CBSE Class 12 Biology(Set 57/5/1) Question Paper with Solutions

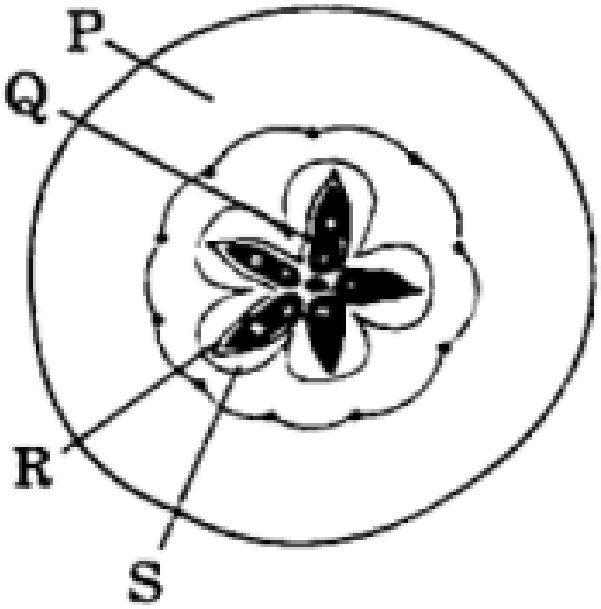
Time Allowed :3 Hour	Maximum Marks :70	Total Questions :33

General Instructions

Read the following instructions very carefully and strictly follow them:

- This question paper contains **33 questions**. **All questions are compulsory.**
- Question paper is divided into **five sections** – Sections A, B, C, D and E.
- **Section A** – questions number 1 to 16 are Multiple Choice Type questions. Each question carries 1 mark.
- **Section B** – questions number 17 to 21 are Very Short Answer Type questions. Each question carries 2 marks.
- **Section C** – questions number 22 to 28 are Short Answer Type questions. Each question carries 3 marks.
- **Section D** – questions number 29 and 30 are Case-Based questions. Each question carries 4 marks. Each question has sub parts with internal choice in one of the sub parts.
- **Section E** – questions number 31 to 33 are Long Answer Type questions. Each question carries 5 marks.
- There is no overall choice. However, an internal choice has been provided in Sections B, D and E of the question paper. A candidate has to write answer for only **one** of the alternatives in such questions.
- Kindly note that there is a separate question paper for Visually Impaired Candidates.
- Wherever necessary, neat and properly labelled diagrams should be drawn.

1. Identify the parts P, Q, R, S in the figure given below and select the option in the correct order.



(A) P – Seed Q – Thalamus R – Mesocarp S – Endocarp
(B) P – Thalamus Q – Seed R – Endocarp S – Mesocarp
(C) P – Seed Q – Thalamus R – Endocarp S – Mesocarp
(D) P – Thalamus Q – Seed R – Mesocarp S – Endocarp

Correct Answer: (4) P – Thalamus, Q – Seed, R – Mesocarp, S – Endocarp

Solution:

Concept: The figure represents a longitudinal section of an **apple (a pome fruit)**. In pomes, the edible portion mainly develops from the **thalamus (receptacle)** rather than the ovary wall. The fruit structure includes:

- **Thalamus** – the fleshy outer edible portion.
- **Mesocarp** – the middle fleshy layer of the pericarp.
- **Endocarp** – the inner papery layer surrounding the seeds.
- **Seed** – located inside the locules at the center.

Step 1: Identify part P.
The label **P** points to the large outer fleshy region of the fruit, which is the edible portion derived from the **thalamus**.

$$P = \text{Thalamus}$$

Step 2: Identify part Q.
The arrow **Q** indicates the dark structures present inside the locules of the fruit, which represent the **seeds**.

$$Q = \text{Seed}$$

Step 3: Identify part R.
The label **R** points to the fleshy layer surrounding the inner core of the fruit, which corresponds to the **mesocarp**.

$$R = \text{Mesocarp}$$

Step 4: Identify part S.
The arrow **S** indicates the thin layer enclosing the seeds, which is the **endocarp**.

$$S = \text{Endocarp}$$

Thus, the correct order is:

$$\boxed{P = \text{Thalamus},\ Q = \text{Seed},\ R = \text{Mesocarp},\ S = \text{Endocarp}}$$

Quick Tip

In pome fruits like apple and pear, the edible portion mainly develops from the **thalamus (receptacle)**, while the **endocarp forms the papery core** surrounding the seeds.

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2. The foetal ejection reflex in humans triggers the release of _____ hormone from _____. Fill in the blanks by choosing the correct option.
(A) oxytocin, foetal pituitary
(B) oxytocin, maternal pituitary
(C) human chorionic gonadotropin, placenta
(D) progesterone, corpus luteum

Correct Answer: (2) oxytocin, maternal pituitary

Solution:

Concept: The **foetal ejection reflex** is an important physiological mechanism involved in childbirth. When the fully developed foetus stretches the cervix of the uterus, signals are sent to the mother's brain, which stimulates the release of a hormone responsible for uterine contractions.
Step 1: Understand the foetal ejection reflex.
During late pregnancy, the pressure exerted by the foetus on the cervix generates nerve impulses that travel to the **hypothalamus** in the mother's brain.
Step 2: Hormone released during this reflex.
In response to these signals, the **posterior pituitary gland of the mother** releases the hormone **oxytocin**.

$$\text{Hormone released} = \text{Oxytocin}$$

Step 3: Function of oxytocin.

Oxytocin stimulates strong **uterine contractions**, which further push the foetus toward the cervix. This creates a positive feedback loop that intensifies labour contractions until delivery occurs.

Step 4: Identify the correct source.

Since oxytocin responsible for labour is secreted from the **maternal posterior pituitary**, the correct answer is:

Oxytocin released from the maternal pituitary

Quick Tip

The foetal ejection reflex during parturition triggers the release of **oxytocin from the maternal posterior pituitary**, which causes strong uterine contractions leading to childbirth.

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3. A DNA molecule is 160 base pairs long. It has 30% Guanine. How many Adenine bases are present in this DNA molecule?

(A) 48
(B) 64
(C) 96
(D) 192

Correct Answer: (2) 64

Solution:

Concept: DNA follows **Chargaff's Rule**, which states:

$$A = T \quad \text{and} \quad G = C$$

Thus, the total percentage of bases in DNA is:

$$A + T + G + C = 100\%$$

Step 1: Use the given percentage of Guanine.

Given:

$$G = 30\%$$

Since $G = C$,

$$C = 30\%$$

Thus,

$$G + C = 60\%$$

Step 2: Find percentage of Adenine and Thymine.

$$A + T = 100 - 60 = 40\%$$

Since $A = T$,

$$A = 20\%$$

Step 3: Find the total number of nucleotides.
The DNA molecule has:

$$160 \text{ base pairs}$$

Each base pair contains **two nucleotides**.

$$\text{Total bases} = 160 \times 2 = 320$$

Step 4: Calculate number of Adenine bases.

$$A = 20\% \text{ of } 320$$

$$A = \frac{20}{100} \times 320$$

$$A = 64$$

Thus, the number of adenine bases present is:

$$\boxed{64}$$

Quick Tip

In double-stranded DNA, always remember: $A = T$ and $G = C$. If base pairs are given, multiply by 2 to get the total number of nucleotides before calculating percentages.

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4. In *Pisum sativum*, the flower colour may be violet (V) or white (v). What proportion of the offspring in a cross of $VV \times vv$ would be expected to be violet?
(A) 25%
(B) 50%
(C) 75%
(D) 100%

Correct Answer: (4) 100%

Solution:

Concept: This problem is based on **Mendel's Law of Dominance**. In *Pisum sativum* (pea plant):

- V = allele for **violet flower** (dominant)
- v = allele for **white flower** (recessive)

When a dominant allele is present, the dominant trait is expressed.
Step 1: Identify the parental genotypes.

$$VV \times vv$$

Gametes produced:

$$VV \rightarrow V, V$$

$$vv \rightarrow v, v$$

Step 2: Construct the Punnett square.

