

Tribhuvan University
Institute of Science & Technology

Four Year B. Sc. (Botany) Curriculum
(2073/2016)

Course Title : Plant Diversity and Ecology

Course No: BOT 101

Nature of the Course: Theory

Year: I year

Full Marks: 100

Pass Marks: 35

Lecture : 150

Course Objectives (Bot. 101 and Bot. 102)

- To introduce concept of diversity of lower (non-vascular) plants and higher (vascular) plants, with suitable examples
- To give a comparative idea of range of vegetative and reproductive structures
- To explain the life cycle patterns
- To recognize the evolutionary trends in different groups of plants.

Unit 1. Introduction

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- 1. Classification of living organisms:** Introduction; History of Classification (Aristotle; Theophrastus; Dioscorides; Pliny the Elder; John Ray; Carolus Linnaeus); Basis for classification; Classification type (Artificial and Natural); Hierarchical classification of living things (Kingdom, Phylum, Class, Order, Family, Genus, Species).....1
- 2. Two-Kingdom system:** Two-Kingdom System by Linnaeus (Plantae and Animalia); Limitations of the Two-Kingdom System; Three-Kingdom System (Haeckel 1866); The Copeland Four-Kingdom System (Monera, Protista, Plantae and Animalia); Limitations of the Copeland System.....2
- 3. Five-Kingdom system** (Whittaker 1969): Characteristics of the Five-Kingdom System; **Monera** (Archaeobacteria and Eubacteria); **Protoctista/Protista** (Chrysophytes, Dinoflagellates, Euglenoids, Slime Moulds, Protozoans); **Fungi** (Phycomycetes, Ascomycetes, Basidiomycetes, Deuteromycetes); **Plantae** (Algae, Bryophytes, Pteridophytes, Gymnosperms, Angiosperms); **Animalia** (Viruses, Viroids and Lichen); Concept of Six- Kingdoms (Archaeobacteria, Eubacteria, Protista, Fungi, Plantae, Animalia).....2

Suggested Readings:

1. Cavalier-Smith, T. 2004. Only six kingdoms of life. *Proc. R. Soc. Lond. B* 271: 1251 – 262.
2. Taylor, D.J., Green, N.P.O. and Stout, G.W. 1997. *Biological Science*. Third Edition. Cambridge University Press.
3. Whittaker, R. H. 1969. New concepts of kingdom of organisms. *Science, New Series* **163** (3863): 150 – 160.

Unit 2. Kingdom: Monera

6

1. **General characteristics:** Features of Bacteria; Morphology; Cell structure (capsule, cell wall, cell membrane, cytoplasm, genetic material, ribosomes, inclusion bodies, flagella).....1
2. **Classification** up to class (Whittaker1969).....1
3. **Reproduction** (Binary fission; Spore formation; Transformation; Conjugation and Transduction).....1
4. **Economic importance bacteria: Beneficial activities:** Genetic engineering; Bacteria and Soil fertility; Bacterial metabolism-its commercial importance; Bacteria as human symbionts; **Harmful effects:** Spoilage of food stuff; Causes of animal diseases; Causes of human diseases; Causes of plant diseases.....1

Oscillatoria (Cyanobacteria)

General characteristics: General features; **Systematic position** (Division, Class, Order, Family, Genus); Occurrence; Structure of the thallus. **Reproduction:** Vegetative reproduction (Fragmentation); Asexual reproduction (Hormogonia formation, Akinete or resting spore). **Economic importance. Life cycle:** Diagrammatic representation.....1

Spirulina (Cyanobacteria)

General characteristics: General features; **Systematic position** (Division, Class, Order, Family, Genus); Occurrence; Structure of the thallus; Cell structure. **Reproduction:** Vegetative reproduction (Binary fission); Asexual reproduction (Hormogonia formation). **Economic importance. Life cycle:** Diagrammatic representation.....1

Suggested Readings:

1. Gangulee, H. C. and A. K. Kar. 1994. College Botany. Vol.II 565-597.
2. Kumar, H.D. and S. Kumar. 1998. *Modern Concepts of Microbiology*. Vikas Publishing House Pvt. Ltd, New Delhi.
3. Rao, A.S. 2004. *Introduction to Microbiology*. University Prentice'Hall of India, New Delhi.
4. Shrivastava, R. P. and S. B. Agarwal. Modern Text Book of Botany: Algae, Fungi, Bacteria, Virus and Lichen. Vol. I. 267.Bacteria (220-240)

Unit 3.A. Kingdom: Fungi (Mycota)

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1. **Introduction of fungi:** General features (Distribution of fungi; Cell structure; Habitat and Habitat [Aquatic, Terrestrial, **Parasitic** (Ectoparasite, Endoparasite): Obligate, Facultative; Saprophytic: Obligate, Facultative; Symbiosis]); Somatic structure (Unicellular; Filamentous: Aseptate, Septate); Aggregation and modification of hyphae: i) Plectenchyma [a) Prosenchyma b) Pseudoparenchyma], ii) Rhizomorph iii) Stroma iv) Sclerotium v) Appressorium vi) Haustorium).....1
2. **Nutrition in fungi:** i) Nutritional requirements ii) Essential elements iii) Reserve food; **Growth factors:** Temperature, light, moisture. **Reproduction:** a) Vegetative reproduction (Fragmentation & Budding); b)

