf ratio results from a Tt × tt monohybrid cross.

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10. What would happen if a gene encoding a polypeptide of 50 amino acids, 25th Codon (UAU) is mutated to "UAA"?

(A) A polypeptide of 49 amino acids will be formed.

(B) A polypeptide of 25 amino acids will be formed.

(C) A polypeptide of 24 amino acids will be formed.

(D) A polypeptide of 50 amino acids will be formed.

Correct Answer: (C) A polypeptide of 24 amino acids will be formed.

Solution:

The codon UAA is a stop codon. Mutation of the 25^{th} codon from UAU (which codes for tyrosine) to UAA will terminate translation prematurely, resulting in only 24 amino acids being formed.

Quick Tip

A premature stop codon (UAA) halts translation, producing a truncated protein.

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11. Large scale industrial production of Butyric acid for human welfare is done using the microbe:

(A) *Aspergillus* sp.

(B) *Streptococcus* sp.

(C) *Clostridium* sp.

(D) *Trichoderma* sp.

Correct Answer: (C) *Clostridium* sp.

Solution:

Clostridium species are anaerobic bacteria known for their role in producing butyric acid as a metabolic by-product in fermentation processes.

Quick Tip

Clostridium bacteria are used in fermentation industries to produce butyric acid.

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12. The correct depiction of the centrifugation step of the experiment conducted by Alfred Hershey and Martha Chase on using radioactive labelled phages to prove that DNA is the genetic material is:

(A)	No Radioactive (^{35}S) detected in cells + Radioactive (^{35}S) detected in supernatant	Radioactive (^{32}P) detected in cells + No Radioactivity detected in supernatant
(B)	Radioactive (^{35}S) detected in cells + Radioactive (^{35}S) detected in supernatant	No Radioactive (^{32}P) detected in cells + No Radioactivity detected in supernatant
(C)	No Radioactive (^{35}S) detected in cells + No Radioactivity detected in supernatant	Radioactive (^{32}P) detected in cells + Radioactive (^{35}S) detected in supernatant
(D)	Radioactive (^{35}S) detected in cells + No Radioactivity detected in supernatant	No Radioactive (^{32}P) detected in cells + Radioactive (^{35}S) detected in supernatant

Correct Answer: (A)

Solution:

In the Hershey-Chase experiment, DNA was labelled with radioactive phosphorus (^{32}P) and protein with radioactive sulfur (^{35}S). After centrifugation, ^{32}P was found in the cells (pellet), showing DNA enters the bacterial cell, whereas ^{35}S was found in the supernatant, showing that proteins do not enter the cells.

Quick Tip

Only radioactive ^{32}P was found inside bacterial cells, confirming DNA as genetic material.

Question numbers 13 to 16 consist of two statements — Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

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

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

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

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

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

Solution:

Step 1: Totipotency refers to the ability of a single plant cell to regenerate into an entire plant — so Assertion is true.

Step 2: Reason is also true as sterile conditions and nutrient media are needed for *in vitro* culture.

Step 3: However, the Reason does not directly explain the definition of totipotency.

Therefore, option (B) is correct.

Quick Tip

Totipotency is the capacity of a cell to regenerate into a whole plant, while *in vitro* conditions provide the environment needed for such growth.

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14. 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:

Step 1: Biogas plants are indeed more prevalent in rural areas due to easy availability of cattle dung — Assertion is true.

Step 2: Cattle dung contains *Methanobacterium*, which helps in methane production — Reason is true.

Step 3: The presence of *Methanobacterium* in gobar is the reason biogas plants are suitable for rural areas — so Reason explains Assertion.

Quick Tip

Cattle dung is a major raw material for biogas, making rural areas ideal for such installations.

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15. 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:

Step 1: Gene pairs on the same chromosome can have varying linkage strength — Assertion is true.

Step 2: Recombination frequency is used to map genes, but between gene pairs on the same chromosome, not different ones — Reason is true but misphrased.

Step 3: Since Reason doesn't explain Assertion properly, (B) is correct.

Quick Tip

Mapping is based on recombination frequencies between linked genes, not genes on different chromosomes.

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16. Assertion (A): Cu-T, Cu-7 and LNG-20 are the most widely used copper-releasing IUDs.

Reason (R): Cu-ions in IUDs effectively suppress sperm motility and the fertilising capacity of sperms.

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

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

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

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

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

Solution:

Step 1: Cu-T, Cu-7, and LNG-20 are common IUDs — Assertion is true.

Step 2: Copper ions impair sperm motility and fertility — Reason is true.

Step 3: This mechanism directly explains the effectiveness of copper IUDs — so (A) is correct.

Quick Tip

Copper IUDs work mainly by releasing ions that make the uterine environment hostile for sperms.

