

# CBSE CLASS 12 Biology Sample Paper Solution 2024-25

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## Section – A

**Q. No. 1 to 12 are multiple choice questions. Only one of the choices is correct. Select and write the correct choice as well as the answer to these questions.**

**Ques 1. Signals for parturition in human female originate from**

- A. Fully developed foetus only**
- B. Both placenta as well as fully developed foetus**
- C. Placenta only**
- D. Oxytocin released from maternal pituitary**

**Ans. B**

**Solu.** Hormonal changes brought on by the placenta and fetus are parturition signals, which eventually cause labor to begin.

**Ques 2. To produce 1600 seeds, the number of meiotic divisions required will be**

- A. 2400**
- B. 2000**
- C. 1600**
- D. 1800**

**Ans. A**

**Solu.** Four haploid cells are produced by each meiotic division, hence 400 meiotic divisions are required to create 1600 seeds (400 divisions  $\times$  4 seeds per division = 1600 seeds).

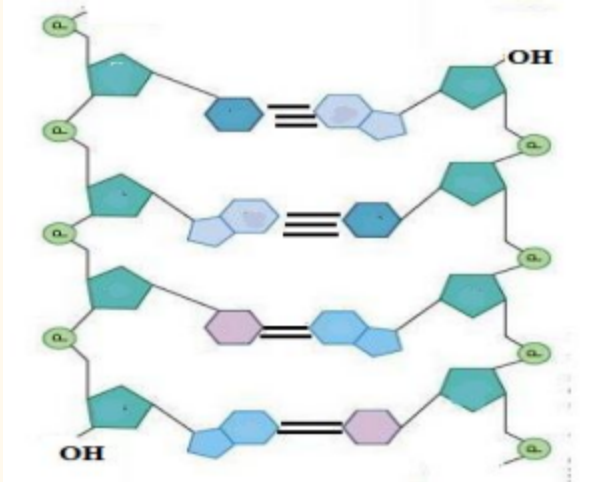
**Ques 3. A sample of normal double-stranded DNA was found to have thymine content of 27%. What will be the expected proportion of guanine in this strand?**

- A. 23%**
- B. 32%**
- C. 36%**
- D. 73%**

**Ans. A**

**Solu.** We can apply Chargaff's criteria, which specify that the amounts of adenine (A) and cytosine (C) are equal to guanine (G) in a sample of normal double-stranded DNA with a thymine content of 27%. Consequently, adenine will likewise be 27% as thymine is 27%. All four bases (A, T, C, and G) must have a combined proportion of 100%. Consequently, we can use the following formula to get the total percentage of guanine and cytosine:  $27\% + 27\% = 46\%$  of 100%. As guanine and cytosine are equal, we may express this as  $2G = 46\%$ , which allows us to determine that guanine makes up 23% of the total. As a result, 23% of guanine should be present in this DNA strand.

**Ques 4. Observe the schematic diagram that depicts a small section of nucleic acid. The bases in two strands are paired through hydrogen bonds that are shown by the dark lines. Identify the correct sequence of nucleotide in the 5'-3' direction.**



- A. GCAT
- B. CGTA
- C. TAGC
- D. ATCG

**Ans. B**

**Solu.** Understanding that the two strands of a DNA double helix run in antiparallel orientations and are joined by particular base pairing via hydrogen bonds is crucial to determining the proper sequence of nucleotides in the 5'-3' direction. Thymine (T) and guanine (G) couple with adenine (A) and cytosine (C). The complementary strand is 3'-CGTA-5' if the provided sequence of one strand is, for instance, 5'-GCAT-3'. We reverse the complimentary bases to obtain 5'-CGTA-3', which is the 5'-3' sequence of the complementary strand. As a result, CGTA is the proper nucleotide sequence in the 5'-3' direction.

**For Visual Impaired Students**

**E. coli has  $4.6 \times 10^6$  base pairs and completes the process of replication in 18 minutes, then the average rate of polymerization is approximately**

- A. 2000 bp/s

- B. 4000 bp/s**
- C. 3000 bp/s**
- D. 1000 bp/s**

**Ans. A**

**Solu.** To determine the average rate of polymerization during DNA replication in \*E. coli\*, we begin by noting that E. coli has  $4.6 \times 10^6$  base pairs and completes replication in 18 minutes. Converting 18 minutes into seconds ( $18 \times 60 = 1080$  seconds), we can calculate the replication rate. Since replication in E. coli is bidirectional, there are two replication forks working simultaneously, so each fork replicates half of the genome. Therefore, each fork replicates  $2.3 \times 10^6$  base pairs. Dividing the number of base pairs per fork by the total time gives the polymerization rate:  $2.3 \times 10^6 / 1080$  base pairs per second, which rounds to approximately 2129.63. Thus, the correct answer is 2000 bp/s.

**Ques 5. Suresh and Rajesh have defective haemoglobin due to genetic disorders. In Suresh, the problem is qualitative as he is having incorrectly functioning globin molecules while in Rajesh the problem is quantitative as he is having very few globin molecules. Identify the disorder they are suffering from.**

	<b>Suresh</b>	<b>Rajesh</b>
<b>A</b>	Thalassemia - Autosomal Dominant blood disorder	Sickle Cell Anaemia - Autosomal linked Recessive trait
<b>B</b>	Sickle Cell Anaemia - Autosomal linked Dominant trait	Thalassemia - Autosomal Recessive blood disorder
<b>C</b>	Sickle Cell Anaemia – Autosomal linked Recessive trait	Thalassemia – Autosomal Recessive blood disorder
<b>D</b>	Thalassemia - Autosomal Dominant blood disorder	Sickle Cell Anaemia - Autosomal linked Dominant trait

**Ans. C**

**Solu.** In this case, Suresh has a qualitative issue, which means that while his hemoglobin is present, it is not functioning properly because of a structural flaw in the globin molecules, a feature common to sickle cell anemia. Red blood cells with an irregular shape are the result of a mutation in the  $\beta$ -globin gene, which causes this condition. The disease sickle cell anemia is recessive by inheritance. Rajesh, on the other hand, suffers from a quantitative issue, which is indicative of thalassemia since he has fewer globin molecules. An insufficient amount of hemoglobin is the result of a malfunction in the synthesis of one or more globin chains, which causes thalassemia. Another autosomal recessive illness is thalassemia.

**Ques 6. In E.coli, the lac operon gets switched on when lactose is**

- A. present in the medium and it binds to the repressor.**
- B. not present in the medium and the repressor binds to the operator.**
- C. not present in the medium and RNA polymerase binds to the operator.**
- D. Active lactose present in the medium binds to RNA polymerase.**

**Ans. A**

**Solu.** When lactose, or more precisely, its product allolactose, attaches to the repressor and releases the operator, the lac operon gets activated. This makes the operon accessible to RNA polymerase, which in turn starts the transcription of the genes required for lactose digestion. Therefore, the lac operon is activated when lactose is present because it eliminates the repressor's inhibition.