Asexual reproduction (Conidia, Zoospores, Spores, Chlamydo­spores, Oidiospores); c) Sexual reproduction [Planogametic copulation, Gametangial contact (gametangiogamy), Gametangial copulation, Spermatization, Somatogamy].....1

3. Classification of fungi: A natural system of classification of fungi as proposed by G.C. Anisworth (1973) (Kingdom, Division, Sub-division, Class, Order, Family, Genus, Species).....1

Albugo candida (Cystopus)

General features, **Systematic position;** Habit and habitat (occurrence or distribution); Somatic structure. **Reproduction:** Vegetative (fragmentation); Asexual reproduction (conidia formation) and Sexual reproduction (Oogamous type). **Life cycle:** Diagrammatic representation. **Economic importance: ‘White rust disease’,** Symptoms of diseases, Control measure (Chemical method; Biological method; Agriculture method).....1

Aspergillus (Eurotium)

General features; **Systematic position;** Habit and habitat (occurrence or distribution); Somatic structure. **Reproduction:** Vegetative reproduction (fragmentation); Asexual reproduction (conidia formation); Sexual reproduction (Formation of antheridia and archicarps; Fertilization, Cleistothecium/Ascocarp formation [closed fruiting body]; Ascus; Ascospores. **Life cycle:** (Haplophase, Dikaryophase, Diplophase) Diagrammatic representation. **Economic importance: Useful activities:** Destruction of organic waste; Industrial mycology; Bio-assays; Antibiotics; Vitamins; Therapeutic uses; Enzymes; Fat production; etc. **Harmful effects:** Spoilage of food; Tropical deterioration; Mycoses;.....2

Peziza (Sac fungi)

General features; **Systematic position;** Habit and habitat (occurrence or distribution); Somatic structure. **Reproduction:** Asexual reproduction (conidia formation); Sexual reproduction (Somatogamy, Ascogenous hyphae, Crozier formation, Karyogamy, Ascus, Ascospores, Apothecium (fruiting body). Structure of apothecium (Hymenium, Hypothecium, Excipulum). **Life cycle:** Diagrammatic representation. **Economic importance:**2

Agaricus or psalliota (Club fungi)

General features; **Systematic position;** Habit and habitat (occurrence or distribution); Somatic structure (monokaryotic and dikaryotic mycelium). **Reproduction:** Asexual reproduction (chlamydo­spores, oidia); Sexual reproduction (Somatogamy; Development of sporophores (Fructification); Basidiocarp (Mature fructification); Basidiospores). Structure of Basidiocarp (Stipe, Pileus, Gills); Liberation and germination of the basidiospores. **Life cycle:** Diagrammatic representation. **Economic importance: Useful activites:** Sources of food, decomposition of dead bodies, wastes materials, Ink, etc. **Harmful effects:** Wood rotters; Poisonous mushroom; Antibiotics; Mycorrhizal associations; Diseases caused by mushrooms, etc.....2

Puccinia graminis (Rust fungi)

General features; **Systematic position**; Habit and habitat (occurrence or distribution); Somatic structure (septed hyphae, monokaryotic and dikaryotic). **Reproduction**: Spore formation, **Occurs through five stages** (Polymorphic stage-Stage 0-Pycnidiospore, Stage i-Aceidiospores, Stage ii-Uredospores, Stage iii-Teleutospores, Stage iv-Basidiospores), Heteroecious (Two host–Wheat and Barberry). In **Wheat**: Uredial stage (Formation, structure and germination of uredospore), Teleuto stage (Formation, structure and germination of teleutospore), Basidiospore stage (Formation, and germination of basidiospore). In **Barberry**: Pycnidial stage (formation of pycniospores, spermatization-takes part in sexual reproduction) and Aecidial stage (Formation, structure and germination of aecidiospores). **Life cycle**: Diagrammatic representation (Alternation of generation). **Economic importance**: “**Black rust of wheat**”, Symptoms of disease; Rust disease in different cereals; Control measure (Chemical and Agriculture method).....2

Alternaria (Fungi imperfecti)

General features; **Systematic position**; Habit and habitat (occurrence or distribution); Somatic structure. **Reproduction**: Asexual reproduction (Conidia formation). **Life cycle**: Diagrammatic representation. **Economic importance**: ‘**Early blight of potato**’; Symptoms of diseases; Other diseases caused by different species of *Alternaria*. eg. *A. solani* cause ‘Early blight’ diseases in potato and members of Solanaceae, *A. brassicae* *A. brassicicola* cause ‘leaf spot disease’ in Crucifers, etc.; Control measure (Chemical, Biological and Agriculture practice).....1

4. Vesicular Arbuscular Mycorrhizae (VAM)

Introduction of mycorrhiza: Types of mycorrhiza (a. Ectomycorrhiza [Ectotrophic] and b. Endomycorrhiza [Endotrophic]).