	V	V
v	Vv	Vv
v	Vv	Vv

Step 3: Determine genotype and phenotype.
All offspring have genotype:

$$Vv$$

Since V is dominant, all offspring will show the **violet flower phenotype**.

$$\text{Violet offspring} = 100\%$$

Thus, the expected proportion of violet flowers is:

$$\boxed{100\%}$$

Quick Tip

When a homozygous dominant parent (VV) is crossed with a homozygous recessive parent (vv), all F_1 offspring become heterozygous (Vv) and express the dominant trait.

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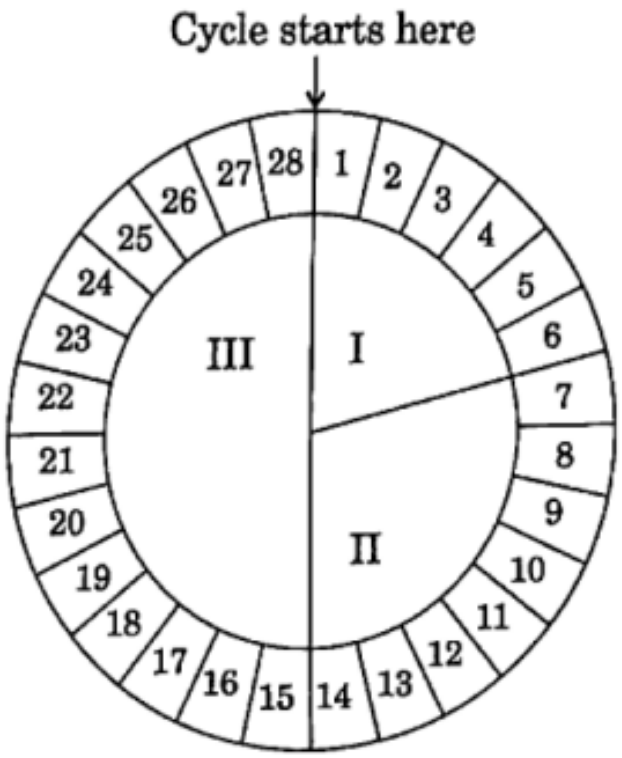
5. In a human female, the menstrual cycle of 28 days is represented by the diagram given below. Select the correct statement related to this diagram.



(A) Primary follicle of ovary matures into Graafian follicle in phase II.
(B) The hormone secreted in large amounts in phase III is also responsible for maintaining pregnancy in human females.
(C) Corpus luteum secretes progesterone in phase I, however it degenerates completely in phase III.
(D) Both (A) and (B).

Correct Answer: (4) Both (A) and (B)

Solution:

Concept: The menstrual cycle in human females typically lasts about **28 days** and is divided into different phases:

- **Phase I – Menstrual phase** (Day 1–5)
- **Phase II – Follicular / Proliferative phase** (Day 6–14)
- **Phase III – Luteal / Secretory phase** (Day 15–28)

Each phase is associated with specific hormonal changes and ovarian events.
Step 1: Analyze statement (A).
During the **follicular phase (Phase II)**, the ovarian follicles develop progressively and the **primary follicle matures into a Graafian follicle** before ovulation occurs.
Thus, statement (A) is **correct**.
Step 2: Analyze statement (B).
In **Phase III (luteal phase)**, the **corpus luteum** secretes large amounts of **progesterone**.
Progesterone plays a crucial role in:

- Preparing the uterus for implantation
- Maintaining pregnancy in early stages

Thus, statement (B) is also **correct**.
Step 3: Analyze statement (C).
The corpus luteum secretes progesterone during the **luteal phase (Phase III)**, not in Phase I. Therefore, this statement is **incorrect**.
Step 4: Determine the correct option.
Since both (A) and (B) are correct:

$$\boxed{\text{Both (A) and (B)}}$$

Quick Tip

In the menstrual cycle: Follicular phase leads to Graafian follicle formation, ovulation occurs around day 14, and the luteal phase is dominated by progesterone secretion from the corpus luteum.

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6. Arrange the following in the correct sequence of their evolution and select the correct option:

(*i*) Seaweed (*ii*) Invertebrates (*iii*) Jawless fish

(A) (i), (ii), (iii)
(B) (i), (iii), (ii)
(C) (ii), (iii), (i)
(D) (ii), (i), (iii)

Correct Answer: (1) (i), (ii), (iii)

Solution:

Concept: Evolution describes the gradual development of life forms from simple organisms to more complex organisms over millions of years. In evolutionary history, primitive aquatic plants appeared before animals, and vertebrates evolved later.
Step 1: Identify the earliest organisms.
Seaweeds are primitive photosynthetic organisms belonging to algae. They appeared very early in the evolutionary history of life in aquatic environments.

$$\text{First} = \text{Seaweed}$$

Step 2: Next stage in evolution.
After simple plant-like organisms, **invertebrates** evolved. These are animals without a backbone, such as sponges, jellyfish, worms, and arthropods.

$$\text{Second} = \text{Invertebrates}$$

Step 3: Evolution of vertebrates.
Jawless fish represent some of the earliest vertebrates (animals with a backbone). They evolved later than invertebrates.

$$\text{Third} = \text{Jawless fish}$$

Step 4: Determine the correct sequence.
Thus, the evolutionary order is:

$$\boxed{\text{Seaweed} \rightarrow \text{Invertebrates} \rightarrow \text{Jawless fish}}$$

which corresponds to:

$$\boxed{(i), (ii), (iii)}$$

Quick Tip

In evolution, simpler life forms such as algae appeared first, followed by invertebrate animals, and later vertebrates like fishes evolved.

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7. *Monascus purpureus* is a yeast used commercially in the production of which one of the following?
(A) Ethanol
(B) Streptokinase
(C) Citric acid
(D) Statins

Correct Answer: (4) Statins

Solution:

Concept: Certain microorganisms are used in biotechnology for the production of commercially important products such as antibiotics, enzymes, acids, and drugs.
Step 1: Understand the organism involved.
Monascus purpureus is a yeast commonly used in biotechnology and fermentation processes.
Step 2: Identify the product associated with this yeast.
This yeast produces compounds known as **statins**. Statins are important drugs used to:

- Lower blood cholesterol levels
- Reduce the risk of cardiovascular diseases

Step 3: Eliminate incorrect options.

- **Ethanol** is mainly produced by *Saccharomyces cerevisiae*.

- **Streptokinase** is produced by *Streptococcus*.
- **Citric acid** is produced by *Aspergillus niger*.

Step 4: Select the correct option.
Thus, *Monascus purpureus* is used for the commercial production of:

Statins

Quick Tip

Statins produced by *Monascus purpureus* act as cholesterol-lowering agents by inhibiting enzymes involved in cholesterol synthesis.

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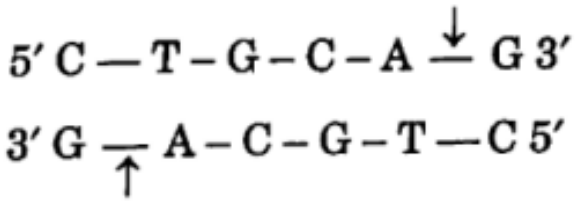
8. Given below is the restriction site of a restriction endonuclease Pst I and the cleavage sites on a DNA molecule. Choose the option that gives the correct resultant fragments.