**Ques 7. Which of the following features shows the mechanism of sex determination in honey-bee?**

- (i) An offspring formed from the union of a sperm and egg develops as a female.**
- (ii) Males have half the number of chromosomes than that of female.**
- (iii) The males are haploid having 32 chromosomes.**
- (iv) All workers and males are diploid having 16 chromosomes**

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

**Ans. A**

**Solu.** Haplodiploidy is the basis for the sex determination mechanism in honeybees. The male develops from unfertilized eggs and is haploid, whereas the female develops from fertilized eggs and is diploid. As a result, the mechanisms underlying honeybee sex determination are accurately described by assertions (i) and (ii).

**Ques 8.** The following diagram shows a fragment of DNA which is going to be transcribed, the upper strand with polarity 3' to 5' is the template strand:

**3' ATTGCC 5'**  
**5' TAACGG 3'**

**After transcription the mRNA can be represented by:**

- A. 5' AUUGCC 3'**
- B. 5' AUUGCC 3'**
- C. 5' UAACGG 3'**
- D. 5' GGCAAU 3'**

**Ans. C**

**Solu.** Using base-pairing rules, the mRNA is generated complementary to the DNA template strand during transcription, where:

In RNA, adenine (A) pairs with uracil (U) rather than thymine.

Adenine (A) and thymine (T) couple together.

Guanine (G) and Cytosine (C) pair together.

Cytosine (C) and Guanine (G) couple together.

The mRNA sequence is complementary to the template strand of DNA, which has the polarity 3' ATTGCC 5'.

- A pairs with U → U
- T pairs with A → A
- T pairs with A → A
- G pairs with C → C
- C pairs with G → G
- C pairs with G → G

Thus, the mRNA sequence will be 5' UAACGG 3'.

**Ques 9. Idli – dosa dough rises due to production of which of the following gas?**

- A. CO**
- B.  $CO_2$**
- C. NO**
- D.  $NO_2$**

**Ans. B**

**Solu.** The idli-dosa dough expands and rises as a result of the fermentation process, producing carbon dioxide (CO<sub>2</sub>), which gives the dough a light and fluffy feel. Therefore, CO<sub>2</sub> is the gas causing this activity.

**Ques 10. Adaptive radiation leads to which of the following?**

- A. Increased competition among species**
- B. Decreased speciation rates**
- C. Limited morphological diversity among species**
- D. Rapid divergence of traits among populations inhabiting a given geographical area.**

**Ans. D**

**Solu.** Rapid species diversification brought about by adaptive radiation enables them to take advantage of various ecological niches and gives rise to unique physical and behavioral characteristics in populations. Increased species variety and the quick evolution of new species are encouraged by this mechanism.

**Ques 11. Eco R1 cuts the DNA between bases G and A only when the sequence of GAATTC is present. The number of nucleotides present in the resultant sticky ends that will be formed in each of the two strands of DNA after this enzyme cuts the DNA will be:**

	<b>Vector DNA</b>	<b>Foreign DNA</b>
<b>A.</b>	<b>1 &amp; 5</b>	<b>5 &amp; 1</b>
<b>B.</b>	<b>2 &amp; 4</b>	<b>4 &amp; 2</b>
<b>C.</b>	<b>2 &amp; 5</b>	<b>5 &amp; 2</b>
<b>D.</b>	<b>3 &amp; 4</b>	<b>4 &amp; 3</b>



**Ans. B**

**Solu.** The restriction enzyme EcoRI can distinguish between the G and A nucleotides in the DNA sequence GAATTC. Due to this cleavage, sticky ends are formed; the bottom strand's sticky end is made up of another single nucleotide (A), whereas the top strand's sticky end is a single nucleotide (G). However, depending on the foreign DNA used and the vector's environment, there might be differences in the total length of the sticky ends generated from the cut DNA strands. The choices offered indicate various nucleotide length combinations for the sticky ends that develop on each strand. According to the usual outcomes of EcoRI cutting, the resulting sticky ends will probably produce configurations like 2 nucleotides on one strand and 4 on the other, making 2 & 4 a reasonable assumption when taking into account the complete cut and additional sequences that may be considered.

**Ques 12. During the secondary treatment of sewage, which of the following change in the effluent occur due to flocs?**

- A. Reduction in BOD**
- B. Increase in BOD**
- C. Decrease in DO**
- D. No change in DO or BOD**

**Ans. A**

**Solu.** The biochemical oxygen demand (BOD) of the effluent significantly decreases as flocs form during the secondary treatment of sewage, indicating a decrease in the organic matter contained in the wastewater.

**Ques 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 and R is not the correct explanation of A.**
- C. A is true but R is false.**
- D. A is False but R is true.**

**Ques 13. Assertion (A): Cells of tapetum have more than one nucleus.  
Reason (R): They undergo meiosis without cytokinesis.**

**Ans. A**

**Solu.** The layer of cells in the anther of blooming plants called the tapetum feeds the germinating pollen grains. Because these cells are involved in delivering nutrients during the generation of pollen, they frequently have many nuclei. They are capable of going through meiosis without cytokinesis, which results in a multinucleated state.

**Ques 14. Assertion (A): Deoxyribonucleoside triphosphates serve dual purposes.**

**Reason (R): They act as proof readers and provide energy.**

**Ans. B**

**Solu.** In fact, deoxyribonucleoside triphosphates, or dNTPs, are necessary for DNA synthesis because they supply the building blocks for DNA as well as the energy needed for polymerization. But rather than being a direct result of dNTPs, proofreading is essentially a function of DNA polymerases and the exonuclease activity that goes along with them. As a result, even though both claims are true, the explanation does not directly address the claim.

**Ques 15. Assertion (A): A floating cover placed over the slurry in a biogas plant keeps on rising.**

**Reason (R): This cover keeps on rising due to the gas produced in the tank by the microbial activity.**

**Ans. A**

**Solu.** Microbial activity breaks down organic waste in a biogas plant, resulting in the production of biogas (mostly methane) as a byproduct. It rises as a result of the methane building up beneath the floating cover. As a result, the claim is supported by the reason, which also accurately explains the claim.

**Ques 16. Assertion (A): DNA fragments can be isolated by Gel electrophoresis on the basis of their size.**

**Reason (R): The larger the fragment size, the faster it moves.**

**Ans. D**

**Solu.** It is accurate to say that DNA fragments are separated according to size using gel electrophoresis. But that's not the real reason. Smaller DNA fragments flow through the gel matrix more quickly than larger ones during gel electrophoresis. As a result, although the statement is true, the logic is flawed.