VAM (Vesicular arbuscular mycorrhizae): Vesicular (vesicle–storage organs or as resting spores) and Arbuscules (dichotomously branched, complex haustoria) containing intercellular hyphae. **Classification** (Class–Zygomycetes, Order–Mucorales, Family–Endogonaceae, Genus: *Gloius*, *Glomerulus*, *Gigaspora*, *Sclerocystis*, etc.). **Economic importance**: Biofertilizers1

5. Economic importance of fungi:

Useful activities: Destruction of organic waste; Formation of humus; Release of carbon dioxide; Role of fungi in medicine (**a.** Antibiotics: Pencillium, Streptomycin, etc., **b.** Ergot: *Claviceps purpurea* used in veterinary and human medicine, **c.** Vitamines: vitamin B, vitamin D, Biotin, Riboflavin, Biotin, Thiamine etc., **d.** Therapeutic uses: Extract of *Aspergillus niger* and *Sacchaaromyces cerevisiae* have proved in extreme cases of malignancy, **e.** Alcohol fermentation, **f.** Steroids.); Role of fungi in Industry (Baking, Brewing, Cheese industry, Preparation of organic acids [Oxalic acids, Citric acid, Gluconic acid, Gallic acid]); Fungi as food (Mushroom, morels, and yeast); Fungal enzyme (Invertase, Amylase, Pertinose); Mycorrhizae (VAM); Growth hormones (Giberrelin); Use of fungi in Bio–assays; Fungi as test organism.(eg Neurospora). **Harmful effects**: Plant diseases (eg. Rust disease, Smut disease, Blight disease, etc.); Destruction of wood; Destruction of utensils and other products

(eg electrical equipment, Textiles, papers, leather, optical instrument, etc.; Food spoilage (Dairy product, Fruits, Canning products, Bakery products, Meat, Vegetable, etc); Mycoses; Poisonous Mushroom.....1

Suggested Readings:

1. Alexopoulos, C.J., Mims, C.W. and Blackwell. 2002. *Introductory Mycology*. Wiley Eastern Ltd.
2. Gangulee, H.C. and Kar, A.K. 1994. *College Botany Vol II*. New Central Book Agency, Calcutta.
3. Webster, J. 1993. *Introduction to Fungi*. Second Edition. Cambridge University Press, New Delhi.
4. Adhikari, M.K. 2000. *Mushrooms of Nepal*. P.U. Printers, Kathmandu, Nepal.
5. Pandey, S.N. and Trivedi, P.S. 1994. *A Text Book of Botany Vol. 1*. Vikash Publishing House, New Delhi.
6. Deacon, J. W. 2005. *Fungal Biology*. Blackwell Publishing, UK.
7. Smith, G.M. 2004. *Cryptogamic Botany*, Vol I. McGraw Hill Book Company, Inc., N.Y.

Unit 3.B. Lichens:

5

1. Introduction of Lichens: General features; Mode of nutrition–biotrophic; Distribution; Habit and Habitat (Saxicolous, Corticolous, Terricolous).....1

2. Lichen thallus: i. Crustose lichen, ii. Foliose lichen, iii. Fruiticose lichen. **Classification:** On the basis of (i) nature of the fungal element and (ii) kind of the frutification.

Thallus on the basis of the nature of the fungal element: I. **Ascolichen** (fungal component is an Ascomycete), Sub divided into two according to ascocarp– (a) Gymnocarpeae (ascocarp-an apothecium type) (b) Pyrenocarpeae (ascocarp-perithecium type) eg. *Parmelia, Physcia, Usnea, Cladonia, Graphis, Verrucaria*, etc. II. **Basidiolichen/Hymenolichen** (fungal component is a Basidiomycetes) eg. *Cora, Rhipidonema*.

Thallus on the basis of the fruitification (structure of asci and ascocarps): I. **Hymeno-ascolichens** with unitunicate asci paraphyses in apothecia; II. **Loculo-ascolichens** with bitunicate asci in apothecia .or hysterothecia; III. **Loculo-ascolichens** with bitunicate asci in pseudothecia; IV. **Deuterolichens** (The lichenes imperfecti): mostly sterile lichens that produce no spores.....1

3. Structure of lichen thallus: Anatomy and Morphology.

On the basis of internal structure of thallus, two groups: (i) Structure of Homoiomerous Lichen thallus, (ii) Structure of Heteromerous Lichen thallus. Structure associated with the lichen thallus: (i) Breathing pores (ii) Cyphellae (iii) Cephellae (iv) Cephalodia (v) Isidia. **Nutrition**1

4. Reproduction: Vegetative reproduction (Fragmentation and propagules (i) Soredia (ii) Isidia); Reproduction of Algal component (phycobiont): (i) Cell division (ii) Hormogonia (iii) Akinetes (iv) Heterocysts; Reproduction of fungal component (mycobiont): (i) Asexual reproduction (sporulation) (ii) Sexual reproduction: Oogamous type (Male reproductive organ spermogonium; Female reproductive organ carpogonium; Fertilization; Post-plasmogamy changes; Fruiting body: (i) apothecia (ii) Perithecia.....1

