

PART - I

(BIO-BOTANY)

SECTION - 1

1. (b)
2. (d)
3. (a)
4. (a)
5. (a)
6. (c)
7. (d)
8. (d)

SECTION – 2

9. The stomium is a specialized thin-walled region in a plant's anther (part of the stamen) or fern sporangium, acting as a weak point that allows for dehiscence (splitting open) to release pollen or spores, respectively, typically located at the junction between pollen sacs (microsporangia). It's essentially the line where the structure breaks open for reproduction, formed by less thickened cells in the endothecium.

In Flowering Plants (Anthers): -

- Location: Found in the groove between the two microsporangia within one anther lobe.
- Structure: Composed of thinner-walled cells of the endothecium (the inner layer of the anther wall).
- Function: When mature, these cells dry and weaken, causing the anther to split along the stomium, releasing pollen grains.

In Ferns (Sporangia):

- Location: A line of specialized cells on the annulus (a ring of cells).
- Function: Marks the spot where the sporangium splits open to disperse spores.

10. Types of Synapsis (Short Solution): -

- (i) Complete synapsis: Homologous chromosomes pair along their entire length.
- (ii) Incomplete synapsis: Homologous chromosomes pair partially.
- (iii) Terminal synapsis: Pairing occurs only at the ends of chromosomes.
- (iv) Partial synapsis: Only certain segments of homologs pair.

11. Chemicals used in Gene Transfer (Short Solution):

- (i) Calcium chloride (CaCl_2) – for making bacterial cells competent.
- (ii) PEG (Polyethylene glycol) – for fusion of protoplasts.
- (iii) DEAE-dextran – helps DNA uptake in plant/animal cells.
- (iv) Liposomes / Cationic lipids – for delivering DNA into cells.

12. Definition: -

- PAR is the portion of solar radiation that plants can use for photosynthesis.
- It includes light with wavelengths from 400 nm to 700 nm (violet to red light).

Key Points: -

- Not all sunlight is useful for plants; UV (<400 nm) and far-red/infrared (>700 nm) are not used in photosynthesis.
- PAR is measured in $\mu\text{mol photons m}^{-2} \text{ s}^{-1}$.
- It is crucial for plant growth, productivity, and crop yield.

In short: PAR = the light that drives photosynthesis.

13. Primary Introduction vs Secondary Introduction (Short Solution): -

Feature	Primary Introduction	Secondary Introduction
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Definition	First time a species is introduced into a new area	Introduction of the species from the already established population in the new area to another area
Source	Directly from native habitat	From the introduced population, not from native habitat
Example	Wheat introduced from Fertile Crescent to India	Wheat spread within India after initial introduction

14. Co-evolution (Short Solution): -

- Definition: Co-evolution is the reciprocal evolutionary change between two or more species that interact closely.
- Key Point: Changes in one species drive adaptations in the other.
- Example: Flowers and their pollinators (e.g., hummingbirds and tubular flowers), predator-prey relationships.

SECTION - 3

15. Layering: -

- Method: A stem is bent down, covered with soil (or media), and encouraged to form roots while still connected to the mother plant, then separated.
- Purpose: To produce exact genetic copies (clones) of the parent plant, often for easy-rooting species.
- Result: A new, independent plant genetically identical to the parent.

Grafting: -

- Method: A shoot (scion) from one plant is physically joined to the root system (rootstock) of another, allowing their vascular tissues to fuse and grow as one.
- Purpose: To combine desirable traits (e.g., strong roots from stock, good fruit from scion) or repair damaged plants.
- Result: A single plant with the root system of the stock and the top growth of the scion.

16. (i) Speciation and Evolution: -

Ploidy changes, especially polyploidy (having extra chromosome sets), are major forces in evolution, particularly in plants, leading to new species and increased genetic diversity, allowing organisms to adapt to different environments, notes and Nature.

(ii) Agricultural & Horticultural Improvement: -

Polyploid plants often exhibit desirable traits like larger flowers, increased biomass, higher yields, and greater vigor (heterosis), making them valuable in breeding for crops like wheat or ornamental plants, explains ScienceDirect and Nature.

