

## CBSE Class 12 2025 Biology Question Paper (57/1/3) With Solutions

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| <b>Time Allowed :3 Hour</b> | <b>Maximum Marks :70</b> | <b>Total questions :33</b> |
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### 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. What type of ecological pyramid would be obtained with the following data?

Primary producer = 10 g

Secondary consumer = 120 g

Primary consumer = 60 g

- (A) Upright pyramid of biomass
- (B) Upright pyramid of number
- (C) Inverted pyramid of biomass
- (D) Upright pyramid of energy

**Correct Answer:** (C) Inverted pyramid of biomass

**Solution:**

**Step 1:** In an ecological pyramid of biomass, typically the biomass decreases at each higher trophic level.

**Step 2:** In this case, the biomass of primary producers is 10 g, primary consumers 60 g, and secondary consumers 120 g.

**Step 3:** Since biomass increases at higher levels, the pyramid will be inverted.

Thus, the data represents an inverted pyramid of biomass.

### Quick Tip

If biomass increases from producers to consumers, it forms an inverted pyramid of biomass — typical in aquatic ecosystems.

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2. Flowers which have a single ovule in the ovary and are packed into inflorescence are usually pollinated by:

- (A) Water
- (B) Bat
- (C) Bee

(D) Wind

**Correct Answer:** (D) Wind

**Solution:**

**Step 1:** Flowers with a single ovule per ovary and those arranged in inflorescences are often adapted for wind pollination.

**Step 2:** Wind-pollinated flowers typically have numerous small, inconspicuous flowers packed together, and produce abundant pollen grains.

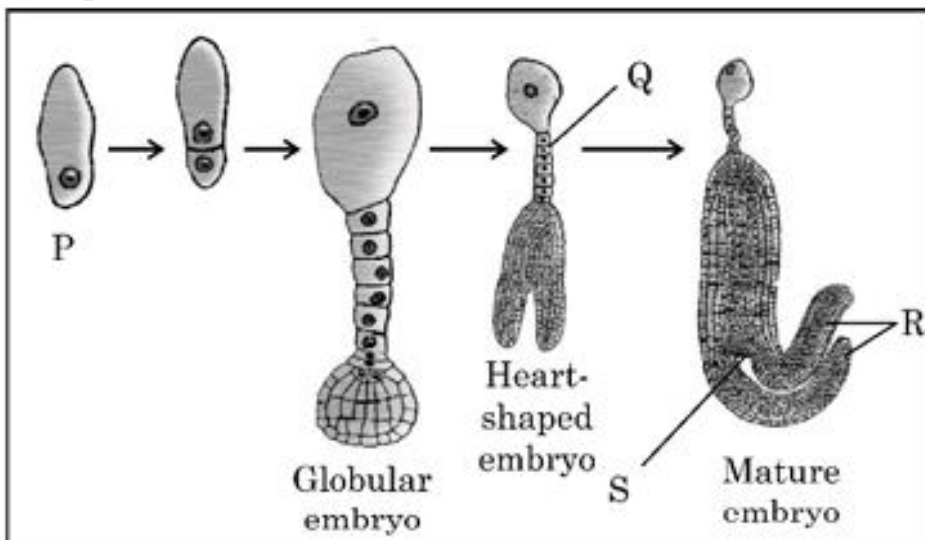
**Step 3:** These adaptations favor successful pollination by wind rather than by insects or animals.

Hence, such flowers are generally wind-pollinated.

**Quick Tip**

In wind pollination, flowers are small, light, numerous, and often packed in inflorescences with a single ovule for efficient pollen transfer.

**3. The diagram given below shows labelling of four parts of a dicot embryo during its development as P, Q, R and S.**



**Choose the option that indicates correct labelling of 'P', 'Q', 'R' and 'S' of embryo in different stages of its development:**

(A) Egg, Suspensor, Radicle, Cotyledon

- (B) Zygote, Suspensor, Cotyledon, Plumule
- (C) Egg, Radicle, Suspensor, Cotyledon
- (D) Zygote, Suspensor, Cotyledon, Radicle

**Correct Answer:** (D) Zygote, Suspensor, Cotyledon, Radicle

**Solution:**

**Step 1:** The labelled parts of the dicot embryo during its development are as follows:

P — Zygote

Q — Suspensor

R — Cotyledon

S — Radicle

**Step 2:** Among the given options, option (D) correctly matches these labels.

#### Quick Tip

In dicot embryo development: Zygote forms the suspensor, followed by formation of cotyledons and radicle in sequence.

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**4. Evolution of modern man involves the following man-like primates. Choose the correct series of human evolution:**

- (A) *Dryopithecus* → *Homo erectus* → *Australopithecines* → *Homo sapiens*
- (B) *Australopithecines* → *Homo erectus* → Neanderthal → *Homo sapiens*
- (C) *Australopithecines* → *Ramapithecus* → *Dryopithecus* → *Homo sapiens*
- (D) *Homo erectus* → *Australopithecines* → *Homo sapiens* → Neanderthal

**Correct Answer:** (B) *Australopithecines* → *Homo erectus* → Neanderthal → *Homo sapiens*

**Solution:**

**Step 1:** Human evolution followed a distinct sequence among hominids.

**Step 2:** *Australopithecines* are the earliest hominids, followed by *Homo erectus*, then Neanderthals, and finally modern *Homo sapiens*.

**Step 3:** Option (B) correctly follows this evolutionary order.

### Quick Tip

Remember: *Australopithecines* are considered the ancestors of *Homo erectus*, who then gave rise to Neanderthals and *Homo sapiens*.

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**5. A man whose father was colour-blind marries a woman who had a colour-blind mother and normal father. What percentage of male children of this couple will be colour-blind?**

- (A) 25%
- (B) 0%
- (C) 50%
- (D) 75%

**Correct Answer:** (C) 50%

#### **Solution:**

**Step 1:** Colour blindness is an X-linked recessive disorder.

**Step 2:** The man (whose father was colour-blind) is normal but a carrier of the normal X chromosome.

**Step 3:** The woman's mother was colour-blind, so the woman must be a carrier (heterozygous).

**Step 4:** Crossing these, 50% of male children will inherit the defective X chromosome from the mother, resulting in colour-blindness.

### Quick Tip

For X-linked recessive disorders, males need only one defective X chromosome to express the trait.