### **Section - B**

**Ques 17. Attempt either option A or B.**

**A. (i) A blood test reported negative for hCG. What does negative hCG imply? Name the tissue which produces hCG?**

**Solu.** Since hCG is a hormone produced by the placenta immediately after a fertilized egg implants in the uterus, a negative result for hCG in a blood test typically indicates that the person is not pregnant. Tests for blood and urine usually reveal the presence of hCG, which indicates pregnancy.

The syncytiotrophoblast, a tissue found in the developing placenta, is the source of hCG. This tissue develops quickly after the embryo is implanted and is in charge of secreting hCG to sustain the corpus luteum and encourage the production of progesterone, which in turn supports pregnancy.

**(ii) If a blood test reported positive for hCG in a person, then which other hormones would also be secreted by the tissue secreting hCG?**

**Solu.** The tissue that secretes hCG, the placenta, also secretes a number of other hormones if a blood test results in a positive result for hCG, which indicates pregnancy. These hormones include:

Progesterone is necessary to support the early phases of pregnancy and to preserve the lining of the uterus.

Estrogen: Rises during pregnancy to promote fetal development and preserve the uterine environment.

Relaxin: Plays a role in uterine relaxation and body preparation for birthing.

Pregnancy metabolism is influenced by human placental lactogen (hPL), which also aids in getting the breasts ready for lactation.

Together, these hormones promote and sustain pregnancy while encouraging the fetus's growth and development.

**OR**

**B. (i) The human male ejaculates about 200 to 300 million sperm during a coitus, however the ovum is fertilized by only one sperm. How does the ovum block the entry of additional sperms?**

**Solu.** Several processes are triggered during fertilization to prevent the entry of additional sperm when a sperm successfully penetrates the ovum:

**Fast Block to Polyspermy:** The electrical potential across the egg membrane rapidly changes as the sperm and egg membranes fuse. This alteration, referred to as the fast block, stops more sperm from merging with the egg.

**Slow Block to Polyspermy (Cortical Reaction):** After the fast block, the egg experiences a cortical reaction in which enzymes are released into the area between the membrane and the zona pellucida, the layer of protection surrounding the egg, by cortical granules, which are tiny vesicles just beneath the membrane. The zona pellucida changes structurally as a result of this reaction, generating a rigid barrier that stops any further sperm from penetrating.

These mechanisms ensure that only one sperm can fertilize the ovum, thus preventing polyspermy, which can lead to abnormal development.

**(ii) All copulations will not lead to fertilization. Why?**

**Solu.** There are various elements that influence the time and conditions required for a successful conception, meaning that not all copulations result in fertilization. Only within the female's fertile window, which coincides with ovulation and the release of the ovum, does fertilization take place; the likelihood of fertilization is significantly decreased if sperm are present outside of this window. Furthermore, in order to be viable, sperm must reach the ovum within a certain amount of time due to their limited lifespan. Sperm quality, particularly motility and morphology, is another important factor to consider. Only healthy, motile sperm can successfully travel the female reproductive tube, which has a number of obstacles, including cervical mucus, that can obstruct sperm movement. Additionally, the ovum's health and viability are crucial; if the egg is not viable, fertilization will not occur, regardless of sperm presence. All these elements contribute to the complex nature of reproduction, leading to situations where copulation does not result in fertilization.

**Ques 18. Attempt either option A or B.**

**A. The schematic representation given below shows a DNA strand and two types of mutations in the DNA strand.**

Original template	A	U	G	C	A	G	A	C	A	U	C	U	U	A	G
	Met			Gln			Thr			Ser		Stop			
Mutation I	A	U	G	A	A	G	A	C	A	U	C	U	U	A	G
	Met			Lys			Thr			Ser		Stop			
Mutation II	A	U	G	A	G	A	C	A	U	C	U	U	A	G	
	Met			Arg			His			Leu					

**(i) Identify the type of mutation exhibited in I and II.**

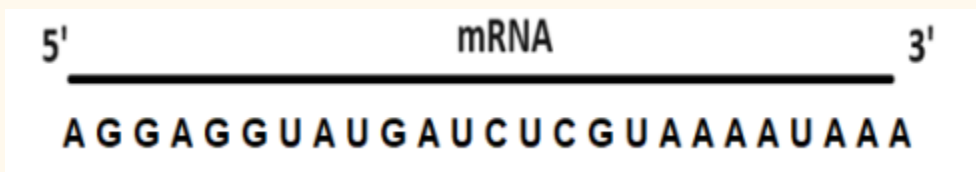
**Solu.**

**(ii) Which of the above mutation is more harmful? Give reason.**

**Solu.**

**OR**

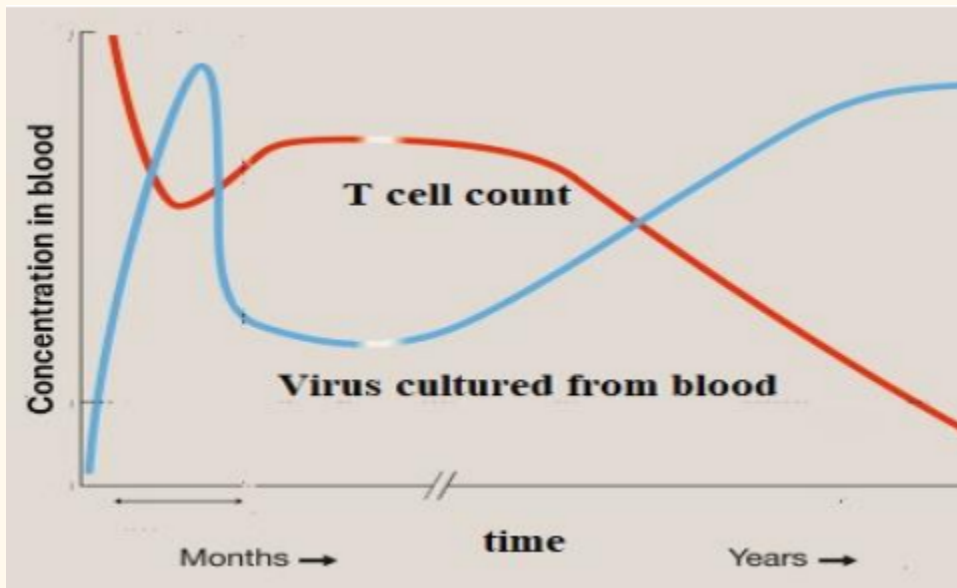
**B. Given below is a schematic representation of a mRNA strand**



**(i) In the above sequence identify the translational unit in mRNA.**

(ii) Where are UTRs found and what is their significance?