(iii) Genetic Buffering & Adaptation: -

Gene redundancy from increased chromosome sets protects against harmful mutations, shielding polyploids and allowing for greater adaptability, while also enabling asexual reproduction, notes Nature and NIH.

17. Casuarina, Eucalyptus, Teak, Malai vembu.

18. Spirulina can be grown easily on materials like waste water from potato processing plants (containing starch), straw, molasses, animal manure, and even sewage, to produce large quantities.

19. (i) The act of observing and assessing the current state and ongoing changes in ecosystem, biodiversity components, landscape including, natural habitats population and species.

(ii) An agricultural drone is an unmanned aerial vehicle applied to farming in order to help increased crop production and monitor crop growth.

- (iii) It can reveal many issues such as irrigation problems, soil variation and pest and fungal infestations.
(iv) It is also used for cost effective safe method of spraying pesticides and fertilizers, which proves very easy and nonharmful.

SECTION - 4

20. (a) Characteristic Features of Anemophilous Plants (Wind-Pollinated Plants):

- (i) Small, inconspicuous flowers – No bright colors or scent, since they don't need insects.
- (ii) Large, feathery stigmas – To catch pollen grains from the air.
- (iii) Abundant, light pollen – Easily carried by wind; usually dry and smooth.
- (iv) Long stamens with exposed anthers – Hang outside the flower to release pollen into the air.
- (v) No nectar or fragrance – Insects are not required for pollination.
- (vi) Often grow in clusters – Helps pollen dispersal over distances.

OR

(b) Incomplete Dominance: -

Definition: In incomplete dominance, the heterozygote shows a phenotype that is intermediate between the two homozygotes.

Key Point: No allele is completely dominant over the other.

Example: -

Snapdragon flower color:

RR → Red flowers

rr → White flowers

Rr → Pink flowers (intermediate between red and white)

21. (a) Anatomical Adaptations of Xerophytes (Short Solution):

- (i) Thick Cuticle: Reduces water loss by transpiration.
- (ii) Sunken Stomata: Minimizes exposure to air, reducing water loss.
- (iii) Reduced Number of Stomata: Fewer openings for transpiration.
- (iv) Hairy Leaves / Trichomes: Trap moisture and reduce airflow.
- (v) Thickened Epidermis / Multiple Epidermal Layers: Protects against water loss.
- (vi) Succulent Leaves or Stem: Stores water for dry periods.
- (vii) Reduced Leaf Surface / Spines: Decreases transpiration; spines may protect from herbivores.
- (viii) Hypodermis / Water Storage Tissue: Specialized tissue beneath epidermis for water storage.

Examples: Cactus, Opuntia, Nerium.

OR

(b) (1). Digitalis (Foxglove)

- Active Principle: Digoxin, Digitoxin

- Medicinal Value:

- Used to strengthen heart contractions

- Treats congestive heart failure and some arrhythmias

(2). Cinchona

Active Principle: Quinine

Medicinal Value:

- Used as an antimalarial drug

- Also has fever-reducing properties

Key point: Plants produce bioactive compounds that have therapeutic uses in humans.

PART-II

(BIO-ZOOLOGY)

SECTION - 1

22.(a)

23.(d)

24.(d)

25.(d)

26.(b)

27.(c)

28.(a)

29.(d)

SECTION – 2

30. The three layers of the uterine wall are:

- (i) Endometrium: -
 - Innermost layer lining the uterine cavity.
 - Rich in glands and blood vessels.
 - Functional layer is shed during menstruation.
- (ii) Myometrium: -
 - Middle muscular layer made of smooth muscles.
 - Responsible for uterine contractions during childbirth.
- (iii) Perimetrium: -
 - Outermost serous layer (part of the peritoneum).
 - Protects and supports the uterus.

31. Non-sense codons (Stop Codons) in Genetic Code:

Definition: Codons that do not code for any amino acid and signal termination of protein synthesis during translation.