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**6. Endosperm is completely consumed by the developing embryo in which of the following?**

- (A) Maize and Castor

- (B) Castor and Groundnut
- (C) Maize and Pea
- (D) Pea and Groundnut

**Correct Answer:** (D) Pea and Groundnut

**Solution:**

**Step 1:** In dicots like Pea and Groundnut, the endosperm is used up during seed development.

**Step 2:** These seeds are non-endospermic or ex-albuminous as their cotyledons store food.

**Step 3:** Thus, no endosperm remains at maturity in these seeds.

**Quick Tip**

In dicots like Pea and Groundnut, the cotyledons store nutrients and the endosperm is completely absorbed during development.

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**7. GEAC stands for**

- (A) Genome Engineering Action Committee
- (B) Ground Environment Action Committee
- (C) Genetic and Environment Approval Committee
- (D) Genetic Engineering Approval Committee

**Correct Answer:** (D) Genetic Engineering Approval Committee

**Solution:**

**Step 1:** GEAC is an Indian regulatory body under the Ministry of Environment, Forest and Climate Change.

**Step 2:** Its full form is Genetic Engineering Approval Committee.

**Step 3:** It monitors the approval of GMOs and related research.

**Quick Tip**

GEAC monitors and regulates the release of genetically engineered organisms in India.

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**8. Transplantation of tissues/organs to some patients often fails due to rejection of such tissues/organs by the body of the patient. Which type of immune response is responsible for such rejections?**

- (A) Autoimmune response
- (B) Humoral immune response
- (C) Physiological immune response
- (D) Cell mediated immune response

**Correct Answer:** (D) Cell mediated immune response

**Solution:**

**Step 1:** Tissue/organ rejection is primarily due to recognition of foreign antigens on transplanted cells.

**Step 2:** This activates T-lymphocytes of the recipient, initiating a cell-mediated immune response.

**Step 3:** Antibodies play a lesser role in acute rejection.

**Quick Tip**

Organ transplant rejection is mainly driven by T-cell mediated immunity, not by antibodies.

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**9. Amplification of gene of interest by using DNA polymerase may go up to**

- (A) 0.1 million times
- (B) 1 million times
- (C) 1 billion times
- (D) 1 trillion times

**Correct Answer:** (C) 1 billion times

**Solution:**

**Step 1:** In PCR, DNA polymerase amplifies the target gene exponentially.

**Step 2:** With 30-35 cycles, amplification can reach about 1 billion copies.

**Quick Tip**

PCR can amplify DNA up to a billion times within hours.

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**10. RNA interference (RNAi) helps in making tobacco-plant resistant to a nematode (*Meloidogyne incognita*)**

**Choose the correct option that shows how RNAi is achieved:**

- (A) Preventing the process of translation of mRNA of the nematode.
- (B) Preventing the process of replication of DNA of the nematode.
- (C) Preventing the process of transcription of DNA of the plant.
- (D) Preventing the process of replication of DNA of the plant.

**Correct Answer:** (A) Preventing the process of translation of mRNA of the nematode.

**Solution:**

**Step 1:** RNAi involves the silencing of specific mRNA to prevent the synthesis of its corresponding protein.

**Step 2:** Double-stranded RNA (dsRNA) triggers degradation of nematode mRNA in host plants.

**Step 3:** Thus, nematode proteins essential for survival are not produced.

**Quick Tip**

RNA interference (RNAi) works by degrading target mRNA and blocking translation.

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**11. The sequence of nitrogenous bases in a segment of a coding strand of DNA is 5' - AATGCTAGGCAC - 3'. Choose the option that shows the correct sequence of nitrogenous bases in the mRNA transcribed by the DNA.**

- (A) 5' - UUACGAUCCGUG - 3'
- (B) 5' - AAUGCUAGGCAC - 3'
- (C) 5' - UUACGUAGCCUG - 3'

(D) 5' - AACGUAGGCAGC - 3'

**Correct Answer:** (B) 5' - AAUGCUAGGCAC - 3'

**Solution:**

**Step 1:** In transcription, mRNA is complementary to the template strand and identical (with U in place of T) to the coding strand.

**Step 2:** Here, the coding strand sequence is copied with U replacing T.

**Step 3:** Thus, the mRNA sequence is 5' - AAUGCUAGGCAC - 3'.

#### Quick Tip

Remember: mRNA sequence is same as coding strand (except U instead of T).

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**12. Which of the following is correct for the condition when plant YyRr is backcrossed with the double recessive parent?**

(A) 9:3:3:1 ratio of phenotypes only

(B) 9:3:3:1 ratio of genotypes only

(C) 1:1:1:1 ratio of phenotypes only

(D) 1:1:1:1 ratio of phenotypes and genotypes

**Correct Answer:** (D) 1:1:1:1 ratio of phenotypes and genotypes

**Solution:**

**Step 1:** Backcrossing YyRr with yyrr (double recessive) produces four types of gametes from YyRr: YR, Yr, yR, yr.

**Step 2:** Crossing these with yyrr gives four possible offspring types, each in equal proportion.

**Step 3:** Thus, the ratio is 1:1:1:1 for both phenotype and genotype.

#### Quick Tip

Backcross with a double recessive always gives a 1:1:1:1 phenotypic and genotypic ratio for dihybrid heterozygotes.

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For Question numbers 13 to 16, two statements are given – one labelled as Assertion (A) and the other labelled as Reason (R). Answer these questions by 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): The mammary glands secrete milk for the nourishment of the young ones.**

**Reason (R): These are modified sweat glands.**

- (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:** Mammary glands are specialized to produce milk for feeding offspring.

**Step 2:** Embryologically, mammary glands are modified sweat glands.

**Step 3:** So, both Assertion and Reason are true and Reason correctly explains Assertion.

**Quick Tip**

Mammary glands are modified sweat glands and function to nourish offspring with milk.

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**14. Assertion (A): Scaffold proteins are non-histone chromosomal proteins.**

**Reason (R): They are rich in lysine and arginine.**

- (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:**

**Step 1:** Scaffold proteins are indeed non-histone chromosomal proteins.

**Step 2:** However, histones—not scaffold proteins—are rich in lysine and arginine.

**Step 3:** So, Assertion is true but Reason is false.

#### Quick Tip

Histones are basic proteins rich in lysine and arginine, not scaffold proteins.

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**15. Assertion (A):** When the two genes in a dihybrid cross are situated on the same chromosome, the proportion of parental gene combinations is much higher than non-parental type.