5. Economic importance: Useful activities: Sources of food; Source of medicines; Source for dyes; For perfume; For minerals; For acid extraction; Indicators of air pollution; Soil formation; As nitrogen fixers; For ecological importance. **Harmful effects:** Source of fire; Serious damage to the windows; Poisonous; Destruction of mosses1

Suggested Readings:

1. Gangulee, H.C. and Kar, A.K. 1994. *College Botany* Vol II. New Central Book Agency, Calcutta.
2. Shrivastava, R. P. and S. B. Agarwal. *Modern Text Book of Botany: Algae, Fungi, Bacteria, Virus and Lichen.* Vol. I. 267.Bacteria (220-240)

Unit 4. Kingdom Plantae: Algae

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1. **General features;** Cell structure; **Distribution** (occurrence and habitat: phytoplanktons, endophytes, symbionts, epiphytes, parasites).....2
2. **Classification up to class** (Fritsch 1944).....2
3. **Range of thallus** (Motile Unicellular form; Motile colonial form; Non-motile Unicellular form; Non-motile colonial form; Palmelloid form; Filamentous form; Heterotrichous form (Erect system and Prostrate system); Thalloid form; Siphonous form; Special form).....1
4. **Reproductive structures: Asexual reproductive structures:** Spores–nonmotile (Akinetes; Hormogonia; Hormospores; Endospores; Exospores; Aplanospores; Hypnospores; tetraspores; monospores; Palmella stage); Motile spores: Zoospores. **Sexual reproductive structures:** Gametes (isogamy, anisogamy, oogamy); Alternation of generation in algae (Haplont, Diplont, Isomorphic, Heteromorphic).....3

Chlamydomonas (Chlorophyceae)

Systematic position (Division, Class, Order, Family, Genus); **Occurrence and distribution;** **Organization of the thallus;** **Cell structure;** **Reproduction:** Asexual reproduction (Zoospore formation; Aplanospore formation; Palmelloid stage), Sexual reproduction: Isogamy; Anisogamy; Oogamy; Origin of sex. **Life cycle:** Diagrammatic representation.....1

Chara (Chlorophyceae)

Systematic position (Division, Class, Order, Family, Genus); **Occurrence and distribution;** **Organization of the thallus:** The plant body (nodes and internodes); Branches of limited growth; Branches of unlimited growth; Stipules. **Cell structure;** **Reproduction:** Vegetative reproduction (Amylum stars, Tubers/bulbils, Protonema). Sexual reproduction: Oogamy (Male reproductive organ-globules; Structure and development of globule; Female reproductive organ-nucule; Structure and development of nucule; Fertilization; Structure of oospore; Germination of oospore). **Life cycle:** Diagrammatic representation.....2

Vaucheria (Xanthophyceae),

Systematic position (Division, Class, Order, Family, Genus); **Occurrence and distribution;** **Structure of the thallus; Cell structure. Reproduction:** Vegetative reproduction (Fragmentation), Asexual reproduction (Spores: Synzoospore [formation, structure and germination], Aplanospore formation, akinetes, Hypnospores or cysts formation); Sexual reproduction: Oogamy (Position of sex organs; Structure and development of Antheridia; Structure and development of oogonia; Fertilization; Germination of oospore); Alternation of generation. Position of Vaucheria. **Life cycle:** Diagrammatic representation.....2

Navicula (Bacillariophyceae)

Systematic position (Division, Class, Order, Family, Genus); **Occurrence and distribution; Cell structure:** Shape, made up of two halves (epitheca, hypotheca); Girdle and valve view; **Reproduction:** Asexual reproduction (Cell division and Auxospores); Sexual reproduction: Conjugation. **Life cycle:** Diagrammatic representation.....1

Fucus (Phaeophyceae)

Systematic position (Division, Class, Order, Family, Genus); **Occurrence and distribution; Organization of the thallus** (Holdfast, Stipe, Frond); **Internal structure of the thallus** (Meristoderm, Cortex or Storage tissue, Medulla). **Reproduction:** Vegetative reproduction (Fragmentation); Sexual reproduction: Oogamous type (Structure and development of conceptacle; Male reproductive organ-antheridia; Development of antheridia; Female reproductive organ-oogonium; Development of oogonium; Fertilization; Post fertilization; Formation of new thallus). **Life cycle:** Diagrammatic representation.....3

Batrachospermum (Rhodophyceae)

Systematic position (Division, Class, Order, Family, Genus); **Occurrence and distribution; Organization of the thallus:** Branches of limited and unlimited growth; Cell structure. **Reproduction:** Sexual reproduction: Oogamous type (Male reproductive organ-spermatium; Development of antheridium; Female reproductive organ-capogonium; Development of carpogonium; Fertilization; Post fertilization changes; Formation of carposporangia; Carpospores; and Cystocarp; Formation of new thallus); Alternation of generation. **Life cycle:** Diagrammatic representation.....2

Economic importance of Algae: Useful activities: Algae constitute the link of food chain; Useful in fish culture; Sewage treatment plant; As food; As fodder; As fertilizer; As medicine; In industries (Algin, Agar, cosmetics, paints, etc); Diatomaceae earth; Soil fertility; Algae and limestone formation; Parasitic algae. **Harmful effects:** Ship fouling; Water blooms.....2