Ques 19. Given below is the relationship between the HIV levels in the blood and helper T cell count in a person detected with AIDS. Study the relationship and answer the questions that follow.



A. What kind of relationship is observed in the virus levels and the immune response after some days of the initial infection?

B. Does it completely clear the virus from the body permanently? Give reason for your answer.

For visually impaired students.

Write the sequence of events that occur when a retrovirus enters a human being, causing reduction in helper T-cells.

Ques 20. A culture plate of *Lactobacillus* shows blue-coloured colonies and colourless colonies. Explain the principle involved in the formation of such variance in the colour of colonies.

**Solu.** The existence of colorless and blue colonies on a Lactobacillus culture plate indicates the various strains' capacities for fermenting carbohydrates through metabolism. Microbiologists can differentiate between strains according to their capacity to ferment particular substrates and the subsequent pH changes in the culture medium thanks to this differential growth response.

**Ques 21. Attempt either option A or B.**

**A. (i) It was estimated that if an evergreen forest has a GPP of 400 J/m<sup>2</sup> /day and 150 J/m<sup>2</sup> /day worth of carbon dioxide flows out of that forest, what is the NPP in that forest?**

**Solu.** To calculate the Net Primary Production (NPP) of the evergreen forest, we use the formula:

$$\text{NPP} = \text{GPP} - \text{R}$$

where GPP (Gross Primary Production) is the total energy captured by photosynthesis, and R (Respiration) represents the energy lost through respiration. Given that the GPP is 400 J/m<sup>2</sup>/day and the carbon dioxide flowing out (which indicates respiration) is 150 J/m<sup>2</sup>/day, we can calculate NPP as follows:  
NPP = 400 J/m<sup>2</sup>/day - 150 J/m<sup>2</sup>/day = 250 J/m<sup>2</sup>/day

**(ii) Explain why pyramids of energy must always be upright.**

**Solu.** Energy pyramids must always be upright because they depict the flow of energy through an ecosystem, in which energy is lost mostly through heat, metabolic processes, and inefficient energy transmission at each trophic level. Only roughly 10% of energy is normally transferred as it moves from producers to primary consumers and then to higher trophic levels, which results in a major decrease in the amount of energy that is available. By forming a pyramid, this highlights the biological idea that fewer species may live at higher trophic levels than at lower ones and shows that energy is more abundant at the base



(producers) than at the top (top consumers). The vertical arrangement emphasizes the essential qualities of energy by graphically representing the declining amount of energy available in ecosystems, highlighting the fundamental nature of energy transfer.

**OR**

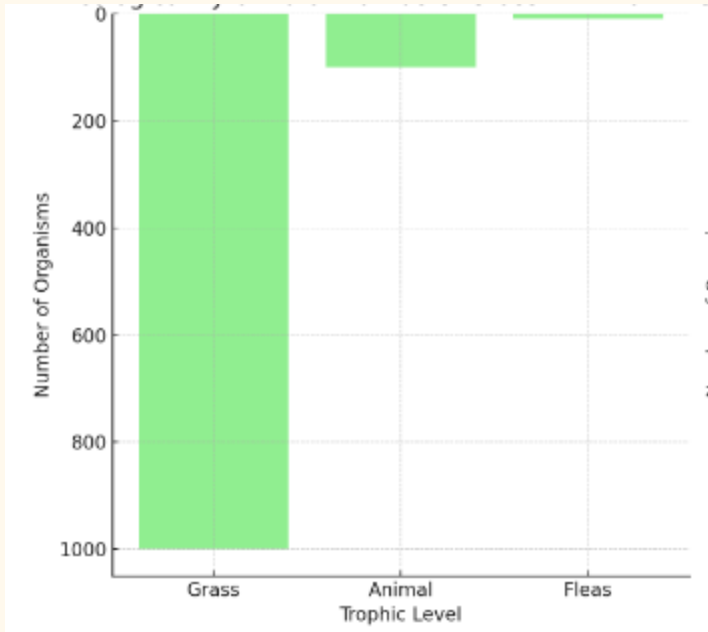
**B. (i) Assume that, GPP Forest A = GPP Forest B = GPP Forest C, If Forest A has NPP = 1254 J/m<sup>2</sup> /day; Forest B, NPP = 2157 J/m<sup>2</sup> /day; and Forest C, NPP = 779 J/m<sup>2</sup> /day, which one of these forests has maximum energy loss by respiration? Give reason.**

**Solu.** Because Forest C has the lowest NPP (779 J/m<sup>2</sup>/day), it has the largest energy loss through respiration. The respiration losses increase with the difference between GPP and NPP. Due to the lowest NPP value, R C will be the largest, indicating that more energy is lost through respiration in Forest C than in Forests A and B.

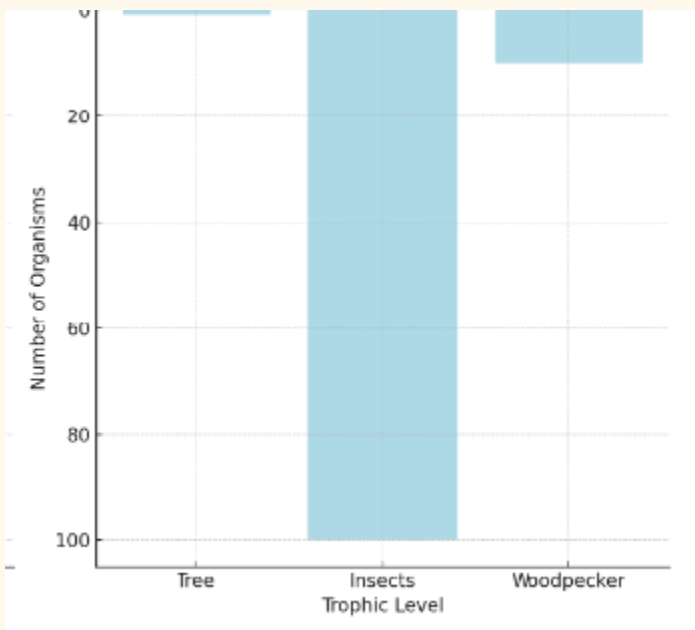
**(ii) Draw an ecological pyramid of number of the following food chains**