**Reason (R):** Higher parental gene combinations can be attributed to crossing over between two genes.

(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:**

**Step 1:** When genes are linked (on same chromosome), parental combinations predominate because crossing over between linked genes is rare.

**Step 2:** Reason incorrectly attributes higher parental combinations to crossing over, which actually increases recombinants.

**Step 3:** Thus, Assertion is true but Reason is false.

### Quick Tip

Linked genes reduce recombination; crossing over increases recombinants, not parental types.

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**16. Assertion (A): A bioreactor provides the optimal conditions for achieving the desired product by providing optimum growth conditions.**

**Reason (R): The most commonly used bioreactors are of stirring type.**

- (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:** Bioreactors ensure optimal conditions (temperature, pH, nutrients, oxygen) for microbial or cell culture growth.

**Step 2:** Stirred-tank bioreactors are the most commonly used type for uniform mixing and aeration.

**Step 3:** So both Assertion and Reason are true and Reason explains Assertion.

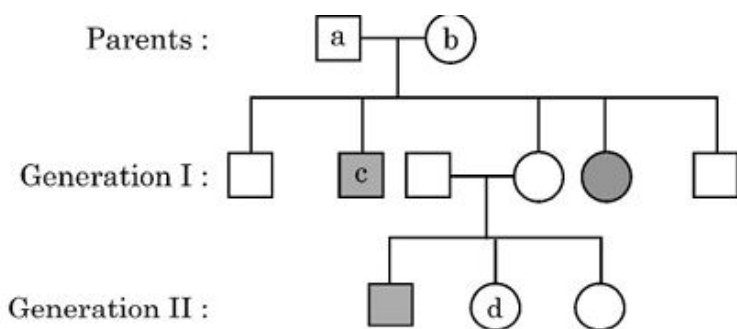
### Quick Tip

Stirred-tank bioreactors are widely used for industrial fermentation and enzyme production.

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## SECTION B

**17. Study the pedigree analysis given below:**



**Answer the following questions:**

**(A) Write genotypes of c and d.**

**(B) Identify whether the trait is**

**(i) Sex-linked or autosomal**

**(ii) Dominant or recessive**

**Solution:**

**Step 1:** Affected individuals are both male and female, suggesting the trait is **autosomal**.

**Step 2:** The trait appears in the offspring of unaffected parents, indicating it is **recessive**.

**Step 3:** In recessive autosomal inheritance:

- Affected individual: aa
- Unaffected carrier: Aa
- Unaffected normal: AA

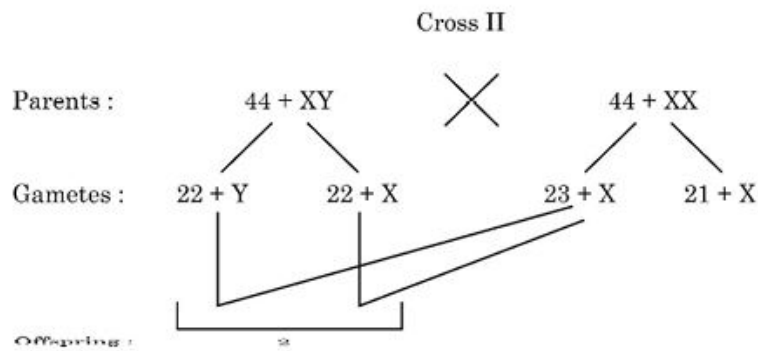
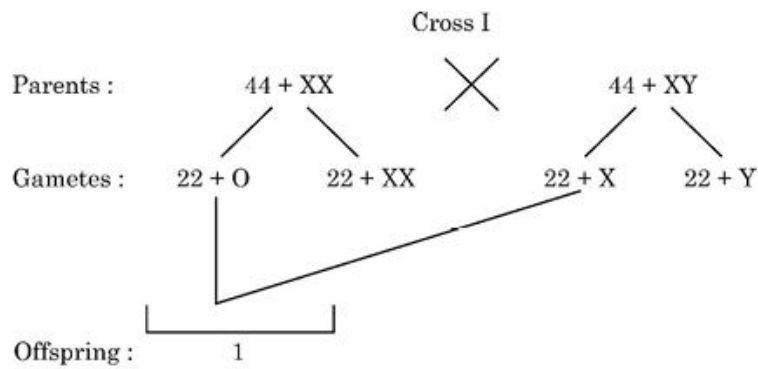
**Step 4:** Since 'c' is unaffected but passes the trait to offspring, 'c' must be Aa.

**Step 5:** 'd' is affected, hence genotype is aa.

#### Quick Tip

In autosomal recessive inheritance, the trait skips generations and affects both sexes equally.

**18. Study the two different crosses given below:**



**Identify the abnormalities '1' and '2' in the offsprings of given crosses and distinguish between them.**

**Solution:**

**Step 1:** In **Cross I**, the mother produces an abnormal gamete ( $22 + O$ ) instead of a normal haploid ( $22 + X$ ). When this fuses with a normal sperm ( $22 + X$ ), it results in an offspring labeled '1'.

**Step 2:** In **Cross II**, nondisjunction during gamete formation leads to gametes with  $23 + X$  and  $21 + X$  chromosomes instead of the normal  $22 + X$  or  $22 + Y$ . Fusion of these abnormal gametes results in offspring labeled '2'.

**Step 3:**

- Abnormality '1' is caused by gamete formation error in the mother.
- Abnormality '2' is caused by nondisjunction in the father's meiosis.

**Step 4:** These abnormalities typically result in chromosomal disorders due to aneuploidy (addition or loss of chromosomes).

### Quick Tip

Nondisjunction during meiosis leads to abnormal chromosome numbers in gametes, causing genetic disorders like monosomy or trisomy in offspring.

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**19.(A) How are morphine and heroin related? Mention their effect on the human body.**

**Solution: Step 1:** Morphine and heroin are both opiate drugs derived from the latex of the poppy plant *Papaver somniferum*.

**Step 2:** Heroin is a chemically modified form of morphine (diacetylmorphine).

**Step 3:** Both act on the central nervous system and are used for pain relief, but are highly addictive.

**Step 4:** Their excessive use leads to drowsiness, slowed heart rate, impaired respiration, and may cause coma or death.

### Quick Tip

Morphine is a natural opiate, while heroin is its synthetic derivative—both depress the central nervous system and are highly addictive.

