1 (a) Name the genus having the following (Attempt any five):

- (i) Air bladder
  - *Fucus* or *Sargassum* (common in brown algae)
- (ii) Ligule
  - *Selaginella* (pteridophyte)
- (iii) Fairy Ring
  - *Agaricus* (mushroom-forming fungus)
- (iv) Foliose Lichen
  - *Parmelia* or *Physcia*
- (v) Gemma cup
  - *Marchantia* (liverwort, a bryophyte)
- (vi) Maidenhair fern
  - *Adiantum* (a true fern)
- (vii) Spiral Chloroplast
  - *Spirogyra* (green algae)

(b) Fill in the blanks (Attempt any five):

- (i) The term algae was coined by **A.L. de Jussieu** (or **Linnaeus** in a broader sense, but Jussieu specifically for the botanical group).
- (ii) The reserve food material of red algae is **floridean starch**.
- (iii) Engler and Prantl system of classification is an example of **phylogenetic** system of classification.
- (iv) Infectious piece of RNA without protein coat is **viroid**.
- (v) The number of capsomere in TMV is **2130**.

- (vi) True vessel is found in the Gymnosperm **Gnetum** (or *Ephedra*, *Welwitschia*).
- (vii) Obliquely placed septa are found in rhizoids of **Riccia** or **Marchantia** (liverworts).

(c) Match the following:

- (i) Peltate Columella - **(c) Rhizopus**
- (ii) Heterotrichous thallus - **(a) Polysiphonia**
- (iii) Scales - **(d) Marchantia**
- (iv) Collar - **(e) Gnetum**
- (v) Operculum - **(b) Funaria**

2 Differentiate between the following (Attempt any five):

- (i) Pteridophytes and Gymnosperms
  - **Pteridophytes:**
    - Are the first true land plants with vascular tissues (xylem and phloem).
    - Reproduce by spores; they do not produce seeds.
    - Require water for fertilization (motile sperms).
    - Examples: Ferns, horsetails, clubmosses.
  - **Gymnosperms:**
    - Are seed-producing plants, but their seeds are "naked" (not enclosed within an ovary).
    - Have well-developed vascular tissues.
    - Do not require water for fertilization (pollen grains are wind-dispersed).

        - Examples: Conifers (pines, firs), cycads, ginkgo.

- (ii) TMV and Bacteriophage
    - **TMV (Tobacco Mosaic Virus):**
        - Infects plants, specifically tobacco and other solanaceous plants.
        - Has a helical capsid symmetry.
        - Its genetic material is single-stranded RNA (ssRNA).
        - Not typically equipped to infect bacteria.
    - **Bacteriophage:**
        - Infects bacteria.
        - Often has complex symmetry (e.g., icosahedral head and helical tail).
        - Its genetic material can be DNA (dsDNA or ssDNA) or RNA (dsRNA or ssRNA), but most common are dsDNA.
        - Specifically designed to target and replicate within bacterial cells.
- (iii) Gram-positive and Gram-negative bacteria
    - **Gram-positive bacteria:**
        - Have a thick peptidoglycan cell wall.
        - Lack an outer membrane.
        - Stain purple/blue with Gram stain.
        - Generally more susceptible to penicillin.
    - **Gram-negative bacteria:**
        - Have a thin peptidoglycan layer.

        - Possess an outer membrane containing lipopolysaccharides (LPS).
        - Stain pink/red with Gram stain.
        - Generally more resistant to penicillin due to the outer membrane barrier.

- (iv) Natural and Artificial classification
    - **Natural Classification:**
        - Based on overall similarities in morphological, anatomical, embryological, phytochemical, and even genetic features, reflecting natural relationships and evolutionary history (phylogeny).
        - Attempts to group organisms that share common ancestry.
        - Examples: Bentham and Hooker's system (though largely artificial at the time, it aimed for natural groups), Engler and Prantl's system, modern phylogenetic classifications.
    - **Artificial Classification:**
        - Based on one or a few easily observable superficial characteristics, regardless of evolutionary relationships.
        - Primarily used for convenience and ease of identification.
        - Examples: Linnaeus's sexual system of classification based on number of stamens and pistils, classifying plants as herbs, shrubs, trees.
- (v) Megasporophyll and Microsporophyll of *Selaginella*
    - **Megasporophyll of *Selaginella***:
        - A modified leaf (sporophyll) that bears a megasporangium.