**a. Grass — Animal — Fleas on the host animal**

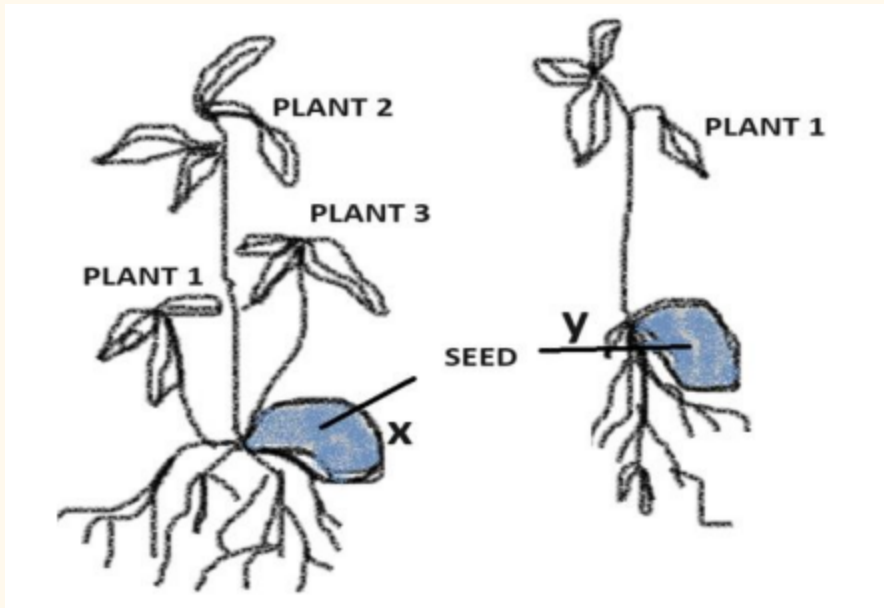
**Ans.**



**b. Tree — Insects — Woodpecker**



**Ques 22. The image below shows two germinated seeds X and Y which belong to the same species. Seed X is produced by apomixis whereas seed Y is a product of sexual reproduction.**



**A. Write the number of embryo(s), embryo sac(s) and ovules in the ovary of seed X.**

**Solu.** Number of Embryos: Seed X will contain several embryos during apomixis. Asexual reproduction known as apomixis produces seeds without fertilization and frequently results in the development of many embryos within the ovule (polyembryony).

Embryo sac count: There will be one embryo sac in Seed X. Several embryos are produced via apomixis, yet they all come from a single embryo sac.

Ovule Count: Since apomixis usually takes place within a single ovule, seed X's ovary will have a single ovule.

**B. How multiples embryos are formed in citrus fruits?**

**Solu.** In citrus fruits, a type of apomixis called nucellar polyembryony forms several embryos. During this procedure, embryos develop from the nucellar cells surrounding the embryo sac in addition to the zygotic embryo created during fertilization. Polyembryony results from the proliferation of these nucellar cells,

which produce more embryos. Consequently, many embryos can develop inside of a single seed.

**C. What advantage will plants developed from seed Y have over seed X?**

**Solu.** Genetic variety is a benefit of plants developed from seed Y, which are created through sexual reproduction. Male and female gametes combine during sexual reproduction, resulting in genetic variety and recombination. Plants that are more diverse may be better able to adapt to shifting environmental conditions and become more resistant to pests, illnesses, and other stressors. However, because they are genetically identical to their parent plant (clones), plants from seed X (apomixis) have less possibility for adaptation and evolution. Plants produced through sexual reproduction have a better capacity to evolve and thrive in varied contexts due to their genetic variety, even while apomixis can guarantee the production of uniform and consistent progeny.

**For visually impaired students**

**Each Mango fruit contains one seed. Two mango seeds, X and Y were sown in the soil. From Seed X, 3 plant saplings germinated but from seed Y only 1 plant sapling germinated.**

**A. For seed X which is apomictic, calculate the number of:**

- i) Embryo(s)**
- ii) Embryo sac(s)**
- iii) Ovules in this seed's ovary**

**Solu.** i) Embryo(s): Three plant saplings emerged from seed X, indicating the presence of three embryos in the seed. Because of polyembryony, many embryos can form within a single seed during apomixis.

- ii) Embryo sac(s): There is(are) one(s) in seed X. Usually, apomixis results in the formation of a single embryo sac, however surrounding the embryo sac, somatic (non-reproductive) cells such as nucellar cells can also give rise to multiple embryos.
- iii) Ovules in the Ovary: Since each mango fruit typically yields a single seed from a single ovule, the mango fruit has one ovule in its ovary.

### **B. How multiples embryos are formed in citrus fruits?**

**Solu.** In citrus fruits, a process known as nucellar polyembryony results in the formation of numerous embryos. Embryos develop from somatic cells of the nucellus in this type of apomixis (tissue enclosing the embryo sac). Multiple embryos can form within a single seed as a result of these nucellar cells developing into embryos without fertilization in addition to the zygotic embryo created during fertilization. The parent plant (clones) and these embryos share the same genetic makeup.

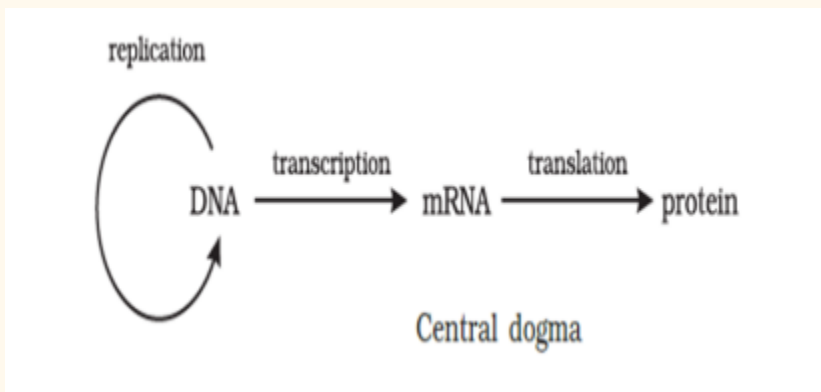
### **C. What advantage will plants developed from seed Y have over seed X?**

**Solu.** The genetic variety that results from sexual reproduction will benefit plants developed from seed Y. The progeny of seed Y will have a mixture of genetic material from both parent plants because seed Y was created through fertilization. These plants' capacity to adapt to shifting environmental conditions, fend off illnesses and pests, and change over time is enhanced by their genetic variety. However, because seed X is apomictic, it yields seedlings that are exact genetic clones of the parent plant. Although apomixis guarantees homogeneity and consistency, it does not offer genetic variation's adaptability and evolutionary potential, which could make plants from seed Y possibly more adaptable in unpredictable circumstances.

**Ques 23. Name the place in human ovary where the first meiotic division is completed during oogenesis. What are the products of this division? Give the chromosome number of each type of cells involved in the process.**

**Solu.** Before ovulation, in the mature Graafian follicle of the ovary, the first meiotic division of human oogenesis is finished. Starting in the fetal stage, this division is stopped at prophase I and doesn't resume until the female enters puberty. The initial meiotic division is finished just before ovulation, resulting in the formation of two cells: a smaller first polar body and a bigger secondary oocyte. These two haploid cells have 23 chromosomes between them. Prior to this split, the original oocyte had 46 chromosomes and was diploid. The polar body typically degenerates while the secondary oocyte advances to the second meiotic division, which is only finished if fertilization takes place.