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**OR**

**19.(B) (i) Name an alcoholic drink which is produced with the help of microbes:**

**(1) With distillation**

**(2) Without distillation**

**(ii) Explain how cyanobacteria can be used as bio-fertilizer.**

**Solution: Step 1:** (1) Alcoholic drink produced **with distillation:** *Whisky, rum, or brandy.*

(2) Alcoholic drink produced **without distillation:** *Wine and beer.*

**Step 2:** Cyanobacteria like *Anabaena*, *Nostoc*, and *Oscillatoria* fix atmospheric nitrogen and enrich the soil.

**Step 3:** They are commonly used in paddy fields as bio-fertilizers, improving soil fertility naturally and reducing the need for chemical fertilizers.

### Quick Tip

Cyanobacteria naturally fix nitrogen, enhancing soil fertility—while wine and beer ferment without distillation, whisky and rum require it.

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**20.(A) Analyse the following ecosystems and discuss which will be more productive in terms of primary productivity: A young forest, a natural old forest, a shallow polluted lake.**

**Solution: Step 1:** Primary productivity refers to the rate at which producers (plants, algae) convert solar energy into organic material.

**Step 2:** Among the given, a shallow polluted lake has the highest primary productivity due to abundant nutrient availability causing algal blooms.

**Step 3:** A young forest shows moderate productivity due to rapid growth, while an old natural forest has stable but lower net primary productivity.

### Quick Tip

Eutrophic (nutrient-rich) shallow water bodies often exhibit the highest productivity due to algal blooms.

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**OR**

**20.(B) Differentiate between Net Primary Productivity (NPP) and Gross Primary Productivity (GPP) in an ecosystem.**

**Solution: Step 1: Gross Primary Productivity (GPP):** Total amount of organic matter produced by producers through photosynthesis.

**Step 2: Net Primary Productivity (NPP):** The organic matter remaining after deducting the energy used by producers for respiration ( $R$ ) from GPP.

**Step 3:** Relation —  $NPP = GPP - R$

### Quick Tip

NPP represents the energy available to consumers in the ecosystem.

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**21.(A) A patient with ADA deficiency requires periodic infusion of genetically engineered lymphocytes. Explain why such periodic infusion is required and also suggest a permanent cure for such ADA deficiency.**

**Solution: Step 1:** ADA (Adenosine Deaminase) deficiency leads to severe combined immunodeficiency (SCID), where lymphocytes are non-functional.

**Step 2:** Periodic infusion of genetically engineered lymphocytes is needed because these modified cells have a limited lifespan and cannot multiply to maintain the therapeutic effect.

**Step 3:** Since these engineered cells are not incorporated into the patient's genome permanently, repeated infusions are necessary.

**Step 4:** A permanent cure can be achieved by gene therapy where a functional ADA gene is introduced into embryonic stem cells or early bone marrow cells of the patient, allowing lifelong expression.

### Quick Tip

Gene therapy offers a long-term solution for ADA deficiency by incorporating the correct gene into the patient's genome—eliminating the need for repeated infusions.

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**OR**

**21.(B) Describe in brief any two techniques that can be utilised to transfer recombinant DNA into the host cell directly without using any vector.**

**Solution: Step 1: Microinjection:** The recombinant DNA is directly injected into the nucleus of an animal cell using a fine micro-needle under a microscope.

**Step 2: Gene Gun or Biolistics:** High-velocity micro-particles coated with DNA are bombarded into plant cells to deliver the recombinant DNA directly.

**Step 3:** These physical methods bypass the need for a vector, allowing direct DNA transfer into host cells.

#### Quick Tip

Microinjection and gene gun are physical, vector-free methods for direct DNA delivery—commonly used in animal and plant biotechnology.

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## SECTION C

### 22. Compare and contrast convergent and divergent evolution.

**Solution: Step 1: Convergent Evolution:** It is the process where unrelated organisms independently evolve similar traits as a result of having to adapt to similar environments or ecological niches.

**Step 2: Example:** The wings of birds, bats, and insects perform the same function but have different structural origins.

**Step 3: Divergent Evolution:** It is the process where related organisms evolve different traits, leading to the formation of new species due to different environmental pressures.

**Step 4: Example:** Darwin's finches evolving different types of beaks to adapt to various kinds of food sources in the Galápagos Islands.

#### Quick Tip

Convergent evolution results in analogous structures, while divergent evolution leads to homologous structures.

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**23. Shyam and Radha are expecting their first child with Radha being in her second month of pregnancy with no complications. Shyam's family has a history of cystic fibrosis while Radha's family has a history of Down's syndrome, leading to a concern that the baby may have one of these conditions.**

- (a) **Suggest and explain a way of testing if their baby is at risk for any genetic disorders.**
- (b) **In case of presence of one or both of the abnormalities and posing a risk to the mother's health, mention one possible option for them to consider. Is that option safe for Radha at the current gestational age? Justify.**
- (c) **Under what conditions is the process mentioned in (b) illegal?**

**Solution: Step 1: (a)** The suitable test is **amniocentesis**, where a small amount of amniotic fluid containing fetal cells is withdrawn and analyzed for chromosomal abnormalities like Down's syndrome and genetic disorders like cystic fibrosis.

**Step 2: (b)** If the fetus is diagnosed with severe abnormalities that threaten the mother's health, one option is **medical termination of pregnancy (MTP)**. However, as Radha is in her second month (8 weeks), MTP can be safely performed under medical supervision.

**Step 3: (c)** MTP is illegal if performed:

- Without the consent of the pregnant woman.
- Beyond 24 weeks of pregnancy (as per the latest Indian law, unless permitted by a medical board in special cases).
- For reasons such as sex selection or without medical justification.

#### Quick Tip

Amniocentesis helps detect genetic disorders early; MTP laws ensure protection of both maternal health and ethical boundaries.

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**24. (a) Write the palindromic nucleotide sequence for following sequence of DNA segment:**

**5'-GAATTC-3'**

**(b) Name the restriction endonuclease that recognizes this sequence.**

**(c) How are sticky ends produced? Mention their role.**

**Solution: Step 1: (a)** The palindromic sequence is:

5'-GAATTC-3'

3'-CTTAAG-5'

**Step 2: (b)** The restriction endonuclease that recognizes this sequence is **EcoRI**.

**Step 3: (c)** Sticky ends are produced when restriction enzymes like EcoRI cut the DNA at specific sites within the palindromic sequence, leaving overhanging single-stranded regions.