Suggested Readings:

1. Fritsch, F.E. 1979. Structure and Reproduction of Algae, Vols I & II. Cambridge University Press, London.
2. Gangulee, H.C. and Kar, A.K. 1994. *College Botany* Vol II. New Central Book Agency, Calcutta.
3. Kumar, H.D. 1999. Introductory Phycology. East West Publications, New Delhi
4. Baral, S.R. 1995. Algae of Nepal. Report of Biodiversity Profile Project.
5. Kumar, H.D. and H.N. Singh. 1995. A Textbook on Algae. Fourth Edition. East West Press Pvt. Ltd., New Delhi.
6. Pandey, S.N. and Trivedi, P.S. 1994. A Text book of Botany Vol. 1. Vikash Publishing House Ltd., New Delhi.
7. Smith, G.M. 1971. Cryptogamic Botany, Vol I. Algae and Fungi. Second Edition. Tata McGraw-Hill Publishing Co. Ltd., New Edition.

Unit 4B. Bryophyta

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1. **Characteristics and distribution of bryophytes** (Distribution, Habit and habitat, morphology of gametophytes, Vegetative reproduction; Structure of sex organs (development of jacketed sex organs, presence of motile male gametes and necessity of water for fertilization); Fertilization and development of embryo/ sporophytes (Concept of embryophyta); Generalized life cycle of bryophytes (alternation of generations).....2
2. Classification of bryophytes: General basis of bryophyte classification; Outline classification Rothmaler (1951); General characteristics of different groups (upto classes).....1
3. **Origin and evolution of bryophytes** (Progressive evolution theory (Algal origin); Regressive evolution theory (Pteridophyte origin); Bryophytes as connecting link between algae and pteridophytes;.....1

Riccia (Hepaticopsida)

Systematic position; Habit and habitat (occurrence or distribution); Morphology; Internal structure of thallus; Growth; Vegetative reproduction Sexual reproduction: Distribution of sex organs; Structure of antheridium and structure of archegonium; Fertilization;..... 1

Development and structure of sporophyte; Spore dispersal and germination; Formation of gametophytes; **Life cycle:** Diagrammatic representation.....1

Pellia (Hepaticopsida)

Systematic position; Distribution and habitat (occurrence or distribution); Morphology of the gametophyte; Internal structure of thallus; Growth; Vegetative reproduction; Sexual reproduction (Distribution of sex organs; Structure of antheridium and structure of archegonium; Fertilization;..... 1

Development and structure of sporophyte; Spore dispersal and germination; Formation of gametophytes; **Life cycle:** Diagrammatic representation.....1

Anthoceros (Anthocerotopsida)

Systematic position; Distribution and habitat (occurrence or distribution); Morphology of the gametophyte; Internal structure of thallus; Growth; Vegetative reproduction; Sexual reproduction (Distribution of sex organs; Structure of antheridium and archegonium; Fertilization;)1

Development and structure of sporophyte; Spore dispersal and germination; Formation of gametophytes; **Life cycle:** Diagrammatic representation.....1

Polytrichum (Bryopsida)

Systematic position; Habit and habitat (occurrence or distribution); Morphology; Internal structure (axis and leaves).....1

Structure of sex organs; Development of sporophyte.....1

Structure of sporophyte; Spore dispersal; Germination. **Life cycle:** Diagrammatic representation.....1

4. Sterilization of sporogenous tissue in bryophytes (with reference to sporophytes in *Riccia*, *Marchantia*, *Pellia*, *Anthoceros* and *Funaria/Polytrichum*).....1

5. Economic importance of bryophytes: Useful activities: As indicator species; As nitrogen fixation; As Erosion control; Bio-indicators of heavy metals in air pollution; Treatment of Waste; Moss Gardens; Moss Industry (Fuel, Harvesting peat and other mosses, Household uses; Packing); Medical Uses; Food Sources; etc. **Harmful effects:** Skin allergy; Source of fire; Poisonous liverworts;1

(Note: While dealing with the development of sex organs in different bryophyte *Riccia* should be taken as a model and only the deviations from this model should be dealt with in other models).

Suggested Readings:

1. Watson, E.V. 1964. *The Structure and Life of Bryophytes*. Hutchinson and Company, UK.
2. Goffinet, B. and Shaw, A.J. 2009. *Bryophyte Biology*, Second edition. Cambridge University Press, UK.

Unit 4C. Pteridophyta

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1. Characteristics and distribution of pteridophytes (General distribution (habitat); Pteridophytes as plants having independent gametophytes and sporophytes; Pteridophytes as land plants; Pteridophytes as vascular plants; General morphology of the sporophyte (root, stem, leaves, sporophylls); Reproduction in

pteridophytes (vegetative, asexual and sexual); Sporangia and spores; Gametophytes and sex organs; Fertilization, development of embryo).....1

2. **Classification of pteridophytes upto divisions** (General basis of pteridophyte classification; Outline classification (Reimers, 1954); General characteristics of different groups [upto classes]).....1