  - The megasporangium produces a few (typically 4) large megaspores.
  - Megaspores develop into female gametophytes.
- **Microsporophyll of *Selaginella***:
  - A modified leaf (sporophyll) that bears a microsporangium.
  - The microsporangium produces numerous small microspores.
  - Microspores develop into male gametophytes.

3 Draw the well labelled diagram of the following (Attempt any three):

- (i) Diagrammatic sketch of Bacterium
  - (Diagram would show a typical bacterial cell with features like cell wall, cell membrane, cytoplasm, nucleoid region, ribosomes, flagellum (if motile), pili/fimbriae, capsule (if present), plasmid.)
- (ii) Rhizopus showing asexual reproduction
  - (Diagram would show a *Rhizopus* fungus, with rhizoids anchoring it to the substrate, sporangiophores extending upwards, and a spherical sporangium at the tip containing numerous spores. A columella would be visible inside the sporangium.)
- (iii) V.S Receptacle of Sargassum showing bisexual conceptacle
  - (Diagram would show a longitudinal section of a *Sargassum* receptacle, with embedded conceptacles. Each conceptacle would be a flask-shaped cavity opening to the outside via an ostiole, containing both antheridia (producing male gametes) and oogonia (producing female gametes), possibly with paraphyses.)

- (iv) Morphology of Basidiocarp of Agaricus
  - (Diagram would show a typical mushroom structure: pileus (cap), stipe (stalk), annulus (ring on stipe), gills (lamellae) on the underside of the cap, and volva (cup-like structure at base, if present for some species). The gills would show basidia producing basidiospores.)
- (v) Morphology of Male cone of Gnetum
  - (Diagram would show a male cone with spirally arranged bracts. In the axil of each bract, a dichasial cyme of male flowers would be shown. Each male flower consists of a perianth and stamens with synangia (fused sporangia). A sterile ovule might be shown at the apex of the axis in each flower cluster.)

4 Write short notes on the following (Attempt any three):

- (i) **Scalariform conjugation of Spirogyra**
  - Scalariform conjugation is a sexual reproductive process observed in filamentous green algae like *Spirogyra*. It involves the formation of a ladder-like (scalariform) arrangement between two adjacent filaments. Cells from one filament form conjugation tubes that extend towards corresponding cells in the other filament. The protoplast of one cell (considered male) migrates through the conjugation tube into the other cell (considered female), where fusion occurs, forming a zygote. The zygote then develops a thick wall to form a zygospore, which can survive harsh conditions and later germinate into a new *Spirogyra* filament through meiosis. This method allows genetic recombination.
- (ii) **Bacterial genetic recombination by Transduction**
  - Transduction is a process of genetic recombination in bacteria where bacterial DNA is transferred from one bacterium to

another by a bacteriophage (a virus that infects bacteria). There are two main types:

- **Generalized Transduction:** During the lytic cycle, the phage mistakenly packages a random fragment of bacterial DNA into a phage capsid. This transducing phage then infects a new bacterium, delivering the bacterial DNA, which can then integrate into the recipient's chromosome via homologous recombination.
- **Specialized Transduction:** Occurs during the lysogenic cycle of temperate phages. When an integrated prophage excises from the bacterial chromosome, it sometimes picks up a specific, adjacent piece of bacterial DNA. This hybrid phage genome is then packaged into new virions and transferred to a new bacterium, allowing the transfer of only certain bacterial genes.

- Transduction is significant for horizontal gene transfer, contributing to bacterial evolution, adaptation, and the spread of traits like antibiotic resistance.

- (iii) **Characteristic features of Fungi**
  - Fungi are a diverse kingdom of eukaryotic organisms distinct from plants, animals, and protists, characterized by:
    - **Heterotrophic Nutrition:** They are heterotrophs, obtaining nutrients by absorption from their environment, typically by secreting extracellular digestive enzymes.
    - **Cell Wall Composition:** Their cell walls are primarily composed of chitin (a polysaccharide also found in insect exoskeletons), not cellulose (like plants) or peptidoglycan (like bacteria).
    - **Body Structure (Thallus):** Most fungi are multicellular, composed of filamentous structures called hyphae, which

collectively form a mycelium. Some are unicellular (e.g., yeasts).

- **Reproduction:** They reproduce both asexually (e.g., budding, fragmentation, spores) and sexually (involving fusion of nuclei and meiosis to form spores like zygospores, ascospores, or basidiospores).
- **Lack of Chlorophyll:** Fungi lack chlorophyll and are non-photosynthetic.
- **Storage Product:** Glycogen is their primary storage carbohydrate, similar to animals.
- **Habitat:** Found in diverse habitats, often as decomposers, parasites, or symbionts.