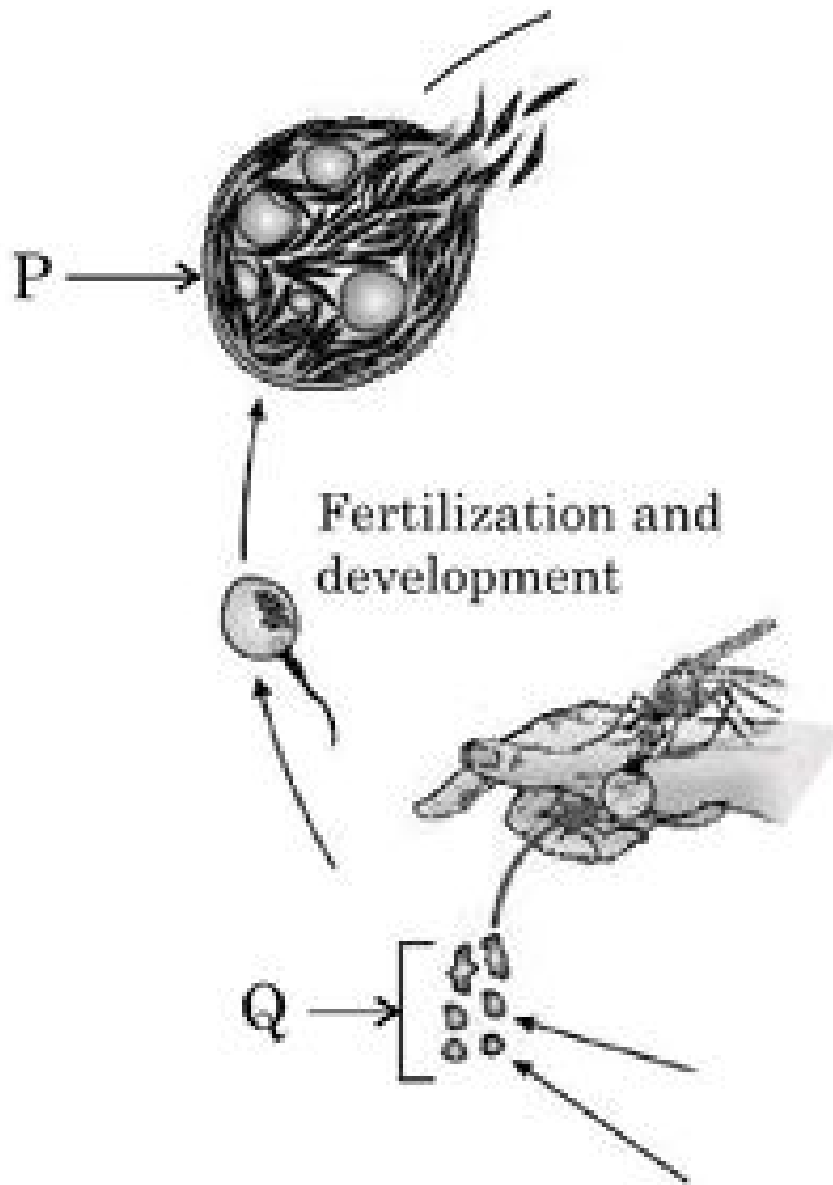
**Step 4:** These sticky ends can form hydrogen bonds with complementary sequences on other DNA fragments, facilitating the ligation process during recombinant DNA formation.

#### Quick Tip

Sticky ends produced by restriction enzymes like EcoRI enable easy and specific joining of DNA fragments in genetic engineering.

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**25. Study a part of life cycle of *Plasmodium* given below:**



**Answer the following questions:**

- (a) Name the infective stage of *Plasmodium* that is stored in the female *Anopheles* mosquito.
- (b) Where does fertilization and development of parasite take place?
- (c) Identify labels P and Q in the given diagram.
- (d) Asexual and sexual phase of the life cycle of the *Plasmodium* takes place in two different hosts. Write their names.

**Solution:**

**Step 1:** (a) The infective stage of *Plasmodium* stored in the female *Anopheles* mosquito is

the **sporozoite**.

**Step 2: (b)** Fertilization and development of the parasite take place inside the **female Anopheles mosquito** (the definitive host).

**Step 3: (c)** In the diagram:

- P is **Ookinete**
- Q is **Sporozoites**

**Step 4: (d)**

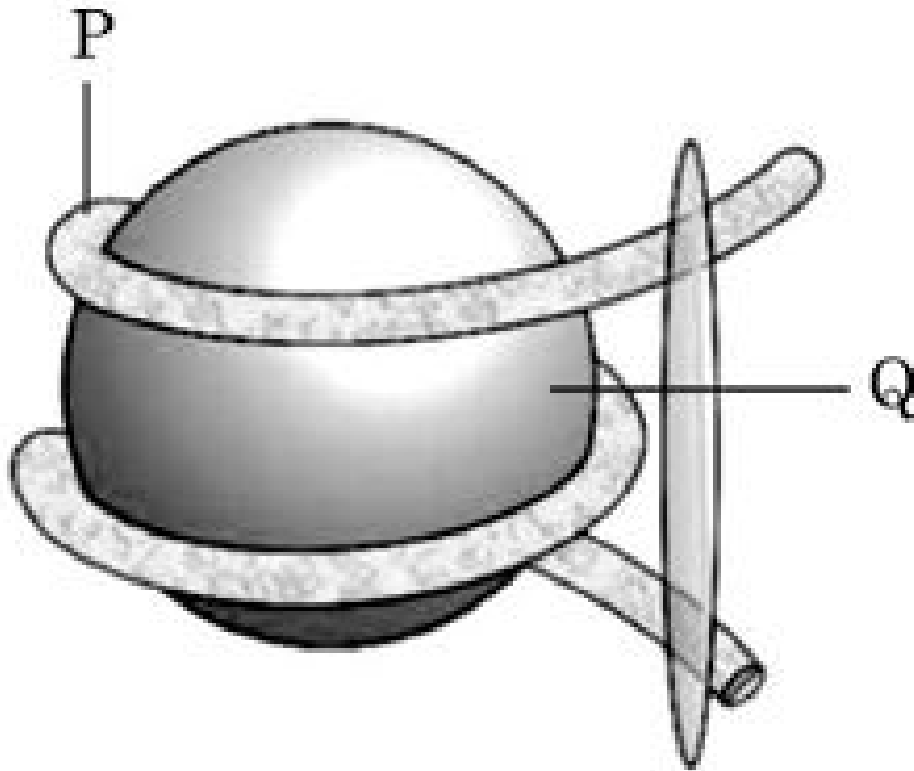
- Asexual phase occurs in the **human** (intermediate host).
- Sexual phase occurs in the **female Anopheles mosquito** (definitive host).