3. **Origin and evolution of pteridophytes**

- Theories on algal and bryophytic origin of pteridophytes.....1
- General evolutionary trends in pteridophytes: Telome theory, Evolution of roots; Evolution of stem (morphology, stele); Evolution of leaves (microphylls, scale leaves, megaphylls); Evolution of sporophylls; Evolution of gametophytes (Progressive reduction in size of gametophytes).....3

Lycopsida (**Lycopodium sensu lato**)

General characteristic features of Lycopsida. **Systematic position**; Habit and habitat (occurrence or distribution of *Lycopodium*), morphology 1

Internal structure of root, stem and leaves; Structure of sporophylls based on two subgenera: Urostachya, Rhopalostachya.....1

Structure of sporangia; Spore dispersal; Types of gametophyte.....1

Structure of sex organs (antheridia, archegonia); Fertilization and development of sporophyte. **Life cycle**: Diagrammatic representation.....1

Lycopsida (**Selaginella**)

Systematic position; Habit and habitat (occurrence or distribution); Morphology (Sporophyte); Internal structure of rhizophore, root, stem, leaves and ligule..... 1

Structure of strobilus (Heterosporous); Structure of sporangia; Spore dispersal;..... 1

Structure of gametophyte; Structure of sex organs (antheridia, archegonia); Fertilization and development of sporophyte. **Life cycle**: Diagrammatic representation1

Sphenopsida (**Equisetum**)

General characteristic features of Sphenopsida. **Systematic position**; Habit and habitat (occurrence or distribution of *Equisetum*); Morphology (*Sporophyte*)..... 1

Internal structure of roots, rhizome and stem; Structure of strobilus; Structure of sporangia; Spore dispersal1

Structure of gametophyte; Structure of sex organs (antheridia, archegonia); Fertilization and development of sporophyte. **Life cycle:** Diagrammatic representation.....1

Pteropsida (**Marsilea**)

General characteristic features of Pteropsida. **Systematic position;** Habit and habitat (occurrence or distribution of *Marsilea*); Morphology (*Sporophyte*); Internal structure of rhizome, stem and leaves.....1

Structure of sporocarp; Structure of sporangia; Dehiscence of sporocarp.....1

Structure of gametophytes; Structure of sex organs (antheridia, archegonia); Fertilization and development of sporophyte.....1

Pteropsida (**Pteris**)

Systematic position; Habit and habitat (occurrence or distribution of *Pteris*); Morphology (*Sporophyte*); Internal structure of rhizome, pinnule and petiole.....1

Structure of sorus, sporangia; spore dispersal and germination; Structure of gametophyte, structure of sex organs; Embryo and development of sporophyte1

4. Stelar system and its evolution in pteridophytes (with reference to *Lycopodium*, *Selaginella*, *Equisetum*, *Marsilea* and *Pteris*)1

5. Heterospory and evolution of seed habit; Alternation of generations in pteridophyt.....1

6. Economic importance of pteridophytes: Useful activities: Ornamental value; Food value; Medicinal; Biofertilizers; Environmental aspects; Horticultural uses; Handicrafts; Dye; Photography; Forensic investigation; etc. **Harmful effects:** Toxic to livestock; Spore as source of allergy; Water pollution; etc.....1

(Note: While dealing with different pteridophytes development of sex organs should be dealt to reflect the structural differences and evolution of these organs in different groups. Emphasis should be given to give the concept of general evolutionary trends in pteridophytes, i.e., the reduction of gametophyte and elaboration of sporophyte. Life cycle should be dealt with in generalized way for all the model species).

Suggested Readings:

1. Pandey, S.N. and Trivedi, P.S. 1998. A text book of Botany vol II. Vikash Publications, New Delhi.
2. Parihar, N.S. 1992. The biology and morphology of Pteridophytes. Central Book Depot, New Delhi
3. Smith, G.M. 1955. Cryptogamic Botany, Volume II. Tata McGraw-Hill Publishing company.
4. Sporne, K.R. 1962. The Morphology of Pteridophyte. Hutchinson and Company, UK.

1. **General characteristics of Gymnosperms:** Introduction; Distribution; Morphology (Habit, stem, leaf, cone, root).....1
2. **Classification of Gymnosperm:** History of classification (Robert Brown (1827); J.D. Hooker (1857); Eichler (1883); Coulter and Chamberlain (1917); Birbal Sahni (1920); Chamberlain (1934); Arnold (1948); Takhtajan (1950); Pant(1957); Raizada and Sahni (1960); Andrews (1961); Sporne (1965); Takhtajan, Cronquist and Zimmermann (1966); Gangulee (1968)) Classification by Sporne (1965) to be followed.....2
3. **Origin and Evolution of Gymnosperm:** (Evolutionary history of gymnosperms; Heterospory; Gametophytes and ovule).....2

Cycadopsida (Cycas)

General features of Cycadopsida. **Systematic position of Cycas:** Morphology (habit, stem, leaf, cones, root); Internal structure of stem.....1

Internal structure of rachis, leaflet, root and coralloid root.....1

Reproduction: Vegetative reproduction (Buds or Bulbil); Sexual reproduction: Male cone or strobilus; Microsporophyll (Development of microsporangia and microspores; Germination of the microspores); Female cone or strobilus; Megasporophyll (Megaspore and development of female gametophyte; Development of archegonia).....1