- (iv) **Bryophytes as amphibians of plant kingdom**
  - Bryophytes (mosses, liverworts, hornworts) are often called the "amphibians of the plant kingdom" because they exhibit characteristics that bridge the gap between aquatic algae and terrestrial vascular plants, similar to how amphibians bridge the gap between aquatic and terrestrial vertebrates.
    - **Dependence on Water for Reproduction:** Like amphibians, bryophytes are tied to moist environments for sexual reproduction. Their male gametes (antherozoids) are flagellated and require a film of water to swim to the female gamete (egg) for fertilization.
    - **Terrestrial Adaptation:** They possess some adaptations for land life, such as a cuticle to prevent desiccation (though rudimentary), rhizoids for anchorage (not true roots for absorption), and stomata (in some species).
    - **Damp Habitats:** They typically thrive in damp, shady places, symbolizing their transitional nature between fully aquatic and fully terrestrial life.

        - **Dominant Gametophyte:** Their life cycle is dominated by the haploid gametophyte generation, which is photosynthetic and independent, while the sporophyte is short-lived and dependent on the gametophyte for nutrition.

- (v) **General features of Viruses**
    - Viruses are obligate intracellular parasites that are non-cellular entities, exhibiting a unique set of features:
        - **Acellular Nature:** They are not composed of cells and lack cellular organelles (e.g., ribosomes, mitochondria) necessary for metabolism and protein synthesis.
        - **Obligate Parasitism:** They can only replicate inside living host cells, using the host cell's machinery to produce new virions.
        - **Genetic Material:** Possess a nucleic acid genome, which can be either DNA or RNA (but never both simultaneously in a single virion), and can be single-stranded or double-stranded, linear or circular, and segmented or non-segmented.
        - **Protein Coat (Capsid):** The nucleic acid is enclosed within a protective protein coat called a capsid, which is made of repeating protein subunits called capsomeres.
        - **Envelope (Optional):** Some viruses have an outer lipid envelope derived from the host cell membrane, which surrounds the capsid.
        - **Lack of Metabolic Machinery:** Viruses do not have their own metabolic enzymes or protein-synthesizing machinery; they rely entirely on the host cell for these functions.

- **Small Size:** They are extremely small, typically ranging from 20 to 300 nm, visible only with an electron microscope.
- **Specificity:** Viruses are typically highly specific to their host range (species) and cell types due to specific receptor-ligand interactions.

5 Attempt any two from the following:

- (a) Explain the affinities of Slime molds with Fungi.
  - Slime molds (Mycetozoa) were historically classified under Fungi due to superficial resemblances, primarily their spore formation and saprophytic mode of nutrition. However, modern classification places them in Protista, separate from Fungi, because of significant differences, especially at the cellular level.
  - **Affinities with Fungi (Similarities):**
    - **Spore Formation:** Both slime molds and fungi reproduce by forming spores, often within sporangia-like structures, which are dispersed for propagation.
    - **Heterotrophic and Saprophytic Nutrition:** Both are heterotrophic, obtaining nutrients by absorbing organic matter from dead or decaying material. They play a role as decomposers in ecosystems.
    - **Cell Wall (in some stages/species):** While typically lacking a rigid cell wall in their vegetative stages, some slime molds (like cellular slime molds) do form cellulose cell walls around their spores, which is a plant-like feature, but still a resemblance with fungal spore walls in function. However, true fungi have chitin walls.
    - **Motility of Reproductive Cells (in some fungi):** Zoospores (motile spores) are found in some lower fungi

(e.g., Chytrids), showing a fleeting similarity to the motile amoeboid or flagellated stages of slime molds.

- **Differences from Fungi (Why they are not true fungi):**
  - **Cell Wall Composition:** The most significant difference is the cell wall. Fungi have cell walls made of chitin. Slime molds, in their vegetative stages, typically lack a rigid cell wall (plasmodial slime molds) or have cellulose cell walls (cellular slime molds).
  - **Mode of Nutrition:** While both are heterotrophic, fungi absorb nutrients after extracellular digestion. Plasmodial slime molds exhibit **phagotrophic** (engulfing) nutrition, consuming bacteria and other small particles, which is animal-like. Cellular slime molds also show phagocytosis in their amoeboid stage.
  - **Vegetative Body:** Fungi exist as hyphae (mycelium) or single cells (yeasts). Plasmodial slime molds form a large, multinucleate, amoeboid mass called a plasmodium, which lacks cell walls. Cellular slime molds exist as individual amoeboid cells that aggregate to form a pseudoplasmodium or slug when nutrients are scarce. These structures are fundamentally different from fungal hyphae.
  - **Motility:** Slime molds exhibit amoeboid movement during their vegetative stages, a characteristic absent in true fungi (except for motile zoospores in some lower fungi).
- In summary, while they share ecological roles and spore-forming reproductive strategies, the fundamental differences in cell wall composition, vegetative body structure, and mode of nutrition distinguish slime molds from true fungi, leading to their separate classification.