(A)

$$5'\ C-T-G \qquad C-A-G\ 3'$$
$$3'\ G-A-C-G-T \qquad C\ 5'$$

(B)

$$5'\ C-T \qquad G-C-A-G\ 3'$$
$$3'\ G-A-C-G \qquad T-C\ 5'$$

(C)

$$5'\ C-T-G-C \qquad A-G\ 3'$$
$$3'\ G-A-C-G \qquad T-C\ 5'$$

(D)

$$5'\ C-T-G-C-A \qquad G\ 3'$$
$$3'\ G \qquad A-C-G-T-C\ 5'$$

Correct Answer: (3)

Solution:

Concept: Restriction endonucleases are enzymes that recognize specific DNA sequences called **restriction sites** and cut DNA at those positions. Many restriction enzymes produce **sticky ends** by making staggered cuts in the DNA strands.

The enzyme **Pst I** recognizes the palindromic sequence:

$$5' \; CTGCAG \; 3'$$
$$3' \; GACGTC \; 5'$$

and cleaves between:

$$CTGCA \downarrow G$$

$$G \uparrow ACGTC$$

Step 1: Identify the cleavage positions.
The enzyme cuts after the nucleotide **A** in the upper strand and before **A** in the complementary strand, producing staggered ends.
Step 2: Separate the fragments after cleavage.
After cutting, the fragments produced are:

$$5' \; C - T - G - C \qquad A - G \; 3'$$

$$3' \; G - A - C - G \qquad T - C \; 5'$$

These fragments contain **sticky ends** that can easily pair with complementary DNA fragments.
Step 3: Match with the options.
The fragment arrangement exactly matches **Option (C)**.
Thus, the correct resultant fragments correspond to:

Option (C)

Quick Tip

Restriction enzymes recognize palindromic DNA sequences and usually create sticky ends by cutting DNA in a staggered manner, which helps in recombinant DNA technology.

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9. Choose a correct option that shows an interaction in which one species benefits while the other is neither harmed nor benefitted.
(A) Mycorrhizal associations between fungi and roots of higher plants
(B) Sea anemone and clownfish
(C) Abingdon tortoises and goats in the Galapagos Island
(D) Cuscuta on hedge plants

Correct Answer: (2) Sea anemone and clownfish

Solution:

Concept: The interaction where **one species benefits while the other is neither harmed nor benefited** is known as **commensalism**.
Step 1: Understand commensalism.
In commensalism:

$$(+ \quad 0)$$

- One organism benefits.
- The other organism is unaffected.

Step 2: Evaluate each option.

- **(A) Mycorrhiza** – mutualism (both fungi and plant roots benefit).
- **(B) Sea anemone and clownfish** – clownfish gains protection while anemone is largely unaffected (commensalism).
- **(C) Abingdon tortoises and goats** – competition for food resources.
- **(D) Cuscuta on hedge plants** – parasitism.

Step 3: Select the correct interaction.
Thus, the example representing commensalism is:

$$\boxed{\text{Sea anemone and clownfish}}$$

Quick Tip

Commensalism is represented as (+,0). A classic example is clownfish living among the tentacles of sea anemones for protection.

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10. Transgenic animals have their genetic material manipulated. Select the correct option in reference to transgenic animals.
(A) Foreign DNA and RNA are present in their cells.
(B) Foreign RNA is present in all of their cells.
(C) Foreign DNA is present in all of its cells.
(D) Foreign RNA is present in some of its cells.

Correct Answer: (3) Foreign DNA is present in all of its cells.

Solution:

Concept: Transgenic animals are organisms whose genomes have been artificially modified by inserting **foreign DNA (transgenes)** using genetic engineering techniques.
Step 1: Understand the meaning of transgenic animals.
A transgenic animal contains an additional gene introduced from another organism. This inserted gene becomes part of the organism's genome.
Step 2: Distribution of the inserted gene.

When the transgene is introduced at the early embryonic stage, the foreign DNA becomes integrated into the genome and is present in **all the cells of the organism**.
Step 3: Evaluate the options.

- Foreign RNA is not permanently inserted into the genome.
- Transgenic organisms are defined by the presence of **foreign DNA**.
- This DNA is incorporated into the genome and inherited by cells during division.

Thus, the correct statement is:

Foreign DNA is present in all of its cells

Quick Tip

Transgenic animals are produced by inserting a foreign gene (DNA) into their genome so that the gene is expressed and inherited in all cells of the organism.

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11. Select the odd option in the context of convergent evolution.
(A) Eyes of Octopus and Mammals
(B) Flippers of Penguins and Dolphins
(C) Flying Squirrel and Flying Phalanger
(D) Thorns of Bougainvillea and Tendrils of Cucurbita

Correct Answer: (4) Thorns of Bougainvillea and Tendrils of Cucurbita

Solution:

Concept: Convergent evolution occurs when unrelated organisms independently evolve similar traits due to adaptation to similar environments. These structures are called **analogous organs**.
Step 1: Identify examples of convergent evolution.

- **Eyes of Octopus and Mammals** – evolved independently but perform the same function.
- **Flippers of Penguins and Dolphins** – similar structures adapted for swimming though they evolved separately.
- **Flying Squirrel and Flying Phalanger** – developed gliding membranes independently.

These are all examples of **analogous structures** formed due to convergent evolution.
Step 2: Analyze option (D).

- **Thorns of Bougainvillea** and **Tendrils of Cucurbita** originate from similar plant parts (axillary buds).
- They have different functions but share the same origin.

Such structures are called **homologous organs** and represent **divergent evolution** rather than convergent evolution.
Step 3: Determine the odd option.
Since option (D) does not represent convergent evolution, it is the odd one out.

Thorns of Bougainvillea and Tendrils of Cucurbita

Quick Tip

Analogous organs indicate convergent evolution, while homologous organs indicate divergent evolution.

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12. Which of the following fish led to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in Lake Victoria of East Africa?
(A) Catla catla
(B) Dogfish
(C) Nile Perch
(D) African Catfish

Correct Answer: (3) Nile Perch

Solution:

Concept: Introduction of non-native species into an ecosystem can disturb ecological balance and may lead to the extinction of native species. Such species are known as **invasive alien species**.
Step 1: Understand the ecological event.
In Lake Victoria (East Africa), a predatory fish called the **Nile perch** was intentionally introduced to increase fish production.
Step 2: Impact of introduction.
The Nile perch is a large carnivorous fish that preyed heavily on native fish species, particularly **cichlid fishes**.
Step 3: Result of the introduction.
Due to intense predation, more than **200 species of endemic cichlid fish** became extinct or severely reduced.

Nile Perch

Quick Tip

The introduction of Nile perch into Lake Victoria is a classic example of how invasive species can cause massive biodiversity loss.

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13. Assertion (A): The embryo with 8 to 16 blastomeres is called a morula.
Reason (R): The morula continues to divide and transform into trophoblast.
Choose the correct option:
(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Correct Answer: (2) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

Solution:

Concept: Early embryonic development in humans involves a series of rapid mitotic divisions called **cleavage**. During this process, the zygote divides to form different developmental stages such as morula and blastocyst.
Step 1: Analyze Assertion (A).
During cleavage, the embryo divides repeatedly to produce smaller cells called **blastomeres**. When the embryo reaches about **8–16 blastomeres**, it forms a solid ball of cells known as the **morula**.
Thus, Assertion (A) is **true**.
Step 2: Analyze Reason (R).
The morula continues to divide and differentiate to form a **blastocyst**. In the blastocyst stage, the outer layer of cells develops into the **trophoblast**, which later contributes to placenta formation.
Thus, Reason (R) is also **true**.
Step 3: Check the explanation relationship.
Although both statements are correct, the reason does not explain why an embryo with 8–16 blastomeres is called a morula. It only describes the next developmental stage.
Therefore:

Both Assertion and Reason are true, but Reason is not the correct explanation

Quick Tip

The morula stage occurs when the embryo consists of about 8–16 blastomeres and resembles a mulberry-like structure.