**Ques 24. The schematic representation given below shows the concept of Central Dogma.**



**A. During the process of replication and transcription the pairing of nitrogenous bases is not similar. Explain.**

**B. How is the above process modified in a retrovirus? Name the process.**

**C. Justify why during the process of transcription only a segment of DNA is copied into RNA.**

**For visually impaired students**

**Central Dogma explains the process of DNA transcription and translation. From DNA mRNA is transcribed and then mRNA is translated into a polypeptide.**

**A. During the process of replication and transcription the pairing of nitrogen bases is not similar. Explain.**

**Solu.** When DNA duplicates during replication, the nitrogen bases pair with thymine (T) and guanine (G) in accordance with the standard Watson-Crick base pairing principles. Replication involves both strands of DNA, and base pairing guarantees that two identical copies of the original DNA are created.

But during transcription, base pairing is a little bit different since DNA is converted into mRNA. Adenine (A) pairs with uracil (U) rather than thymine (Th) because uracil replaces thymine in RNA, while cytosine still couples with guanine. In transcription, the base-pairing rule is:

- A pairs with U
- C pairs with G
- G pairs with C
- T pairs with A

Thus, the difference in nitrogen base pairing between replication and transcription lies in the replacement of thymine (T) with uracil (U) in RNA.

**B. How is the above process modified in viruses? Name the process.**

**Solu.** Reverse transcriptase, an enzyme, modifies the mechanism in retroviruses (like HIV), enabling the virus to flip the fundamental idea. The virus transforms its RNA genome into DNA rather than converting DNA into RNA. After being incorporated into the genome of the host cell, this DNA can be translated into viral proteins by transcription. We refer to this procedure as reverse transcription.

**C. Justify why during the process of transcription only a segment of DNA is copied into RNA.**

**Solu.** During transcription, only a specific DNA sequence known as a gene—which encodes instructions for producing proteins or functional RNAs—is transcribed from DNA into RNA. Non-coding sections, introns, and other regulatory elements that are not directly involved in protein synthesis would be included in the transcription of the complete DNA. Because transcription is a selective process, only the necessary genes are expressed in a given cell type and at a given time. Not only does this careful regulation of transcription save energy by generating only the proteins required, but it is also essential for controlling cellular growth, development, and function.

**Ques 25. Describe the steps involved in Southern blot hybridization using radiolabeled VNTR as a probe.**

**Solu.** Several crucial processes are involved in employing a radiolabeled variable number tandem repeat (VNTR) probe for southern blot hybridization. First, restriction enzymes that cut the DNA at specified locations are used to harvest genomic DNA from cells. After that, the resultant DNA fragments are separated and sorted by size using gel electrophoresis. Blotting is the process of transferring these pieces from the gel onto a membrane, usually composed of nylon or nitrocellulose. A radiolabeled VNTR probe, a brief DNA sequence corresponding to the VNTR areas of interest, is then incubated with the membrane. Any complementary DNA sequences on the membrane are bound by the probe when it hybridizes. The membrane is subjected to X-ray film or a phosphorimager to identify the extra probe after washing it away. The radiolabeled DNA, revealing the VNTR pattern in the sample. This method is commonly used in genetic fingerprinting and forensic analysis.

**Ques 26. Bio-fertilisers are organisms that enrich the nutrient quality in the soil. Explain the role of three main sources of bio-fertilisers.**



**Solu.** The three primary types of organisms that improve the nutrient quality of soil are mycorrhizae, phosphate-solubilizing microorganisms, and nitrogen-fixing bacteria. These organisms are known as bio-fertilizers.

**Bacteria that fix nitrogen:** These microorganisms, which include *Azotobacter* and *Rhizobium*, change atmospheric nitrogen into forms that plants can use, including ammonia. Leguminous plants and *Rhizobium* have symbiotic interactions in which the former lives in root nodules and supplies nitrogen to the latter, while *Azotobacter* and other free-living nitrogen-fixers independently replenish the soil.

**Phosphate-solubilizing microorganisms:** *Pseudomonas* and *Aspergillus* are two examples of bacteria and fungus that are essential for changing insoluble phosphate compounds in the soil into soluble forms that plants may absorb. This increases the availability of phosphorus, which is essential for root formation, plant growth, and energy transfer.

**Mycorrhizae:** These fungi grow in symbiotic relationships with plant roots to increase the surface area available for absorbing nutrients, especially water and phosphorus. The plant gives the fungal sugars in return. In nutrient-poor soils, mycorrhizal fungi are particularly helpful for enhancing soil structure and plant growth.

Together, these bio-fertilisers promote sustainable agriculture by reducing the need for chemical fertilizers and improving soil health.

**Ques 27. Explain how PCR technique can be used for amplification of a small amount of DNA template.**

**Solu.** Using a little DNA template and a potent technology called polymerase chain reaction (PCR), tiny quantities of DNA can be amplified to create millions of copies. There are three crucial steps in the process:

Denaturation: The two strands of the DNA template are separated into single strands by heating it to a temperature of approximately 94–98°C, which breaks the hydrogen bonds between them.

Annealing: To enable short, synthetic DNA primers to bind (anneal) to complementary sequences on the single-stranded DNA template, the temperature is decreased (usually to between 50 and 65°C). The intended placement of these primers is to flank the desired amplified DNA region.

Extension: The temperature is increased to around 72°C, which is the ideal temperature for Taq DNA polymerase, an enzyme that synthesizes new DNA strands complementary to the template by appending nucleotides to the 3' end of primers.

For 25–35 cycles, these three procedures are performed, doubling the desired DNA amount each time. Millions of copies of the targeted DNA area are produced at the conclusion of the PCR process, making even minuscule amounts of beginning DNA identifiable and accessible for additional investigation. PCR is extensively utilized in cloning, diagnostics, forensics, and genetic research.

**Ques 28. A. Diagram given below depicts different species of Warbler birds feeding on different regions on a Spruce tree. Explain the mechanism which helps them to co-exist.**



**B. What does Gause's exclusion principle state? Does it apply in the case shown above? Explain.**

**For visually impaired students**

**A. Name and explain the mechanism where two species competing for the same resource co-exist.**

**Solu.** Partitioning of resources is the mechanism.

A technique known as resource partitioning permits the coexistence of two species that are in competition for the same resource. When species modify their resource utilization to evade direct competition, this happens. They may target distinct areas of the ecosystem, utilize resources at various times of day, or focus on particular facets of the resource. To lessen competition, two bird species might, for instance, forage in different areas of a tree or at different times of the day. By reducing resource usage overlap, this partition of the ecological niche promotes stable relationships between species that enable them to coexist in the same habitat.