SECTION B

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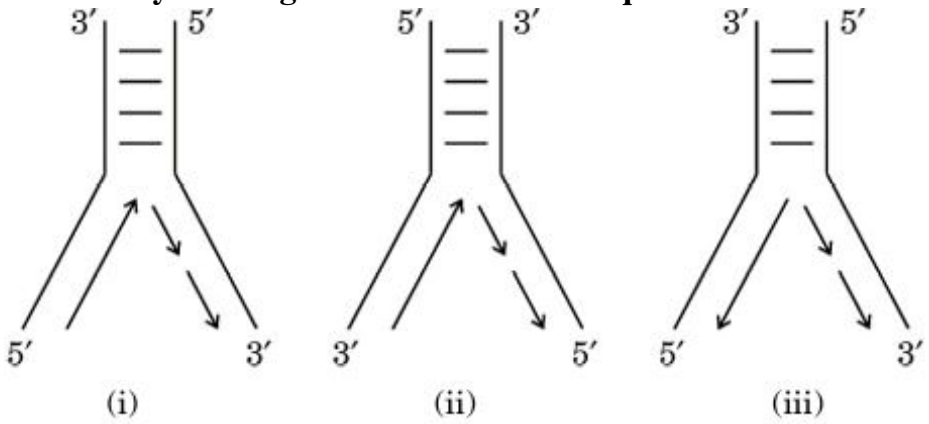
18. Given below are the diagrammatic representations of the replicating fork of DNA in *E. coli*. Study the diagrams and answer the questions that follow.



(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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19. 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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20. 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.

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21. 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.

SECTION C

22. 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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23. During a medical investigation, an infant was found to possess an extra copy of chromosome no. 21. Identify the disorder the child is suffering from. Describe the symptoms the child is likely to develop later in life.

Solution:

Step 1: The child is suffering from **Down's syndrome**, a genetic disorder caused by trisomy of chromosome 21.

Step 2: Symptoms and characteristics include:

- Intellectual disability and delayed development.
- Distinct facial features — flat facial profile, upward slanting eyes.

- Poor muscle tone and short stature.
- Increased risk of congenital heart defects and respiratory issues.

Quick Tip

Down's syndrome is caused by nondisjunction leading to trisomy 21 and is associated with both physical and mental developmental delays.

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24. (a) Write the full form of BOD.

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

Solution:

Step 1: **(a)** The full form of BOD is **Biochemical Oxygen Demand**.

Step 2: **(b)** BOD is the amount of dissolved oxygen needed by aerobic microorganisms to break down organic matter present in a water sample.

- A higher BOD indicates more organic pollution and microbial activity.
- It is an indicator of the level of biodegradable organic matter in the water body.

Quick Tip

BOD is used as a key measure of water quality—more BOD means more pollution.

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25. Enlist three advantages of genetically modified plants.

Solution:

Step 1: Genetically modified (GM) plants have been engineered for specific beneficial traits.

Step 2: Key advantages include:

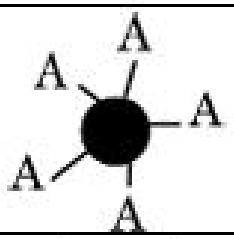
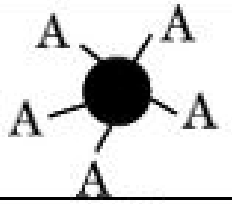
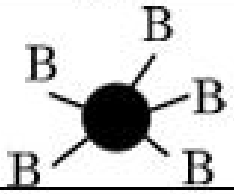
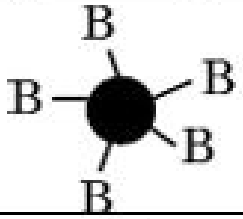
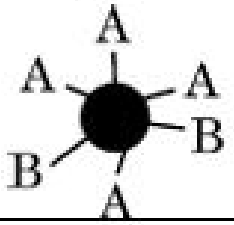
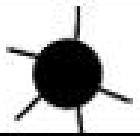
- Increased resistance to pests and diseases (e.g., Bt cotton).
- Enhanced tolerance to herbicides and environmental stresses.

- Improved nutritional content and shelf life.

Quick Tip

GM plants can improve crop yield, reduce dependency on chemical pesticides, and enhance food security.

26.

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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27. 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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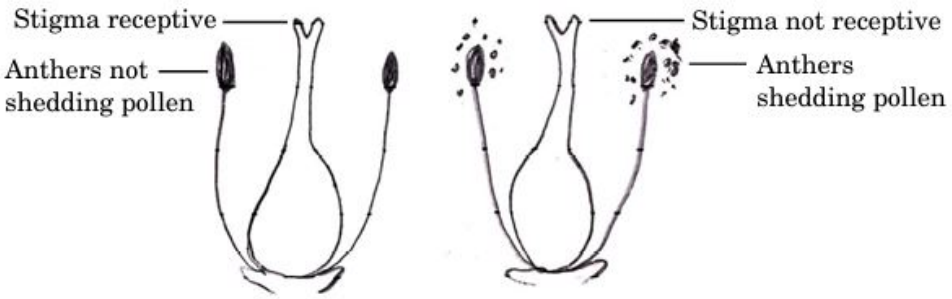
28. Many of the flowering plants producing hermaphrodite flowers have developed many devices to discourage self-pollination and to encourage cross-pollination. Given below is a picture of one such outbreeding device in a flowering plant. Study the picture and answer the questions that follow:



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.