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14. Assertion (A): Repetitive sequences make up a very large portion of the human genome.
Reason (R): Repetitive sequences do not have direct coding functions in the genome.
Choose the correct option:

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Correct Answer: (1) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

Solution:

Concept: The **human genome** contains both coding and non-coding DNA sequences. A significant portion of the genome consists of repetitive DNA sequences that do not directly code for proteins.
Step 1: Analyze Assertion (A).
Studies from the **Human Genome Project** revealed that a large fraction of the human genome is composed of **repetitive DNA sequences**. These include satellite DNA, minisatellites, microsatellites, and transposable elements.
Thus, Assertion (A) is **true**.
Step 2: Analyze Reason (R).
Most repetitive sequences are part of the **non-coding region** of DNA and generally do not code for proteins or enzymes. Hence, they lack direct coding functions.
Thus, Reason (R) is also **true**.
Step 3: Check the explanation relationship.
Because repetitive sequences largely belong to the **non-coding DNA**, they accumulate in the genome and constitute a large portion of it. Therefore, the reason correctly explains the assertion.

Both Assertion and Reason are true and Reason correctly explains the Assertion

Quick Tip

Less than 2% of the human genome codes for proteins, while a large part consists of non-coding repetitive DNA sequences.

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15. Assertion (A): *Trichoderma* species are free living fungi that are very common in the root ecosystems.
Reason (R): They are effective bio-control agents of several plant pathogens.
Choose the correct option:
(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Correct Answer: (2) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

Solution:

Concept: *Trichoderma* is a genus of fungi widely used in agriculture and biotechnology. These fungi are commonly found in soil and root ecosystems and play an important role in controlling plant diseases.
Step 1: Analyze Assertion (A).
Trichoderma species are **free-living fungi** commonly present in soil, especially in the **root ecosystem (rhizosphere)** of plants.
Thus, Assertion (A) is **true**.
Step 2: Analyze Reason (R).
These fungi act as **biocontrol agents** by suppressing the growth of harmful plant pathogens through mechanisms such as competition, antibiosis, and parasitism.
Thus, Reason (R) is also **true**.
Step 3: Check explanation relationship.
Although both statements are correct, the ability of *Trichoderma* to act as a biocontrol agent does not explain why it is commonly found in root ecosystems.
Therefore:

Both Assertion and Reason are true, but Reason is not the correct explanation

Quick Tip

Trichoderma species are widely used as biological control agents to protect crops from fungal plant pathogens.

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16. Assertion (A): The use of chitinase enzyme is necessary for the separation of DNA from yeast cells but not in the case of *Spirogyra*.
Reason (R): Fungal cell wall is made up of fungal chitin.
Choose the correct option:
(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.

Correct Answer: (1) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

Solution:

Concept: To isolate DNA from cells, the **cell wall must be broken**. Different organisms have different cell wall compositions, so specific enzymes are required.
Step 1: Analyze Assertion (A).
Yeast cells belong to fungi and have a cell wall composed mainly of **chitin**. Therefore, the enzyme **chitinase** is required to break down the cell wall and release DNA.
However, *Spirogyra* is a green alga whose cell wall is mainly composed of **cellulose**, not chitin. Hence chitinase is not required.
Thus, Assertion (A) is **true**.
Step 2: Analyze Reason (R).
Fungal cell walls indeed contain **chitin**, a strong structural polysaccharide.
Thus, Reason (R) is also **true**.
Step 3: Check explanation relationship.
Because yeast cell walls contain chitin, the enzyme chitinase is needed to digest the wall and isolate DNA. Therefore, the reason correctly explains the assertion.

Both Assertion and Reason are true and Reason correctly explains the Assertion

Quick Tip

Different enzymes are used for DNA isolation depending on cell wall composition: cellulase for plant cells and chitinase for fungal cells.

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17 (a). Mention the functions of each of the following:

- (i) Tassels of Corn Cob
- (ii) Scutellum

Solution:

Concept: Different plant structures perform specific roles in reproduction and seed development. Understanding their functions helps in explaining plant physiology and reproduction.
Step 1: Function of Tassels of Corn Cob.
Tassels in maize represent the **male inflorescence**. Their main functions are:

- Production of **pollen grains**.
- Facilitation of **pollination** by releasing pollen into the air (wind pollination).

Step 2: Function of Scutellum.
The scutellum is a part of the **embryo in monocot seeds** (like maize). Its functions include:

- Acting as a **cotyledon**.
- Absorbing nutrients from the **endosperm**.

- Transferring nutrients to the growing embryo during germination.

Quick Tip

In maize, tassel = male reproductive part, while scutellum = nutrient-absorbing cotyledon of the embryo.

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17 (b). Farmers prefer apomictic seeds over hybrid seeds. Give any two reasons.

Solution:

Concept: **Apomixis** is a type of asexual reproduction in plants where seeds are formed without fertilization. It results in offspring genetically identical to the parent plant.
Step 1: Understand advantage of apomixis.
Apomictic seeds preserve desirable traits across generations without genetic variation.
Step 2: State reasons for preference.

- Farmers can **reuse seeds every year** without loss of hybrid vigor, unlike hybrid seeds.
- Apomictic seeds maintain **genetic uniformity and desirable traits** (such as high yield) across generations.

Apomixis ensures stable, high-yielding crops without repeated seed purchase

Quick Tip

Hybrid seeds need to be purchased every season, whereas apomictic seeds can be reused without losing their superior traits.

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18. Define the term 'amniocentesis'. Why has the government imposed a statutory ban in spite of its importance in the medical field?

Solution:

Concept: Amniocentesis is a medical diagnostic technique used during pregnancy to detect genetic and chromosomal abnormalities in the developing fetus.
Step 1: Definition of Amniocentesis.
Amniocentesis is a prenatal diagnostic procedure in which a small amount of **amniotic fluid** is withdrawn from the amniotic sac surrounding the fetus. The fetal cells present in this fluid are examined to detect genetic disorders such as Down syndrome or other chromosomal abnormalities.
Step 2: Reason for government ban.

Although it is useful for detecting genetic disorders, the technique was widely misused in some places for **determining the sex of the fetus**.
Step 3: Misuse and consequences.
Sex determination often led to **female foeticide**, which disturbed the natural sex ratio in the population. To prevent this unethical practice, the government imposed a statutory ban under laws such as the **Pre-Conception and Pre-Natal Diagnostic Techniques (PCPNDT) Act**.
Thus, the ban was imposed to **prevent sex-selective abortion and protect the female child**.

Quick Tip

Amniocentesis is medically useful for detecting genetic disorders, but its misuse for sex determination led to legal restrictions in many countries including India.

---

19. Name the lymphoid organ that acts as a large reservoir of erythrocytes. Explain its role as a lymphoid organ.

Solution:

Concept: Lymphoid organs are specialized organs where lymphocytes originate, mature, and participate in immune responses.
Step 1: Identify the lymphoid organ.
The lymphoid organ that acts as a large reservoir of erythrocytes is the **spleen**.

Spleen

Step 2: Role of spleen as a lymphoid organ.
The spleen performs several important functions in the immune system:

- It contains a large number of **lymphocytes and phagocytes**.
- It helps in **initiating immune responses** against blood-borne pathogens.
- It filters blood and removes **old or damaged erythrocytes**.
- It acts as a **reservoir of erythrocytes**.
- It produces antibodies and participates in **immune defense**.

Quick Tip

The spleen is the largest lymphoid organ in the body and plays an important role in immunity and blood filtration.

---

20 (a). Suggest how a virus-free healthy plant can be obtained from a diseased sugarcane plant.

Solution:

Concept: Virus-free plants can be produced from infected plants using **plant tissue culture techniques**. The most commonly used method is **meristem culture** because viruses generally do not infect the actively dividing meristematic cells.
Step 1: Selection of meristem tissue.
A small portion of the **apical meristem** is removed from the diseased sugarcane plant. Meristem cells divide rapidly and are usually free from viral infection.
Step 2: In vitro culture.
The meristem tissue is placed in a sterile **nutrient culture medium** containing appropriate growth regulators.
Step 3: Development of plantlets.
Under controlled laboratory conditions, the meristem develops into a **complete plantlet**.
Step 4: Transfer to soil.
The plantlets are hardened and then transferred to soil, where they grow into **virus-free healthy sugarcane plants**.