**B. What does Gause's exclusion principle state? Does it apply in the above situation? Explain.**

**Solu.**

Gause's Theory of Competitive Exclusion

According to Gause's Competitive Exclusion Principle, two species that are in competition for the same limiting resource cannot coexist in a stable manner. The other species will always be driven to local extinction, migration, or niche divergence by the dominant species' constant outcompete and exclusion. This principle highlights the fact that total overlap in ecological niches results in the removal of competitors.

Use in the Aforementioned Circumstance

Gause's exclusion principle does not immediately apply to resource partitioning. Through niche difference, the two species avoid direct competition even though they are vying for comparable resources. They lessen rivalry by making use of several facets of the environment or resource, enabling coexistence without one species outcompeting the other. Because resource partitioning permits species to share a resource, it serves as an exception to the competitive exclusion principle habitat without being driven to extinction.

**Assuming that within a population of beetles where Hardy Weinberg conditions are met, the colour black (B) is dominant over the colour red (b). 40% of all beetles are red (bb).**

**Given this information, answer the questions below:**

**A. What is the frequency of red beetles?**

**B. Calculate is the percentage of beetles in the population that are heterozygous.**

**Attempt either subpart C or D.**

### **C. What is the frequency of homozygous dominant individuals?**

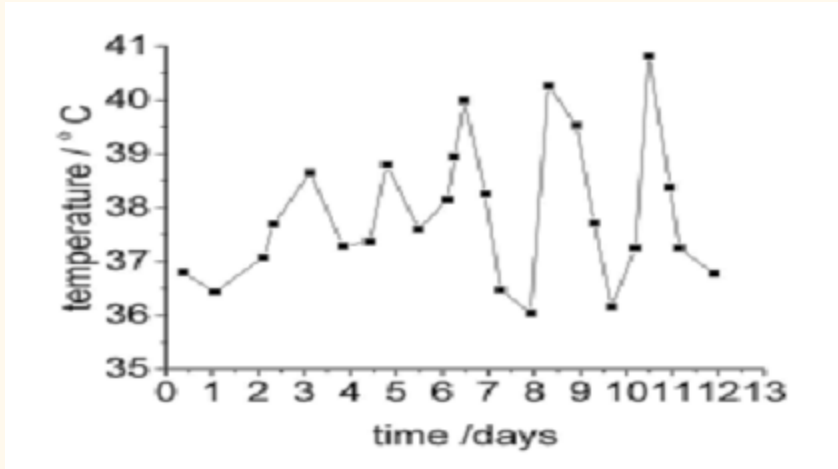
**Solu.** The frequency of homozygous dominant individuals in a population can be determined using the Hardy-Weinberg equation, which describes genetic equilibrium in a population. The equation is  $p^2 + 2pq + q^2 = 1$ , where  $p^2$  represents the frequency of homozygous dominant individuals (AA),  $2pq$  represents heterozygous individuals (Aa), and  $q^2$  represents homozygous recessive individuals (aa). To calculate the frequency of homozygous dominant individuals, first determine the allele frequencies of the dominant (p) and recessive (q) alleles. If the frequency of the recessive allele (q) is known, you can find the dominant allele frequency by using  $p = 1 - q$ . Once you have p, square it to calculate the frequency of homozygous dominant individuals:  $p^2$ . This value gives the proportion of the population that is homozygous for the dominant allele (AA).

**OR**

**D. Assuming that Hardy Wienberg conditions are met in the beetle population consisting of 1500 beetles. How many beetles would you expect to be black and red in colour respectively?**

**Solu.**

**Ques 30. Given below is the pattern of temperature in a person suffering from a non-viral disease transmitted by mosquitoes. Study the graph and answer the questions that follow:**



**A. Explain the factor(s) responsible for this pattern of temperature.**

**B. How does this pathogen multiply in the human body?**

**Attempt either subpart C or D.**

**C. How is this infection transmitted to humans?**

**D. Which stages of the life cycle of this pathogen are completed in the mosquito's gut?**

**For visually impaired students**

**A. A non-viral disease that is transmitted by mosquitoes causes recurring fever in an infected person. Explain giving reason(s).**

**Solu.** Malaria is a non-viral disease that is spread by the bite of an infected female Anopheles mosquito and is brought on by Plasmodium parasites. The parasite reproduces asexually inside red blood cells, which is why the fever keeps coming back. Red blood cells rupture due to the growth of Plasmodium parasites, releasing poisons and more parasites into the bloodstream. Fever, chills, and

sweating follow a cyclical pattern as a result, which is consistent with red blood cells bursting at regular intervals (usually 48–72 hours, depending on the Plasmodium species).

**B. How does this pathogen multiply in the human body? (2) Attempt either subpart C or D.**

**Solu.** The Plasmodium parasite infects humans when it bites a mosquito, entering the bloodstream and making its way to the liver, where it multiplies asexually by invading liver cells. When the parasites reach adulthood, the liver releases them back into the circulation, where they infect red blood cells. The parasite reproduces asexually inside red blood cells, growing and finally bursting the cells to release additional parasites into the bloodstream and restarting the cycle.

**C. How is this infection transmitted to humans?**

**Solu.** Humans contract malaria through the bite of a female Anopheles mosquito carrying the infection. A mosquito injects saliva containing Plasmodium sporozoites, the parasite's infectious form, into a person's circulation when it bites them. These sporozoites make their way to the liver, where they develop and start the human infection process.

**OR**

**D. Which stages of the life cycle of this pathogen are completed in the mosquito's gut?**

**Solu.** The Plasmodium parasite goes through numerous stages of life in the intestines of the mosquito. The mosquito develops into male and female gametes after ingesting blood that contains the sexual forms of Plasmodium, or gametocytes. After these gametes unite, a zygote is created, which eventually becomes an ookinete. The ookinete creates an oocyst after penetrating the

mosquito's intestinal wall. Thousands of sporozoites grow inside the oocyst. When the sporozoites reach maturity, they are expelled from the oocyst and move to the salivary glands of the mosquito, where they await the opportunity to infect a human host during the mosquito's subsequent blood meal.

**Ques 31. Attempt either option A or B.**

**A. Cryptorchidism is a condition in which the testes fail to descend into the scrotum. It can also lead to compromised Sertoli cell function and has an impact on Leydig cell function.**

**(i) Identify at least 3 parameters of male fertility which get affected due to cryptorchidism.**

**Solu.** Sperm Production (Spermatogenesis): Cryptorchidism affects the ability of the testes to produce sperm. Spermatogenesis is hampered by the elevated warmth in the abdominal cavity, where the undescended testes are still present, which results in decreased or nonexistent sperm generation.