#### Quick Tip

The sporozoite stage of *Plasmodium* is transmitted from mosquito to human and initiates the infection. Sexual reproduction always occurs in the definitive host—here, the mosquito.

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**26. Study the diagram given below and answer the questions that follow:**



**Answer the following questions:**

- (a) Identify the structure shown in the above figure.**
- (b) Identify the labels P and Q.**
- (c) Write the nature of histone proteins.**
- (d) Distinguish between Euchromatin and Heterochromatin.**

**Solution:**

**Step 1: (a)** The structure shown in the figure is a **nucleosome**.

**Step 2: (b)** In the diagram:

- P is **Histone octamer**
- Q is **DNA strand**

**Step 3: (c)** Histone proteins are **basic in nature** due to the presence of positively charged amino acids like lysine and arginine.

**Step 4: (d)** Difference between Euchromatin and Heterochromatin:

- **Euchromatin:** Lightly stained, transcriptionally active, loosely packed.
- **Heterochromatin:** Darkly stained, transcriptionally inactive, tightly packed.

### Quick Tip

Nucleosomes help in compacting DNA and play a role in gene regulation. Histones are positively charged, allowing tight binding with negatively charged DNA.

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**27. (A) Who is having more species diversity — Columbia or Greenland and why?**  
**(B) Explain the concept proposed by Paul Ehrlich.**

**Solution: Step 1: (A)** Columbia has more species diversity than Greenland because it lies near the equator where tropical regions support higher biodiversity due to favourable climatic conditions, consistent temperature, abundant rainfall, and diverse habitats.

**Step 2: (B)** Paul Ehrlich proposed the **Rivet Popper Hypothesis**, which compares an ecosystem to an airplane where all parts (species) are like rivets. Removal of a few rivets (species) might not affect flight (ecosystem stability) immediately, but beyond a point, loss of key species can cause ecosystem collapse.

### Quick Tip

Tropical regions like Columbia are biodiversity hotspots. Ehrlich's hypothesis warns against unchecked species loss, comparing it to removing bolts from a flying plane.

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**28. (A) Differentiate between Recombinant DNA and cDNA.**  
**(B) Explain the method to increase the competency of the bacterial cell membrane to take up recombinant DNA.**

**Solution: Step 1: (A)** Difference between Recombinant DNA and cDNA:

- Recombinant DNA: Artificially created by joining DNA fragments from different sources.
- cDNA (complementary DNA): Synthesized from an mRNA template using reverse transcriptase enzyme.

**Step 2: (B)** Bacterial cell membrane competency can be increased by:

- Treating cells with a cold calcium chloride ( $CaCl_2$ ) solution.
- Followed by a brief heat shock which creates pores in the bacterial membrane, allowing the uptake of recombinant DNA.

#### Quick Tip

Recombinant DNA joins genes from different sources, while cDNA is made from mRNA. Calcium chloride treatment and heat shock boost bacterial DNA uptake.

## 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:**

**In nature, we rarely find isolated, single individuals of any species; majority of them live in groups in a well-defined geographical area, share or compete for similar resources, potentially interbreed and thus constitute a population. The population has certain attributes whereas, an individual organism does not. A population at a given time is composed of individuals of different ages. The size of the population tells us a lot about its status in the habitat. Whatever ecological processes we wish to investigate in a population, be it the outcome of competition with another species, the impact of the predator or the effect of pesticide application, we always evaluate in terms of any change in the population size. The size, in nature, could be low or go into millions. Population size, technically called population density ( $N$ ) need not necessarily be measured in numbers only. The size of a population for any species is not a static parameter. It keeps on changing with time depending on various factors including food availability, predation pressure and adverse weather.**

**(a) The Monarch butterfly is highly distasteful to its predator because of a special chemical present in its body. How does the butterfly acquire this chemical?**

**(b) If population density at a time  $t + 1$  is 800, Emigration = 100, Immigration = 200, Natality = 200 and Mortality = 150, calculate the population density at time  $t$  and**

comment upon the type of age pyramid that will be formed in this case.

Student to attempt either sub-part (c) or (d):

(c) What is the difference in a method of measuring population density in an area if there are 200 carrot grass plants to only single huge banyan tree?

OR

(d) Name two methods to measure the population density of tigers.

**Solution: Step 1: (a)** The Monarch butterfly acquires the distasteful chemical by feeding on a poisonous plant called *Milkweed* during its caterpillar stage, which makes it unpalatable to predators.

**Step 2: (b)**

$$N_{t+1} = N_t + (Natality + Immigration) - (Mortality + Emigration)$$

Given:

$$800 = N_t + (200 + 200) - (150 + 100)$$

$$800 = N_t + 400 - 250$$

$$800 = N_t + 150$$

$$N_t = 800 - 150 = 650$$

Since natality and immigration are higher than mortality and emigration, it indicates a **triangular age pyramid** (expanding population).

**Step 3: (c)** For 200 carrot grass plants: **Number of individuals per unit area (density)** is used.

For a single banyan tree: **Biomass or canopy cover area** is a better parameter than simple count.