This technique is known as meristem culture

Quick Tip

Meristem culture is widely used in agriculture to produce virus-free plants such as potato, banana, and sugarcane.

---

20 (b). In order to force bacteria to take up the recombinant DNA, they must be made competent. Explain how it can be achieved.

Solution:

Concept: For bacteria to take up recombinant DNA, their cell membranes must be made **permeable**. This process is called making the cells **competent**.
Step 1: Treatment with divalent cations.
Bacterial cells are treated with **calcium chloride ($CaCl_2$)**. Calcium ions increase the permeability of the bacterial cell membrane and facilitate the entry of DNA.
Step 2: Incubation with recombinant DNA.
The competent bacterial cells are mixed with recombinant DNA so that the DNA can attach to the bacterial cell surface.
Step 3: Heat shock treatment.
The mixture is briefly exposed to **high temperature (around 42°C)** followed by rapid cooling on ice. This heat shock creates pores in the membrane through which the DNA enters the bacterial cell.
Step 4: Recovery and growth.

The bacteria are then allowed to grow in suitable culture media where the recombinant DNA replicates inside the host cells.

Thus bacteria become competent and can take up recombinant DNA

Quick Tip

Competent bacterial cells are commonly produced using calcium chloride treatment followed by heat shock to allow uptake of recombinant DNA.

---

21 (a). Differentiate between grazing food chain and detritus food chain.

Solution:

Concept: Food chains represent the flow of energy from one organism to another in an ecosystem. Two major types are the **grazing food chain** and the **detritus food chain**.
Step 1: Grazing Food Chain.

- Begins with **living green plants (producers)**.
- Energy flows from producers to **herbivores** and then to **carnivores**.
- Example: Grass → Deer → Tiger.

Step 2: Detritus Food Chain.

- Begins with **dead organic matter (detritus)**.
- Energy flows through **decomposers** and **detritivores**.
- Example: Dead leaves → Earthworms → Birds.

Step 3: Key Differences.

Feature	**Grazing Food Chain**	**Detritus Food Chain**
StartingPoint	*Livingproducers*	*Deadorganicmatter*
PrimaryConsumers	*Herbivores*	*Decomposers/Detritivores*
EnergySource	*Photosynthesis*	*Decomposition*

Quick Tip

Grazing food chains begin with green plants, whereas detritus food chains begin with dead organic matter.

---

21 (b). Ecological pyramids are widely accepted but they still have some limitations. Write any two limitations.

Solution:

Concept: Ecological pyramids represent the relationship between organisms at different trophic levels in terms of number, biomass, or energy. However, they have certain limitations.
Step 1: Limitation 1.
Ecological pyramids **do not account for organisms that occupy more than one trophic level**. For example, humans may act as both herbivores and carnivores.
Step 2: Limitation 2.
They **do not represent food webs**. In nature, organisms are connected through complex feeding relationships rather than simple linear food chains.
Step 3: Additional limitation (conceptual).
Ecological pyramids also do not adequately represent **decomposers and detritivores**, which play an essential role in ecosystems.

Thus ecological pyramids provide a simplified but incomplete representation of ecosystems

Quick Tip

Ecological pyramids simplify energy flow but cannot accurately represent complex food webs or organisms occupying multiple trophic levels.

---

22. List any three outbreeding devices that flowering plants have developed for cross-pollination and explain how they help to encourage cross-pollination.

Solution:

Concept: Flowering plants have evolved several mechanisms called **outbreeding devices** to prevent self-pollination and promote **cross-pollination**. These mechanisms ensure genetic variation and healthier offspring.
Step 1: Dichogamy.
In this mechanism, the **anthers and stigma mature at different times**. As a result, pollen is not available when the stigma of the same flower is receptive.

- This prevents self-pollination.
- It promotes transfer of pollen from another flower.

Step 2: Herkogamy.
In herkogamy, there is a **physical separation between anthers and stigma** within the same flower.

- This spatial arrangement prevents pollen from reaching the stigma of the same flower.
- It encourages pollen transfer from other plants.

Step 3: Self-incompatibility.
Some plants possess a **genetic mechanism** that prevents pollen from fertilizing the ovules of the same plant.

- Pollen grains from the same plant fail to germinate on the stigma.
- Only pollen from a different plant can successfully fertilize the ovule.

These outbreeding devices prevent self-pollination and promote genetic diversity

Quick Tip

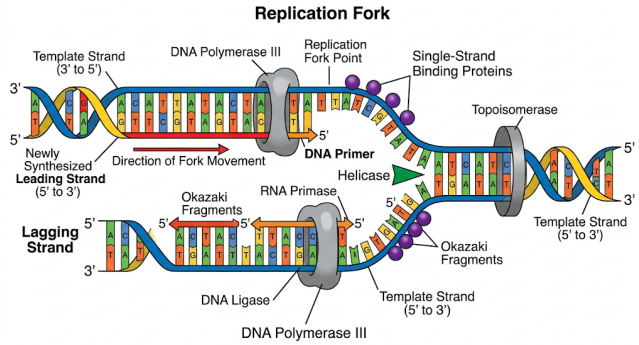
Common outbreeding devices in plants include dichogamy, herkogamy, self-incompatibility, and production of unisexual flowers.

---

23. Draw a labelled diagram of a 'replicating fork' showing the polarity. Why does DNA replication occur within such fork?

Solution:

Concept: During DNA replication, the double-stranded DNA unwinds to form a **replication fork**. DNA polymerase can synthesize DNA only in the **5' → 3'** direction, so replication occurs in a fork-like structure where both strands are copied simultaneously.



Step 1: Labelled diagram of replication fork.

Leading Strand
$5' \rightarrow\rightarrow\rightarrow\rightarrow 3'$
\
\Replication Fork
/
$3' \leftarrow\leftarrow\leftarrow\leftarrow 5'$
Lagging Strand (Okazaki fragments)

Important labels:

- **Replication fork** – region where DNA strands separate.
- **Leading strand** – synthesized continuously in the 5' → 3' direction.
- **Lagging strand** – synthesized discontinuously as **Okazaki fragments**.
- **DNA polymerase** – enzyme responsible for DNA synthesis.

Step 2: Reason replication occurs within a fork.
DNA replication occurs within a replication fork because:

- The DNA double helix must **unwind and separate** to expose the template strands.
- DNA polymerase can add nucleotides only in the **5' → 3'** direction.
- The fork structure allows **simultaneous synthesis** of the leading and lagging strands.

Thus, the replication fork provides the proper structure for **efficient and accurate DNA replication**.

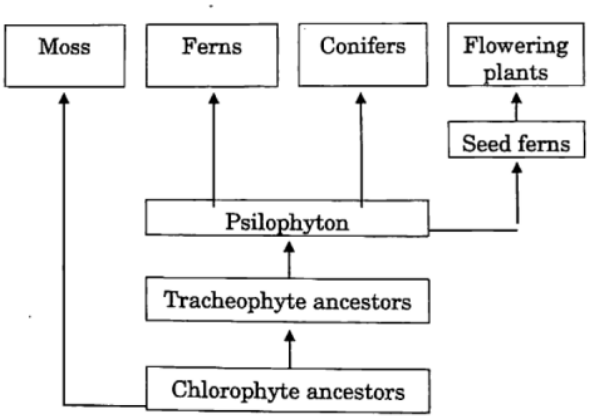
Replication fork allows both DNA strands to be copied according to their polarity

Quick Tip

DNA polymerase always synthesizes DNA in the 5' → 3' direction, which results in continuous synthesis of the leading strand and discontinuous synthesis of the lagging strand.