Stop Codons / Non-sense Codons:

- (i) UAA – Ochre
- (ii) UAG – Amber
- (iii) UGA – Opal (or Umber)

32. Convergent Evolution: Unrelated species develop similar traits due to similar environments → forms analogous structures.

Example: Wings of bats and insects.

Divergent Evolution: Related species develop different traits to adapt to different environments → forms homologous structures.

Example: Forelimbs of mammals (human hand, whale flipper, bat wing).

33. Four Human Viral Diseases: -

- (i) Influenza – caused by Influenza virus
- (ii) HIV/AIDS – caused by Human Immunodeficiency Virus
- (iii) Hepatitis B – caused by Hepatitis B virus
- (iv) Chickenpox – caused by Varicella-zoster virus

34. Expansions: -

- (a) CFC → Chlorofluorocarbon
- (b) PAN → Peroxyacetyl Nitrate

Explanation: -

- CFCs: Man-made compounds used in refrigerants and aerosols, contribute to ozone layer depletion.
- PAN: A photochemical oxidant and component of smog, harmful to plants and humans.

35. Stenotherms (Short Solution): -

- Definition: Stenotherms are organisms that can survive only within a narrow range of temperature.
- Key Point: They are sensitive to temperature changes and cannot tolerate wide fluctuations.

Examples: -

- (i) Salmon – freshwater fish
- (ii) Corals – marine invertebrates
- (iii) Snow leopard – adapted to cold regions

Key point: Stenotherms = narrow temperature tolerance.

SECTION - 3

36. Regeneration (Short Solution): -

Definition: Regeneration is the ability of an organism to regrow lost or damaged body parts.

Key Point: It is a type of asexual reproduction in some organisms and also a healing process in higher animals.

Examples: -

- (i) Starfish – can regrow lost arms.
- (ii) Planaria (flatworm) – can regenerate a complete body from a small fragment.
- (iii) Lizard – can regrow its tail.

37. Three Applications of Karyotyping (Short Solution):

- (i) Detection of Chromosomal Disorders:

- Identifies abnormalities like Down syndrome (Trisomy 21), Turner syndrome (Monosomy X), Patau syndrome (Trisomy 13).

(ii) Determination of Sex:

- Can determine genetic sex of an individual by analyzing sex chromosomes (XX or XY).

(iii) Genetic Counseling and Prenatal Diagnosis:

- Helps in advising parents about risk of inherited chromosomal abnormalities before or during pregnancy.

Key point: -Karyotyping = analysis of chromosome number and structure for medical and genetic purposes.

38. Single Cell Protein (SCP) (Short Solution):-

- Definition: Single Cell Protein (SCP) refers to protein-rich biomass obtained from cultured microorganisms such as bacteria, yeast, fungi, or algae, which can be used as food or feed.

Uses: -

(i) Human Consumption: Source of protein in nutritional supplements and protein-enriched foods.

(ii) Animal Feed: Used in livestock, poultry, and fish feed as a high-protein supplement.

(iii) Waste Utilization: Microorganisms can convert agricultural or industrial waste into protein, reducing pollution.

(iv) Health Benefits: Some SCP (like yeast) is rich in vitamins and amino acids.

39. In-situ vs Ex-situ Conservation (Short Solution): -

Feature	In-situ	Ex-situ
Meaning	Conservation in natural habitat	Conservation outside natural habitat
Examples	National parks, wildlife sanctuaries	Zoos, botanical gardens, seed banks
Advantage	Maintains natural ecosystem	Protects species from immediate threats
Disadvantage	Difficult to prevent poaching	Expensive, species may lose natural behavior

40. Multipotent cells involved: Adult stem cells (Tissue-specific stem cells / Hematopoietic stem cells, Mesenchymal stem cells, etc.)

- They can differentiate into a limited range of cell types to replenish adult tissues.

Rich source: -

(i) Bone marrow – rich in hematopoietic stem cells and mesenchymal stem cells

(ii) Umbilical cord blood – contains hematopoietic stem cells

(iii) Adult tissues – liver, skin, brain, etc., have tissue-specific stem cells

Key point: Adult stem cells = multipotent, repair and maintain tissues in adults.