Pollination; Fertilization; Development of embryo; Formation of seed; Germination of the seed.....1

Coniferopsida (Pinus)

General features of Coniferopsida. **Systematic position of Pinus:** Morphology (Habit, branches of limited and unlimited growth, leaves (Scale and foliage) cones, root); Internal structure of root.....1

Internal structure of stem and leaf. **Reproduction:** Development of microsporangium and microspores; Development of the megasporangium (Ovule)1

Pollination; Development of male and female gametophyte; Development of archegonium; Fertilization; Development of embryo; Formation of Seed; Dispersal and germination of the seed.....1

Gnetopsida (Ephedra)

General features of Gnetopsida. **Systematic position of Ephedra:** Morphology; Internal structure of stem. **Reproduction:** Male cone (Microsporogenesis); Female cone (Megasporesogenesis).....1

Development of the male gametophyte; Development of the female gametophyte and archegonium; Pollination; Fertilization; Development of embryo; Formation of Seed; Dispersal and germination of the seed.....1

4. Distribution of Gymnosperm in Nepal: Total taxa in Nepal (Family, Genus and Species); Distribution pattern (Ecological zones/Bioclimatic zone).....1

5. Economic Importance of Gymnosperm: Useful activities: Medicinal value; Timber; Resin and oils; Craft paper; Food; Fuel; Ornamental; Industrial uses; etc. **Harmful effects:** Soil acidity; Allelopathic effects; Forest fire; Harmful to human health; etc.....1

Suggested Readings:

1. Bhatnagar, S.P. and A. Mitra. 1996. *Gymnosperms*. New Age International Limited, New Delhi.
2. Gangulee, H.C. and Kar, A.K. 1994. *College Botany* Vol II. New Central Book Agency, Calcutta.
3. Pandey, S.N. and Trivedi, P.S. 1997. *Botany Vol. II*. Vikash Publications, New Delhi.
4. Chamberlain, C.J. 1986. *Gymnosperms: Structure and Evolution*. CBS Publishers & Distributors, New Delhi.
5. Shrestha, T.B. 1999. *Indigenous Gymnosperms*. In: Majpuriya, T.C. and Majpuria, R.K. (eds.). *Nepal Nature's Paradise*. M. Devi, Gwalior, India.
6. Sporne, K. R. 1974. *The Morphology of Gymnosperms*, Hutchinson & Co., London.

Unit 4F. Paleobotany

8

1. Introduction: History and scope of Paleobotany.....1

2. Origin of and evolution of life on earth..... 2

3. General account of the geological eras and periods with examples.....1

4. Mode of fossil formation: Molecule by molecule replacement theory; Infiltration theory..... 1

5. Type of fossils: Compression; Impression; Incrustation; Petrification (Mineralized plants); Compactions (Mummified plants); Amber 2

6. Morphology and anatomy of Rhynia: Morphology (Occurrence and External feature); **Anatomy of Rhynia:** (aerial axis; sporangium)1

Suggested Readings:

1. Andrews, H.N. 1961. *Studies in Paleobotany*. John Wiley & Sons, New York.
2. Arnold, C. A. 2007. *An Introduction to Paleobotany*. Miller Press, South Dakota, USA.
3. Pandey, S.N. and Trivedi, P.S. 1998. *Botany Vol. II*. Vikash Publications, New Delhi.

Unit 4E. Ecology

35

1. Basic Concept: Branches and scopes of ecology; Biotic and abiotic factors; Species interactions. 4
2. Biogeochemical Cycles: Carbon, Nitrogen, Phosphorus, and Sulphur . 4
3. Community Ecology: Nature (organismic vs. continuum-individualistic views) and attributes; Succession: Types, Mechanisms and examples from aquatic and terrestrial ecosystems; Vegetation types and distribution in Nepal. 10
4. Ecosystem: Structure and function of major ecosystems (forest, grassland and fresh water). 3
5. Plant adaptation: Plant adaptation in xerophyte, hydrophyte, epiphyte, alpine plants. 5
6. Environmental Issues: pollution (air, water, soil and noise), acid rain, global warming, ozone depletion. 5
7. Nature Conservation: Protected areas, landscape approaches for conservation. 4

Suggested Readings

Ecology

Ambasht RS. Environment and Pollution. Students, Friends and Co., Lanka, Varanasi, India.

Chapman and Reis. Ecology: Principle and Applications. Cambridge.

Chaudhary RP. Biodiversity in Nepal. S Devi, Saharanpur, UP, India, and Tecpress Books, Bangkok, Thailand.

Odum EP and GW Barrett. Fundamental of Ecology. Thomson Brooks/Cole, Thompson Business Information India Pvt. Ltd., India.

Sharma PD. Ecology and Environment. Rastogi Publications, India.