- (b) With the help of diagrams, explain briefly the gametophore of Marchantia.
    - **Gametophore of *Marchantia***:
        - *Marchantia* is a dioecious liverwort, meaning male and female reproductive structures are borne on separate plants. The gametophyte is the dominant, photosynthetic generation, and it produces specialized upright, stalked structures called gametophores (or gametangiophores) that bear the gametangia (sex organs).
        - **Antheridiophore (Male Gametophore):**
            - **Structure:** It is a stalked, flat-topped, disc-like structure with an undulating or lobed margin. It rises vertically from the thallus of the male *Marchantia* plant.
            - **Antheridia:** The upper surface of the disc contains numerous flask-shaped cavities, each housing several antheridia (male sex organs). Each antheridium produces numerous biflagellate antherozoids (sperms).
            - **Release:** When mature, the antherozoids are released through a pore in the antheridial chamber and dispersed by splashing raindrops to reach the archegoniophore.
            - **Diagram:** (A vertical stalk topped by a flat, somewhat lobed disc. The upper surface of the disc would show circular depressions representing antheridial chambers.)
        - **Archegoniophore (Female Gametophore):**
            - **Structure:** It is also a stalked structure, but its apical portion is distinctively stellate or umbrella-

shaped, with 8-9 radiating rays or lobes. It arises from the thallus of the female *Marchantia* plant.

- **Archegonia:** The archegonia (female sex organs) are borne on the *underside* of the radiating rays, hanging downwards between the lobes. Each archegonium is flask-shaped and contains a single egg.
- **Fertilization:** Water is essential for the antherozoids to swim from the antheridiophore to the archegonia for fertilization.
- **Post-fertilization:** After fertilization, the zygote develops into a sporophyte, which remains dependent on the gametophyte. The archegoniophore continues to grow, and its rays grow downwards, enveloping the developing sporophytes.
- **Diagram:** (A vertical stalk topped by a multi-lobed, star-shaped or umbrella-like structure. The undersides of the lobes would show hanging flask-shaped archegonia.)

- **Function:** The gametophores elevate the sex organs, aiding in spore dispersal (in the case of the sporophyte developed from the archegoniophore) and facilitating the transfer of male gametes via water.

- (c) What is heterospory? Explain giving one example.
  - **Heterospory:**
    - Heterospory is a condition in certain plants where two different types of spores are produced, differing in size and sex. These spores are:

- **Microspores:** Smaller in size, produced in microsporangia, and germinate to form male gametophytes (which produce male gametes).
- **Megaspores:** Larger in size, produced in megasporangia, and germinate to form female gametophytes (which produce female gametes).

- In heterosporous plants, the male and female gametophytes are typically endosporic, meaning they develop largely *within* the spore wall. This contrasts with homospory, where all spores are of the same size and give rise to bisexual gametophytes.
- Heterospory is a significant evolutionary step in the plant kingdom, as it is considered a precursor to seed habit found in gymnosperms and angiosperms. It ensures cross-pollination and offers protection to the developing female gametophyte within the megaspore.

- **Example:**
  - **Selaginella** (a Pteridophyte, often called "Spikemoss"):
    - *Selaginella* is a classic example of a heterosporous plant.
    - Its strobili (cone-like structures) bear two types of sporophylls:
      - **Microsporophylls:** Bear microsporangia, which produce numerous small microspores. These microspores germinate to form highly reduced male gametophytes (microgametophytes) that contain antherozoids.
      - **Megasporophylls:** Bear megasporangia, which produce typically four large

megaspores. These megaspores germinate to form female gametophytes (megagametophytes) that contain archegonia with eggs.

- After fertilization (which still requires water for sperm motility), the zygote develops into a new sporophyte. The retention of the megaspore and the development of the female gametophyte within it, at least for some time, is a key step towards the evolution of seeds.