---

24. Study the given chart showing evolution of plants and answer the following questions.



Solution:

Concept: Plant evolution shows a gradual progression from primitive aquatic plants to advanced flowering plants. Major groups evolved from common ancestors, leading to diversification of plant forms.
Step 1: (a) Identify the plant which acts as an immediate ancestor of both ferns and conifers.
From the evolutionary chart, both **ferns** and **conifers** originate from **Psilophyton**.

Psilophyton

Step 2: (b) Name the nearest ancestors of flowering plants.
The chart shows that flowering plants evolved from **seed ferns**.

Seed ferns

Step 3: (c) Name the most primitive group of plants.
At the base of the evolutionary chart are **chlorophyte ancestors**, which represent the earliest plant forms.

Chlorophyte ancestors

Step 4: (d) Psilophyton provides common ancestry to which classes?
According to the chart, **Psilophyton** gives rise to:

- Ferns
- Conifers
- Seed ferns

Ferns, Conifers, and Seed ferns

Step 5: (e) Name the common ancestor of Psilophyton and seed ferns.
Both **Psilophyton** and **seed ferns** arise from **tracheophyte ancestors**.

Tracheophyte ancestors

Step 6: (f) Name the common ancestor of mosses and tracheophytes.
The chart shows that both **mosses** and **tracheophytes** evolved from **chlorophyte ancestors**.

Chlorophyte ancestors

Quick Tip

Plant evolution generally follows the sequence: Chlorophyte ancestors → Tracheophytes → Psilophyton → Ferns / Seed ferns → Conifers → Flowering plants.

---

25. Mention a product of human welfare obtained with the help of each one of the following:

- (a) *Saccharomyces cerevisiae*
- (b) *Propionibacterium shermanii*
- (c) *Aspergillus niger*
- (d) *Trichoderma polysporum*
- (e) *Acetobacter aceti*
- (f) *Streptococcus*

Solution:

Concept: Many microorganisms are beneficial to humans and are widely used in industrial fermentation, medicine, and food production.
Step 1: (a) *Saccharomyces cerevisiae.*
This yeast is used in fermentation processes to produce:

Ethanol / Alcohol

It is also commonly used in the **baking industry** for bread making.
Step 2: (b) *Propionibacterium shermanii.*
This bacterium is used in the production of:

Swiss cheese

It produces carbon dioxide which forms the characteristic holes in the cheese.
Step 3: (c) *Aspergillus niger.*
This fungus is used for the commercial production of:

Citric acid

Citric acid is widely used in the food and pharmaceutical industries.
Step 4: (d) *Trichoderma polysporum.*
This fungus produces:

Cyclosporin A

Cyclosporin A is an immunosuppressive drug used during organ transplantation.
Step 5: (e) *Acetobacter aceti.*
This bacterium converts alcohol into:

Acetic acid (Vinegar)

It is widely used in the food industry.
Step 6: (f) *Streptococcus.*
Certain species of *Streptococcus* are used to produce:

Streptokinase

Streptokinase is used as a **clot-busting drug** to remove blood clots.

These microorganisms provide several products important for human welfare

Quick Tip

Microbes are widely used in industries to produce antibiotics, acids, enzymes, and fermented foods.

26. Transgenic animals are produced by man. Explain any three ways in which such animals can be beneficial to humans.

Solution:

Concept: Transgenic animals are animals whose genetic material has been modified by introducing foreign genes using genetic engineering techniques. These animals are valuable in biological research, medicine, and biotechnology.
Step 1: Production of biological products.
Transgenic animals can be used to produce valuable **biological or therapeutic products**. For example, transgenic animals may produce human proteins such as **antithrombin** or other pharmaceuticals in their milk.
Step 2: Study of gene function and normal physiology.
Transgenic animals help scientists understand how genes regulate the development and functioning of the body. By inserting or altering genes, researchers can study **gene expression and physiological processes**.
Step 3: Study of human diseases.
Transgenic animals are used as **disease models**. They help in understanding the genetic basis of diseases such as cancer, Alzheimer's disease, cystic fibrosis, etc., and aid in developing treatments.
Step 4: Testing safety of vaccines and drugs.
Before medicines are used in humans, they are tested on transgenic animals to evaluate their **safety and effectiveness**. This helps in identifying potential side effects.

Thus transgenic animals play an important role in medicine, research, and biotechnology

Quick Tip

Common uses of transgenic animals include studying gene functions, producing therapeutic proteins, and testing drugs and vaccines.

---

27. Explain Gause's 'Competitive Exclusion Principle' with the help of a suitable example.

Solution:

Concept: The **Competitive Exclusion Principle**, proposed by **G. F. Gause**, states that two species competing for the same limited resources cannot coexist indefinitely in the same habitat.
Step 1: Statement of the principle.
If two species occupy the same ecological niche and compete for identical resources, one species will eventually outcompete and eliminate the other from that habitat.
Step 2: Explanation.

When two species use the same food, space, or other environmental resources, competition occurs. Over time, the species that is better adapted to the environment will survive, while the weaker competitor will be excluded.
Step 3: Example.
Gause conducted experiments using two species of *Paramecium*:

- *Paramecium aurelia*
- *Paramecium caudatum*

When both species were grown together in the same culture medium, *Paramecium aurelia* outcompeted and eliminated *Paramecium caudatum*.

This experiment demonstrated the Competitive Exclusion Principle

Quick Tip

Two species with identical ecological niches cannot coexist permanently; one species will dominate and the other will be eliminated.

---

28. Explain the level of biodiversity at genetic, species and ecological levels with the help of one example each.

Solution:

Concept: Biodiversity refers to the variety of life forms present on Earth. It can be studied at three major levels: genetic diversity, species diversity, and ecosystem diversity.
Step 1: Genetic diversity.
Genetic diversity refers to the variation of genes within a species. These genetic differences allow populations to adapt to environmental changes.
Example:
Different varieties of rice or wheat cultivated in different regions.

Example: Different varieties of rice

Step 2: Species diversity.
Species diversity refers to the variety of species present in a particular area or ecosystem.
Example:
A tropical rainforest contains numerous species of plants, animals, fungi, and microorganisms.

Example: High species diversity in tropical rainforests

Step 3: Ecological (ecosystem) diversity.
Ecological diversity refers to the variety of ecosystems present in a geographical region.
Example:
Different ecosystems such as forests, grasslands, deserts, and wetlands.

Example: Forests, deserts, and wetlands in a region

Quick Tip

Biodiversity is studied at three levels: genetic diversity (within species), species diversity (among species), and ecosystem diversity (among ecosystems).

---

29. Read the following passage and answer the questions that follow:
The process of copying genetic information from template strand of DNA into RNA is called transcription. It is mediated by RNA polymerase. Transcription takes place in the nucleus of eukaryotic cells. In transcription, only a segment of DNA and only one of the strands is copied into RNA.

(a) Why is the strand of DNA with 3' → 5' polarity transcribed and not the other strand of 5' → 3' polarity?

Solution:

Concept: RNA polymerase synthesizes RNA only in the **5' → 3'** direction. Therefore, it must read the template strand in the opposite direction.
Step 1: Direction of RNA synthesis.
RNA polymerase adds nucleotides in the **5' → 3'** direction.
Step 2: Template strand requirement.
To synthesize RNA in this direction, the enzyme must read the DNA strand in the **3' → 5'** direction.
Step 3: Conclusion.
Hence, the DNA strand with **3' → 5'** polarity is transcribed, while the other strand is not used.

Because RNA polymerase synthesizes RNA in 5' → 3' direction

Quick Tip

Template strand is always read in 3' → 5' direction so that RNA can be synthesized in 5' → 3' direction.

(b) (i) Why is hnRNA required to undergo splicing?