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 substitu
(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 molecular divergence over time.

(b) (i) Human and Kangaroo: **Divergent evolution** — they have a common ancestor but have evolved differently over time.

(ii) Human and Rodent: **Divergent evolution** — differences accumulated due to different evolutionary paths from a common ancestor.

(c) (ii) **Divergent evolution** is the process in which two or more related species become more dissimilar due to different environments and selective pressures.

Quick Tip

Greater genetic difference in conserved genes like Cytochrome-C usually indicates a longer evolutionary separation between species.

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 are people 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) Adolescents in the age group of **15 to 16 years** are more vulnerable to drug abuse due to psychological and hormonal changes during development.

(b) Coca cultivation contributes to **"Narco-deforestation"** indirectly by promoting organised crime, land speculation and the destruction of rainforest ecosystems.

(c) (ii) The scientific name of the plant is **Erythroxylum coca**. Excessive use of cocaine can lead to **severe addiction and brain damage**.

Quick Tip

Adolescence is a high-risk period for drug addiction; early awareness and preventive measures are essential for long-term health and safety.

SECTION E

31.

(a) Define transgenic animals. Explain in detail any four areas where they can be used for human benefit.

OR

(b) Describe the structure and working of a sparged stirred-tank bioreactor.

Solution:

(a) **Transgenic animals** are those animals whose DNA has been deliberately altered by introducing a foreign gene. These animals carry and express an extra gene (transgene) from another organism.

Four important uses of transgenic animals for human benefit:

- **Normal physiology and development:** To study gene regulation and the effect of genes on normal functions and development.
- **Disease models:** To understand the development and progression of diseases like cancer, cystic fibrosis, rheumatoid arthritis, etc.
- **Biological products:** Transgenic animals can be used to produce therapeutic proteins such as human insulin or -1-antitrypsin in their milk.
- **Vaccine safety testing:** Transgenic mice are used for toxicity and safety tests for vaccines.

(b) **Sparged stirred-tank bioreactor:** It is a cylindrical vessel equipped with a mechanical stirrer for mixing and sparger for air supply.

Structure:

- It contains an agitator (stirrer), sparger (for aeration), baffles (to break vortex), and a jacket (for temperature control).

Working:

- Air or oxygen is sparged through the culture medium to supply oxygen to the growing cells.
- The stirrer ensures even mixing and proper distribution of nutrients and gases.
- This maintains uniform environmental conditions and enhances cell growth and productivity.

Quick Tip

Transgenic animals play a critical role in studying gene functions and producing valuable biological products. Bioreactors ensure optimum conditions for industrial-scale production.

32.

(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 resources are unlimited, a population grows exponentially. It starts slowly but grows rapidly over time.

(ii) The equation is:

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

where N is the population size, r is the intrinsic rate of natural increase, and $\frac{dN}{dt}$ is the rate of change in population size.

(iii) The curve is called the **J-shaped growth curve**. The graph shows population size on the Y-axis and time on the X-axis.

(b) (i) Alexander von Humboldt observed that within a region, species richness increased with the explored area, but only up to a limit.

(ii) The species-area relationship is described by the equation:

$$S = CA^Z$$

where S is species richness, A is area, C is a constant, and Z ranges from 0.1 to 0.2 for smaller regions.

(iii) The graph is a curve that rises rapidly at first and then levels off, showing a logarithmic relationship between species richness and area.

Quick Tip

The J-shaped curve applies to populations with unlimited resources. The Species-Area relationship reflects biodiversity patterns: larger areas tend to support more species.

33.

(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) A typical monocot embryo consists of one cotyledon (called scutellum), a radicle enclosed in coleorhiza, and a plumule enclosed in coleoptile. The embryo is small and lies in one corner of the seed, with the rest filled by endosperm.

(ii) Multiple embryos in citrus fruits arise due to the development of additional embryos from the nucellus or integuments (maternal tissue), besides the zygotic embryo. This mechanism is known as **polyembryony**.

(b) (i) The male sex accessory ducts include:

- **Rete testis**: a network of tubules in the testis
- **Vasa efferentia**: transport sperm from the testis to the epididymis
- **Epididymis**: where sperm mature and are stored
- **Vas deferens**: carries sperm from epididymis to urethra
- **Urethra**: common passage for sperm and urine to exit the body

(ii) FSH (Follicle Stimulating Hormone) acts on the Sertoli cells in seminiferous tubules and stimulates the process of spermatogenesis by promoting the nourishment and development of spermatogenic cells.

Quick Tip

Monocot embryos have a single cotyledon, and polyembryony is a common asexual phenomenon in citrus. In males, accessory ducts ensure sperm transport, and FSH is crucial for initiating and sustaining spermatogenesis.