SECTION – 4

41. (a) (i) Head: -

- Acrosome: Cap-like structure containing enzymes (hyaluronidase, acrosin) that help penetrate the egg.

- Nucleus: Contains 23 haploid chromosomes.

(ii) Midpiece (Neck):

- Packed with mitochondria arranged in a spiral.

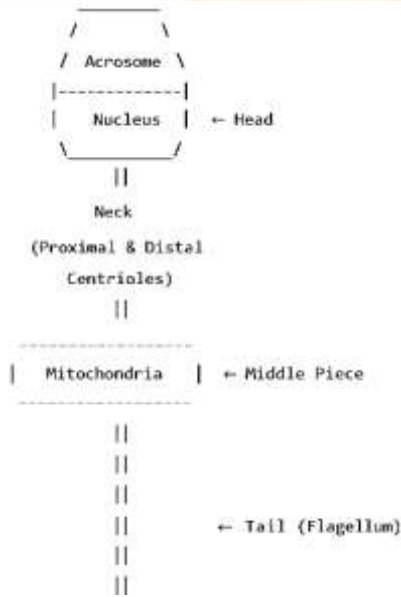
- Provides energy (ATP) for movement of the tail.

Tail (Flagellum): -

- Long, whip-like structure for motility.

- Composed of microtubules in 9+2 arrangement.

Neat Labelled Diagram:



Key point: Sperm is highly specialized for fertilization, with head (DNA), midpiece (energy), tail.

OR

(b) Structure of Immunoglobulin:

(i) Basic Units:

Made of 4 polypeptide chains:

- 2 Heavy (H) chains – longer chains
- 2 Light (L) chains – shorter chains

(ii) Regions:

Fab (Fragment antigen-binding) region:

- Forms the arms of the Y
- Contains variable region (V region) that binds specifically to an antigen

(iii) Fc (Fragment crystallizable) region:

- Forms the stem of the Y
- Responsible for effector functions (e.g., binding to macrophages, complement activation)

(iv) Chains Linked by:

- Disulfide bonds (–S–S–) between heavy and light chains
- Disulfide bonds between heavy chains in the hinge region

(v) Variable & Constant Regions:

- Variable (V) region: Specific antigen-binding site
- Constant (C) region: Determines class of antibody (IgG, IgM, IgA, IgE, IgD)

Antigen Binding Site



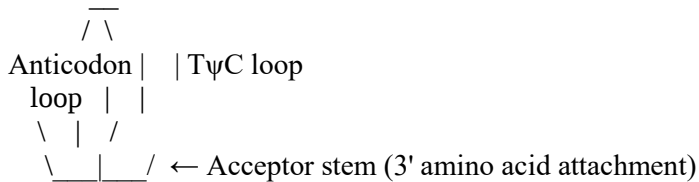
42. (a) Definition: tRNA is a small RNA molecule that carries specific amino acids to the ribosome during protein synthesis, matching them to codons on mRNA.

Structure (Cloverleaf):

- (i) Acceptor Stem (3' end): Binds amino acid
- (ii) Anticodon Loop: Contains anticodon complementary to mRNA codon
- (iii) D-loop: Recognition by aminoacyl-tRNA synthetase
- (iv) T ψ C Loop: Helps in ribosome binding
- (v) Variable Loop: tRNA identity

Diagram (Cloverleaf): -

D-loop



OR

(b) Human Activities Causing Biodiversity Loss (Short Solution):

- (i) Deforestation: Clearing forests for agriculture, urbanization, and logging.
- (ii) Overexploitation: Hunting, poaching, and overfishing of species.
- (iii) Pollution: Air, water, and soil pollution harming ecosystems.
- (iv) Habitat Fragmentation: Roads, dams, and settlements breaking habitats.
- (v) Introduction of Exotic Species: Non-native species outcompete native ones.
- (vi) Climate Change: Global warming, altering habitats and species distribution.
- (vii) Agricultural Expansion: Monoculture reduces natural habitats.

Key point: -Human activities lead to habitat loss, species extinction, and ecosystem imbalance.