Solution:

Concept: In eukaryotes, the primary RNA transcript (hnRNA) contains both coding and non-coding sequences.
Step 1: Structure of hnRNA.
hnRNA contains:

- **Exons** – coding sequences

- **Introns** – non-coding sequences

Step 2: Need for splicing.
Introns do not code for proteins and must be removed to produce functional mRNA.
Step 3: Conclusion.
Splicing removes introns and joins exons to form **mature mRNA**.

To remove non-coding introns and form functional mRNA

Quick Tip

Splicing converts hnRNA into mature mRNA by removing introns and joining exons.

(b) (ii) Mention the two additional processes which hnRNA needs to undergo after splicing to become functional.

Solution:

Concept: After splicing, hnRNA undergoes further processing to become mature mRNA.
Step 1: 5' capping.
Addition of a **methyl guanosine cap** at the 5' end which protects mRNA and helps in translation.
Step 2: 3' tailing.
Addition of a **poly-A tail** at the 3' end which increases stability and facilitates transport.

5' capping and 3' polyadenylation

Quick Tip

mRNA processing includes splicing, 5' capping, and 3' poly-A tailing.

(c) Why is only one strand of the DNA transcribed? Give two reasons.

Solution:

Concept: Although DNA is double-stranded, only one strand is transcribed for each gene to ensure correct protein synthesis.
Step 1: Avoidance of conflicting RNA.
If both strands were transcribed, two RNA molecules would be formed with **complementary sequences**, leading to non-functional or double-stranded RNA.
Step 2: Gene specificity.
Each gene is coded on only one strand, called the **template strand**, ensuring accurate transcription.

Only one strand is transcribed to ensure correct and functional RNA synthesis

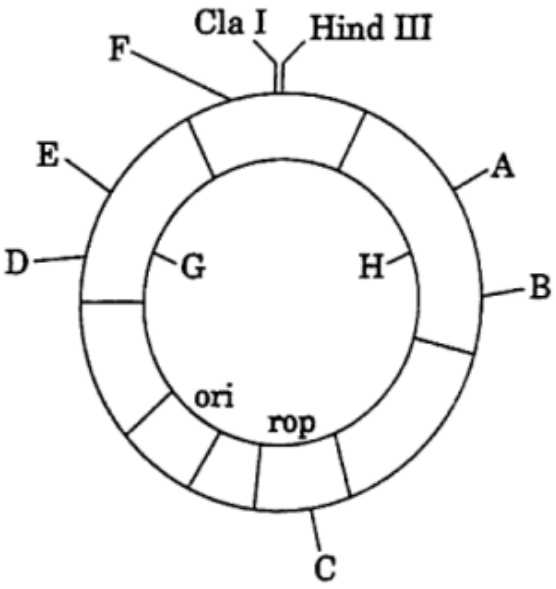
Quick Tip

Only one DNA strand acts as template for a gene to prevent formation of non-functional RNA.

---

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

We know that plasmids and bacteriophages are the most commonly used vectors in biotechnology experiments. If we can link an alien piece of DNA to the plasmid DNA, the alien DNA can be multiplied equal to the copy number of the plasmid. Engineered vectors are used these days. Study the diagram of the E. coli cloning vector pBR322 and answer the questions that follow.



(a) Why are plasmids and bacteriophages used as cloning vectors?

Solution:

Concept: A cloning vector is a DNA molecule used to carry foreign DNA into a host cell and replicate it.
Step 1: Independent replication.
Plasmids and bacteriophages contain an **origin of replication (ori)** which allows them to replicate independently inside host cells.
Step 2: Multiplication of inserted DNA.
When a foreign DNA fragment is inserted into these vectors, it replicates along with the vector, producing many copies.
Step 3: Ease of genetic manipulation.
They are small, easy to isolate, and can be engineered with restriction sites and selectable markers.

Hence they efficiently carry and replicate foreign DNA

Quick Tip

Cloning vectors must contain an origin of replication, selectable markers, and restriction enzyme sites.

(b) (i) Identify:
(I) The gene in the cloning vector that controls the copy number of the vector.
(II) The restriction site – C in the 'rop' gene.

Solution:

Step 1: Gene controlling copy number.
The gene that regulates the copy number of plasmid pBR322 is the:

rop gene

Step 2: Restriction site C in rop gene.
The restriction enzyme site located at position C within the rop gene is:

Pvu II

Quick Tip

The rop gene in pBR322 regulates plasmid copy number and contains restriction enzyme sites used for cloning.

OR (b) (ii) Identify and name two selectable markers shown in the diagram.

Solution:

Concept: Selectable markers are genes that help identify cells that have taken up the recombinant plasmid.
Step 1: Selectable markers in pBR322.
Two selectable marker genes present in the vector are:

- **amp^{R}** – Ampicillin resistance gene
- **tet^{R}** – Tetracycline resistance gene

Ampicillin resistance and Tetracycline resistance

Quick Tip

Selectable markers help identify transformed bacteria by providing resistance to specific antibiotics.

(c) Name the two restriction sites each in the two genes you have identified as selectable markers.

Solution:

Concept: Restriction enzyme sites within selectable marker genes allow insertion of foreign DNA and help in screening recombinant clones.
Step 1: Restriction sites in tetracycline resistance gene.

- **Bam HI**
- **Hind III**

Step 2: Restriction sites in ampicillin resistance gene.

- **Pst I**
- **Sal I**

Bam HI, Hind III, Pst I, and Sal I

Quick Tip

Insertion of foreign DNA into selectable marker genes disrupts antibiotic resistance and helps identify recombinant colonies.

---

31 (a). Briefly explain the events of fertilisation and implantation in an adult human female.

Solution:

Concept: Fertilisation and implantation are crucial stages in human reproduction that lead to the establishment of pregnancy.
Step 1: Fertilisation.

- Fertilisation is the fusion of a **male gamete (sperm)** and a **female gamete (ovum)**.
- It usually occurs in the **ampullary–isthmic junction of the fallopian tube**.
- During fertilisation, the sperm penetrates the ovum and their nuclei fuse to form a **diploid zygote**.

Step 2: Cleavage and formation of morula/blastocyst.

- The zygote undergoes repeated mitotic divisions called **cleavage**.
- It first forms a **morula** (8–16 cells) and later develops into a **blastocyst**.
- The blastocyst consists of an **inner cell mass** and an outer **trophoblast layer**.

Step 3: Implantation.

- The blastocyst moves into the uterus and attaches to the **endometrium**.
- The trophoblast helps the blastocyst embed within the uterine wall.
- This process is called **implantation** and marks the beginning of pregnancy.

Implantation ensures nourishment and development of the embryo

Quick Tip

Fertilisation occurs in the fallopian tube, while implantation occurs in the uterine endometrium.

OR

31 (b) (i). Arrange the following hormones in sequence of their secretion in a pregnant woman:

hCG, LH, FSH, Relaxin

Solution:

Concept: Different hormones are secreted during pregnancy to maintain the uterine environment and support fetal development.
Step 1: Initial hormones from pituitary.
Before fertilisation, the anterior pituitary secretes:

- **FSH** – stimulates follicular development.
- **LH** – triggers ovulation.

Step 2: Hormones after fertilisation.
After fertilisation and implantation:

- **hCG** is secreted by the developing embryo/placenta.
- **Relaxin** is produced later by the ovary and placenta during pregnancy.

Sequence: FSH $\rightarrow$ LH $\rightarrow$ hCG $\rightarrow$ Relaxin

Quick Tip

hCG maintains the corpus luteum during early pregnancy, while relaxin helps prepare the reproductive tract for childbirth.

---

31 (b) (ii). Mention the source and the functions of the above mentioned hormones.

Solution:

Step 1: FSH (Follicle Stimulating Hormone).

- **Source:** Anterior pituitary gland
- **Function:** Stimulates growth and maturation of ovarian follicles.