OR

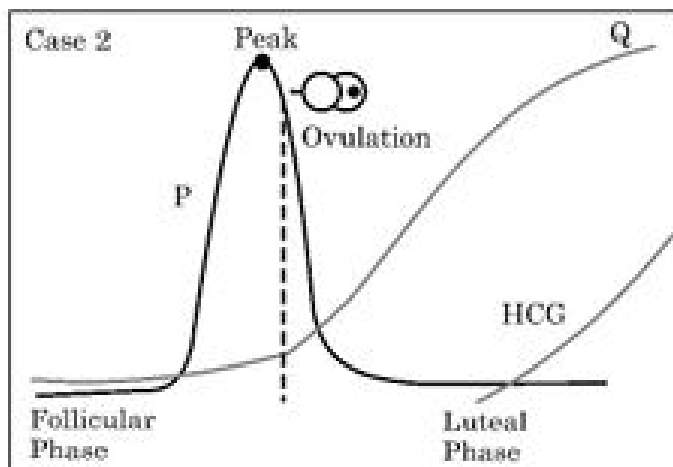
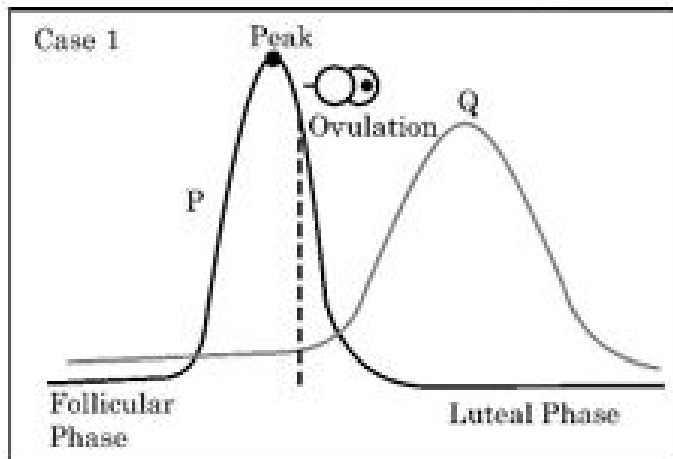
**Step 4: (d)** Two methods to measure tiger population density:

- **Pugmark analysis**
- **Camera trapping**

### Quick Tip

Population density can be expressed by number, biomass, or area cover. Monarch butterflies acquire toxins from Milkweed, and increasing population trends form triangular age pyramids.

30. Study the graphs given below for Case 1 and Case 2 showing different levels of certain hormones and answer the questions that follow:



Answer the following questions:

(a) Which hormone is responsible for the peak observed in Case 1 and Case 2? Write one function of that hormone.

(b) Write changes that take place in the ovary and uterus during follicular phase.

*Student to attempt either sub-part (c) or (d):*

(c) Name the hormone Q of Case 2. Write one function of hormone Q.

**OR**

**(d) Which structure in the ovary will remain functional in Case 2? How is it formed?**

**Solution:**

**Step 1: (a)** The hormone responsible for the peak in Case 1 and Case 2 is **Luteinizing Hormone (LH)**.

**Function:** LH triggers ovulation and the formation of the corpus luteum.

**Step 2: (b)**

- **Ovary:** Maturation of ovarian follicles takes place.
- **Uterus:** Endometrial lining of uterus proliferates under the influence of estrogen.

**Step 3: (c) Name of Hormone Q: Progesterone**

**Function:** Maintains the endometrial lining and prepares uterus for implantation.

**OR**

**(d) Structure that remains functional: Corpus luteum**

**Formation:** Formed from the ruptured Graafian follicle after ovulation under the influence of LH.

#### Quick Tip

The LH surge induces ovulation. If fertilization occurs, HCG from the embryo maintains the corpus luteum and supports progesterone secretion to sustain pregnancy.

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### SECTION E

**31. Student to attempt either option-(A) or (B).**

**(A)**

- You are given axial pea flowers with violet colour whose genotypes are unknown. How would you find the genotype of these plants? Explain with the help of cross.
- Explain Haplodiploidy in honey-bees.

**Solution:**

**Step 1: (i)** To determine the genotype of axial violet pea flowers (which could be either homozygous  $AA$  or heterozygous  $Aa$ ), perform a **test cross** by crossing the plant with a double recessive axial white flowered plant ( $aa$ ).

**Step 2:**

- If the unknown plant is **homozygous dominant (AA)**:

$$AA \times aa \rightarrow 100\%Aa \text{ (All violet flowers)}$$

- If the unknown plant is **heterozygous (Aa)**:

$$Aa \times aa \rightarrow 50\%Aa \text{ (Violet)} + 50\%aa \text{ (White)}$$

- The resulting progeny phenotype ratio reveals the genotype.

**Step 3: (ii)** In honey-bees, sex determination occurs through **haplodiploidy**.

- **Fertilized eggs (2n)** develop into **diploid females** (queens and workers).
  - **Unfertilized eggs (n)** develop into **haploid males** (drones) through **parthenogenesis**.
- 

**OR**

**(B) Explain the steps of DNA fingerprinting that will help in processing of the two blood samples R and S picked up from the crime scene.**

**Solution:**

**Step 1:** Isolate DNA from both blood samples R and S.

**Step 2:** Cut the DNA using specific **restriction endonucleases** at specific sites.

**Step 3:** Separate the resulting DNA fragments by **gel electrophoresis**.

**Step 4:** Transfer the separated DNA fragments onto a **nylon or nitrocellulose membrane** by **Southern blotting**.

**Step 5:** Hybridize the membrane with radioactive or fluorescent **DNA probes** specific for known variable number tandem repeat (VNTR) sequences.

**Step 6:** Develop the **autoradiograph** or imaging and compare the banding pattern of samples R and S.

**Step 7:** Matching banding patterns confirm if both samples originate from the same individual.

**Quick Tip**

A test cross helps reveal an unknown dominant genotype, and haplodiploidy controls sex in honey-bees. DNA fingerprinting uniquely identifies individuals using VNTR patterns.

**32. Student to attempt either option-(A) or (B).**

**(A) Answer the following questions:**

- (i) State what do you understand by “MALT”? Where is it located inside our body?
- (ii) Explain cytokine barriers.
- (iii) Name the diagnostic test for AIDS. On what principle does it work?
- (iv) Bone marrow and thymus play an important role in human immune system. Explain how are they able to achieve this.

**OR**

**(B)**

- (i) Fill ‘H’, ‘I’, ‘J’, ‘K’, ‘L’ and ‘M’ in the following table with suitable words:

|     | Chemical / Bioactive Molecule | Micro-organism            | Category | Use   |
|-----|-------------------------------|---------------------------|----------|---|
| (a) | Butyric acid                  | H                         | I        | Important applications in food, chemical & pharma industry<br>Inhibit cholesterol biosynthesis pathway. |
| (b) | J                             | <u>Monascus purpureus</u> | K        |   |
| (c) | Cyclosporin A                 | L                         | Fungus   |   |

- (ii) Why are baculoviruses used as biological control agents?