Sperm Quality: The morphology and motility of sperm are essential for successful fertilization, and cryptorchidism can lead to the production of aberrant or non-motile sperm.

Testosterone Levels: Leydig cells, which generate testosterone, are impacted by cryptorchidism. Hormonal abnormalities resulting from a decrease in testosterone might affect both overall fertility and sexual function.

**(ii) Which process will be affected if mature spermatids are not released from Sertoli cells?**

**Solu.** Spermiation, the last stage of spermatogenesis in which mature spermatids are discharged from Sertoli cells into the lumen of seminiferous tubules, is the



process that is impacted. Infertility is the outcome of this process failing, which prevents mature sperm from accessing the reproductive system.

**(iii) Name and explain one assisted reproductive technology (ART process) in which the sperm/semen is used to assist fertilization.**

**Solu.** Intrauterine Insemination (IUI): IUI is a type of assisted reproduction in which sperm is collected, cleaned, and concentrated—either from the partner or from a donor—and then inserted directly into the uterus of the woman at the approximate moment of ovulation. In cases of unexplained infertility or low sperm motility or count, this procedure increases the likelihood that sperm will reach the egg.

**(iv) Name and explain the assisted reproductive technology that should be used to complete the development of embryos I and II shown in the figure given below.**

**Solu.** IVF stands for in vitro fertilization, and it is the proper method of assisted reproductive technology to finish developing embryos I and II. This procedure involves taking eggs out of a woman's ovaries and fertilizing them in a lab with sperm. The fertilized eggs, or embryos, are subsequently placed into the woman's uterus for implantation and continued development after being cultivated in a controlled environment until they reach an ideal stage of development. IVF is frequently used to treat infertility that cannot be explained, blockage of the fallopian tubes, or failure of other reproductive therapies.

**Ques 32. Attempt either option A or B.**

**A. Explain how advent of biotechnology has helped in preventing infestation by nematodes and thereby increasing crop yield.**

**Solu.** Through genetic engineering, biotechnology has made a substantial contribution to agricultural nematode infestation prevention. The creation of genetically modified (GM) crops that express particular genes to ward off pests is one of the innovations. For instance, RNA interference (RNAi) technology has been employed by researchers to produce transgenic plants that have the ability to silence crucial nematode genes. The RNAi mechanism interferes with the gene function of the plants these worms try to infest and feed on, inhibiting the nematodes' growth and reproduction. By preventing nematode damage to the crops, biotechnological interventions—including genetically modified (GM) crops like Bt cotton and modified potatoes—help produce healthier plants and higher yields without the use of hazardous chemical pesticides.

**B. In the future, genetic therapies may be used to prevent, treat, or cure certain inherited disorders in humans. Justify the statement with a suitable example.**

**Solu.** By repairing faulty genes at the cellular level, gene therapy has great potential to treat inherited genetic illnesses. For severe combined immunodeficiency (SCID), a condition brought on by mutations in the ADA gene that results in a significantly compromised immune system, gene therapy is one example. Patients with sickle cell disease (SCID) have weakened immune systems, which leaves them more vulnerable to infections. A corrected form of the ADA gene can be inserted into the patient's cells by gene therapy, enabling them to generate the enzyme necessary for healthy immunological response. Patients with SCID have demonstrated progress in regaining immunological function with this therapy. As genetic therapies advance, they could eventually treat a number of hereditary diseases, such as hemophilia, muscular dystrophy, and cystic fibrosis, by repairing the underlying genetic defects.

**Ques 33. Attempt either option A or B.**

**A.**

**(i) Why is there a need to conserve biodiversity? (Any two reasons)**

**Solu.** Ecosystem Stability: Ecosystem resilience and stability are enhanced by biodiversity. Diverse ecosystems are more resilient to shocks and can bounce back from them faster. This includes climatic swings and natural calamities. Maintaining ecological services that are essential to human survival and well-being, such as pollination, water purification, and soil fertility, depends on this stability.

Economic Value: Resources found in biodiversity, such as food, medicine, and raw materials, are useful to humans economically. Natural substances that can be found in both plants and animals are the source of many medications. Global economics and health may be impacted by the reduction of biodiversity, which may also restrict possibilities for food security and the creation of new medications.

**(ii) Name and explain any two causes that are responsible for the loss of biodiversity.**

**Solu.** Habitat damage: Often brought on by urbanization, agriculture, deforestation, and mining, habitat destruction is one of the main drivers of biodiversity loss. Many species that are unable to adapt to new conditions or locate alternative habitats will eventually decline or become extinct as a result of the conversion of natural habitats for human use.

Pollution: Biodiversity is negatively impacted by pollution from urban, agricultural, and industrial sources. Pesticides, heavy metals, and plastic trash are examples of chemicals that can contaminate soil, water, and air, affecting both plants and animals. A reduction in biodiversity can be attributed to a variety of factors, including reduced reproductive success, habitat degradation, and higher mortality rates among different species in polluted environments.

**OR**

**B.**

**(i) Name the two types of desirable approaches to conserve biodiversity? Explain with examples bringing out the difference between the two types.**

**Solu.** In-situ Conservation: This strategy aims to preserve biodiversity in its native environment. In-situ conservation is practiced in protected places such as national parks, wildlife reserves, and marine protected zones. For example, the United States' Yellowstone National Park protects a variety of ecosystems and species in their native habitats, enabling natural interactions and processes to take place.

Ex-situ Conservation: This strategy entails protecting species away from their native environments. Zoos, botanical gardens, seed banks, and breeding initiatives are a few examples of this. As an illustration, the Svalbard Global Seed Vault keeps seeds from all over the world in order to conserve genetic diversity and guard against loss from natural disasters or climate change. The major distinction is that ex-situ conservation entails maintaining animals in controlled surroundings, whereas in-situ conservation preserves species in their native ecosystems.

**(ii) State the features of a stable biological community?**

**Solu.** The following characteristics are usually present in a stable biotic community:

**Biodiversity:** A community's ability to endure shocks and bounce back swiftly from environmental changes is facilitated by a high degree of species diversity.

**Trophic Structure:** An ecosystem's ability to efficiently cycle nutrients and energy is dependent on a well-defined trophic structure, which includes different levels of producers, consumers, and decomposers.

**Homeostasis:** In spite of changes in the external environment, stable groups are able to preserve internal balance. They have systems in place to control resource availability and population levels, preventing the extinction of any one species from the ecosystem.

Interconnectedness: Robust interspecies connections, including mutualism, predation, and competition, promote ecological functions and balance.

Resistance and Resilience: Because of their intricate relationships and interspecies redundancy, stable communities are resilient to changes and disturbances like invasive species and natural disasters. They can also bounce back from them successfully.