Step 2: LH (Luteinising Hormone).

- **Source:** Anterior pituitary gland
- **Function:** Induces ovulation and formation of corpus luteum.

Step 3: hCG (Human Chorionic Gonadotropin).

- **Source:** Placenta
- **Function:** Maintains corpus luteum and stimulates progesterone secretion during early pregnancy.

Step 4: Relaxin.

- **Source:** Ovary (corpus luteum) and placenta
- **Function:** Relaxes pelvic ligaments and softens cervix to facilitate childbirth.

These hormones regulate ovulation, pregnancy maintenance, and parturition

Quick Tip

FSH and LH are pituitary hormones, whereas hCG and relaxin are mainly produced during pregnancy by the placenta and ovary.

---

32 (a). Work out separate monohybrid crosses up to F_2 generation between two pea plants and two *Antirrhinum* plants, both having contrasting traits with respect to

the colour of the flower. Comment on the patterns of inheritance in the crosses carried out in such two cases.

Solution:

Concept: Monohybrid crosses help to understand patterns of inheritance. In pea plants the inheritance shows **complete dominance**, while in *Antirrhinum* (snapdragon) it shows **incomplete dominance**.
Step 1: Monohybrid cross in pea plants (complete dominance).
Let:

$$P = \text{Purple flower (dominant)}, \quad p = \text{White flower (recessive)}$$

Parental Generation (P):

$$PP \text{ (Purple)} \times pp \text{ (White)}$$

F_1 **Generation:**
All offspring:

$$Pp \text{ (Purple)}$$

F_2 **Generation:**

$$Pp \times Pp$$

Genotypic ratio:

$$1PP : 2Pp : 1pp$$

Phenotypic ratio:

$$3 \text{ Purple} : 1 \text{ White}$$

Step 2: Monohybrid cross in *Antirrhinum* (incomplete dominance).
Let:

$$R = \text{Red flower}, \quad r = \text{White flower}$$

Parental Generation:

$$RR \text{ (Red)} \times rr \text{ (White)}$$

F_1 **Generation:**

$$Rr \text{ (Pink)}$$

F_2 **Generation:**

$$Rr \times Rr$$

Genotypic ratio:

$$1RR : 2Rr : 1rr$$

Phenotypic ratio:

$$1 \text{ Red} : 2 \text{ Pink} : 1 \text{ White}$$

Step 3: Conclusion.

- Pea plants show **complete dominance**.

- *Antirrhinum* shows **incomplete dominance**.

Thus different organisms may exhibit different inheritance patterns

Quick Tip

Complete dominance gives a 3:1 phenotypic ratio, whereas incomplete dominance results in a 1:2:1 phenotypic ratio.

OR

32 (b) (i). How does a chromosomal disorder differ from a Mendelian disorder? Write one example for each.

Solution:

Concept: Genetic disorders can arise due to changes in individual genes or due to abnormalities in chromosome number or structure.

Step 1: Chromosomal disorders.

- Caused by **abnormal number or structure of chromosomes**.
- Usually occur due to errors in chromosome segregation.
- **Example: Down syndrome**.

Step 2: Mendelian disorders.

- Caused by **mutation in a single gene**.
- Follow Mendelian patterns of inheritance.
- **Example: Sickle-cell anaemia**.

Chromosomal disorders involve chromosomes; Mendelian disorders involve single genes

Quick Tip

Chromosomal disorders arise from chromosome abnormalities, while Mendelian disorders result from mutations in specific genes.

---

32 (b) (ii). Name the phenomenon that leads to situations like 'XO' abnormality in humans. Also name this genetic disorder. How are individuals with an XO chromosomal abnormality affected? Write its symptoms as well as karyotype.

Solution:

Step 1: Phenomenon causing XO abnormality.
The condition arises due to **non-disjunction** during meiosis, where chromosomes fail to separate properly.

$$\boxed{\text{Phenomenon: Non-disjunction}}$$

Step 2: Name of the genetic disorder.
The XO chromosomal abnormality results in:

$$\boxed{\text{Turner Syndrome}}$$

Step 3: Symptoms.
Individuals with Turner syndrome show:

- Short stature
- Webbed neck
- Underdeveloped ovaries
- Sterility
- Lack of secondary sexual characters

Step 4: Karyotype.

$$\boxed{45, XO}$$

This indicates the presence of **45 chromosomes** with only one X chromosome.

$$\boxed{\text{Thus Turner syndrome results from monosomy of the X chromosome}}$$

Quick Tip

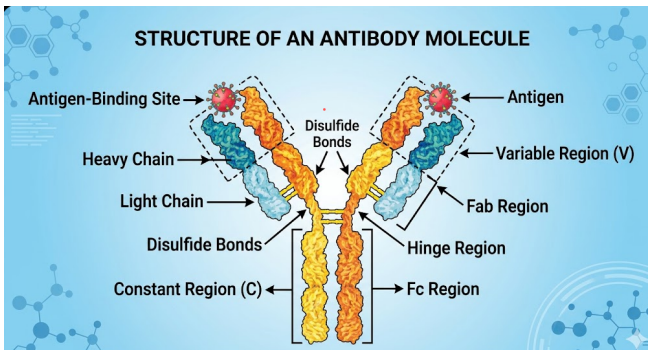
Turner syndrome occurs due to loss of one X chromosome (45,XO) and affects only females.

---

33 (a) (i). Draw the structure of an antibody molecule and label any four of its parts.

Solution:

Concept: Antibodies (immunoglobulins) are Y-shaped glycoproteins produced by B-lymphocytes in response to antigens. They consist of two heavy chains and two light chains linked by disulfide bonds.
Step 1: Structure of antibody.



Step 2: Parts of an antibody molecule.

- **Heavy chains**
- **Light chains**
- **Antigen binding site**
- **Hinge region**
- **Disulfide bonds**

Antibody consists of two heavy chains and two light chains forming a Y-shaped structure

Quick Tip

The tips of the Y-shaped antibody contain antigen-binding sites that specifically recognize antigens.

---

33 (a) (ii). Differentiate between active and passive immunity. Write any three differences.

Solution:

Concept: Immunity refers to the ability of the body to resist infections. It can be either active or passive depending on how antibodies are acquired.

Feature	Active Immunity	Passive Immunity
$Source of antibodies$	$Produced by the body$	$Received from outside$
$Time of response$	$Develops slowly$	$Provides immediate protection$
$Memory$	$Immunological memory present$	$No immunological memory$

Active immunity is long lasting whereas passive immunity is temporary

Quick Tip

Vaccination produces active immunity, while antibodies transferred from mother to child provide passive immunity.

OR

33 (b) (i) (I). Write the scientific names of the two species of filarial worms causing filariasis.

Solution:

Wuchereria bancrofti and *Wuchereria malayi*

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33 (b) (i) (II). How do they affect the body of infected persons?

Solution:

The filarial worms live in the **lymphatic vessels** of humans. They cause:

- Blockage of lymphatic vessels
- Accumulation of lymph fluid
- Severe swelling of body parts such as legs and scrotum

This condition is commonly known as:

Elephantiasis

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33 (b) (i) (III). How does the disease spread?

Solution:

Filariasis spreads through the bite of infected **female Culex mosquitoes**. The mosquito acts as a vector transmitting the infective larvae to humans.

Transmission occurs through mosquito bites

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33 (b) (ii). Mention the source and the role of the following in providing defence against infection in the human body:

- (I) Histamine
- (II) Interferons

Solution:

(I) Histamine

- **Source:** Mast cells and basophils
- **Role:** Causes inflammation and increases blood flow to infected tissues.

(II) Interferons

- **Source:** Virus-infected cells
- **Role:** Protect neighbouring cells by inhibiting viral replication.

Both histamine and interferons help the body defend against infections

Quick Tip

Histamine is involved in inflammatory responses, whereas interferons provide defence against viral infections.