**Solution:**

**Option (A):**

- (i) **MALT** stands for Mucosa-Associated Lymphoid Tissue. It is located in the lining of respiratory, digestive and urogenital tracts.
- (ii) **Cytokine barriers** involve antiviral proteins like interferons that protect non-infected cells from viral infection.
- (iii) **ELISA** (Enzyme Linked Immunosorbent Assay) is used for AIDS diagnosis. It works on the principle of antigen-antibody interaction.
- (iv) **Bone marrow** produces lymphocytes. **Thymus** is the site for T-cell maturation. Both are primary lymphoid organs and ensure immune cell development.

**Option (B):**

- (i) Table with filled values:

|     |                |                               |                           |  |
|-----|----------------|-------------------------------|---------------------------|--|
| (a) | Butyric acid   | <b>Clostridium butylicum</b>  | <b>Anaerobic bacteria</b> | Important applications in food, chemical & pharma industry |
| (b) | <b>Statins</b> | <i>Monascus purpureus</i>     | <b>Fungus</b>             | Inhibit cholesterol biosynthesis pathway                   |
| (c) | Cyclosporin A  | <b>Trichoderma polysporum</b> | Fungus                    | <b>Immunosuppressive agent in organ transplant</b>         |

- (ii) **Baculoviruses** are used as biological control agents as they are species-specific, affect only insect pests (especially arthropods), and do not harm plants, mammals, or beneficial insects.

**Quick Tip**

MALT forms a major part of our immune defense in mucosal regions. Microbes like *Monascus* and *Trichoderma* produce bioactive compounds with crucial industrial applications.

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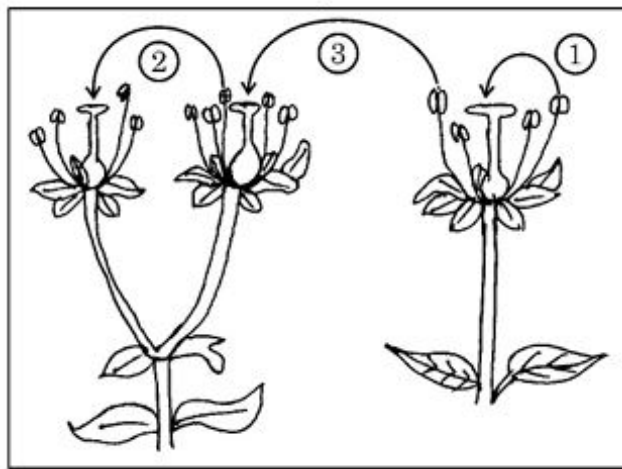
**33. Student to attempt either option-(A) or (B):**

**(A)**

1. Distinguish between the two cells enclosed in a mature male gametophyte of an angiosperm.

**(B)**

1. Study the diagram given below showing the modes of pollination. Answer the questions that follow.



- (a) The given diagram shows three methods of pollen transfer in plants. Examine them carefully and write the technical terms used for pollen transfer methods '1', '2' and '3'.
- (b) How do the following plants achieve pollination successfully?
  - (a) Water lily
  - (b) *Vallisneria*
- (c) Write advantages of pollen transfer method '3'.

**Solution:**

**Step 1: (A)** In a mature male gametophyte of an angiosperm, the two cells enclosed are:

- **Generative cell:** Divides to form two male gametes.
- **Tube cell:** Forms the pollen tube for sperm delivery.

**Step 2: (B) (i)** The technical terms are:

1 – Autogamy

2 – Geitonogamy

3 – Xenogamy

**(ii)** (a) Water lily – Pollination occurs through insects (entomophily).

(b) *Vallisneria* – Pollination occurs through water (hydrophily).

**(iii)** Advantages of xenogamy:

- Introduces genetic variation.
- Helps plants adapt to changing environments.

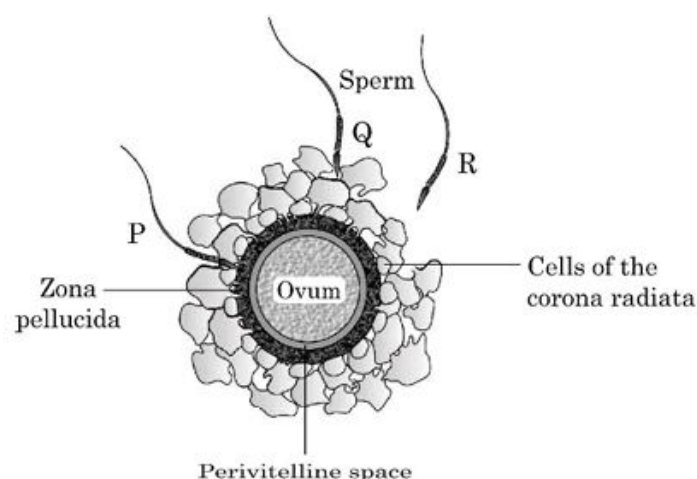
#### Quick Tip

Xenogamy leads to maximum genetic diversity, improving adaptability and survival of plant species.

**OR**

**33.**

**(B)** Given below is the diagram of human ovum surrounded by a few sperms. Observe the diagram and answer the questions that follow:



1. Compare the fate of sperms P, Q and R shown in the diagram.

2. Write the role of Zona pellucida in this process.
3. Analyse the changes occurring in the ovum after the entry of sperm.
4. How are acrosome and middle piece of a human sperm able to play an important role in human fertilization?

**Solution:**

**(i) Fate of sperms:**

- Sperm P: Does not reach the ovum; blocked by surrounding layers.
- Sperm Q: Actively moving toward the ovum, may achieve fertilization.
- Sperm R: Unable to penetrate; will degenerate eventually.

**(ii) Role of Zona pellucida:** It is a glycoprotein membrane that ensures species-specific sperm binding and prevents polyspermy after the first sperm fuses with the ovum.

**(iii) Changes after sperm entry:**

- Completion of ovum's second meiotic division.
- Formation of second polar body.
- Restoration of diploid number through fusion of male and female pronuclei.
- Zona reaction prevents entry of other sperms.

**(iv) Role of acrosome and middle piece:**

- **Acrosome:** Releases hydrolytic enzymes to digest corona radiata and zona pellucida.
- **Middle piece:** Contains mitochondria that provide energy for sperm motility, aiding fertilization.

**Quick Tip**

The zona pellucida plays a critical role in preventing multiple sperm from fertilizing an ovum, thus ensuring proper embryonic development.