Verma PS and VK Agrawal. Principles of Ecology. S. Chand & Co. (P) Ltd., New Delhi, India

Botany

Subject: Plant Diversity & Ecology
Course No.: BOT 102 (Major/Minor)
Nature of the course: Practical

Full Marks: 50
Pass Marks: 20
Year: 1
Total Number of Periods: 180

1. Bacteria

1. Study of sterilization Techniques (Structure and Operation of Hot Air Oven, Autoclave, Ultraviolet chamber, Incubator).
2. Preparation of culture media (Preparation of Nutrient Agar (solid and broth).
3. Culture of Bacteria (Soil microorganism by Serial Dilution Plating Technique, on Nutrient Agar medium).
4. Study of gram positive and gram negative staining of bacteria.
5. Study of vegetative and reproductive structure of *Anabaena/ Oscillatoria* and *Spirulina* (Preparation of slide by using iodine and glycerol).

2. Fungi

1. Preparation of culture media –Natural media –PDA (Potato dextrose agar).
2. The culture of *Aspergillus* in Lab. (Bell jar method)
3. Field visit for collection of the infected plant host. (*Albugo, Alternaria, Puccinia*)
4. Study of habit and habitat, vegetative structure, symptoms of diseases (*Albugo, Puccinia, Alternaria*)
5. Study of vegetative reproduction through section cutting: conidia – *Albugo*, and different spores of *Puccinia* (Uredospores, Teleutospores, Basidiospores, Pycnidiospores, aeciospores) by preparing semi-permanent slide.
6. Study of different spores of *Agaricus* (Basidiospores); *Aspergillus* (Conidia); *Alternaria* (Conidia) by preparing semi-permanent slide.
7. Study of reproductive parts in *Albugo* (Oogonium, Antheridium); *Aspergillus* (Cleistothecium, ascus, ascospores); *Peziza* (Apothecium, asci, ascospores) by preparing semi-permanent slide and permanent slide.

3. Lichens

1. Study of habit and habitat, morphological study of different types of Lichens (crustose, foliose, fruticose)
2. Anatomy of vegetative structure (Internal structure of thallus). i) V.S of Homomerous thallus, ii)V.S of Heteromerous thallus by preparing semi-permanent slide.
3. Reproductive structure of foliose and fruticose lichens by preparing semi-permanent slide.
4. Study of museum specimens and permanent slides.
5. Field visit for the collection of different lichens species.

4. Algae

1. Study of permanent slides for *Chlamydomonas*, *Vaucheria*, *Chara*, *Navicula*, *Fucus* and *Batrachospermum*.
2. Study of vegetative and reproductive parts in *Chlamydomonas*, *Vaucheria*, and *Chara* through slide preparation.
3. Study of vegetative and reproductive parts in *Navicula*, *Fucus* and *Batrachospermum* through slide preparation.
4. Field visit. (Collection and preservation of representative algal species)

5. Bryophytes

1. Study of vegetative and reproductive structures in *Riccia* (Habit, dorsal and ventral surface, VS of thallus, VS of thallus through antheridium, VS of thallus through archegonium, VS of thallus through sporophyte).
2. Study of vegetative and reproductive structures in *Pellia* (Habit, dorsal and ventral surface, VS of thallus, VS of thallus through antheridium, VS of thallus through archegonium, LS of sporogonium).
3. Study of vegetative and reproductive structures in *Anthoceros* (Habit, dorsal and ventral surface, VS of thallus, VS of thallus through antheridium, VS of thallus through archegonium, TS/VS of sporophyte).
4. Study of vegetative and reproductive structures in *Polytrichum* (Habit, VS through leaf, TS of stem; LS of the apex of male and female branches; LS of sporophyte).
5. Comparative study of saprophytes in *Riccia*, *Marchantia*, *Pellia*, *Antheceros* and *Funaria/Polytrichum* to study the sterilization of sporogenous tissue in bryophytes.

(Students should be motivated to make drawings directly on the practical sheets in the laboratory and efforts should be made to engage the students in the lab throughout the practical session.)

6. Pteridophyta

1. General survey of pteridophytes: Different species of representative types (*Lycopodium*, *Selaginella*, *Equisetum*, *Marsilea*, and *Pteris*) as well as economically important species from nearby locality (if possible) should be dealt with.
2. Study of vegetative and reproductive structures in *Lycopodium*: Morphology of the sporophyte (one representative from each sub genus); internal structure of the stem (*L. clavatum*, *L. cernum*, *L. serratum*); structure of sporophylls; Structure of gametophyte (using permanent slide); early sporophyte (using permanent slide)
3. Study of vegetative and reproductive structures in *Selaginella*: Morphology of the sporophyte; internal structure of the rhizophore, stem; structure of strobilus and sporophylls (micro- and mega-sporophylls); Structure of micro- and mega-gametophyte (through permanent slides); early sporophyte (using permanent slide).
4. Study of vegetative and reproductive structures in *Equisetum*: Morphology of the sporophyte; internal structure of the stem; structure of strobilus; Structure of gametophyte (through permanent slides); early sporophyte (permanent slide).
5. Study of vegetative and reproductive structures in *Marsilea*: Morphology of the sporophyte; internal structure of the stem; structure of sporocarp (*permanent slide*)
6. Study of vegetative and reproductive structures in *Pteris*: Morphology of the sporophyte; internal structure of the rachis and pinnules; structure of sorus; Structure of sporangium; structure of prothallus (permanent slide); early sporophyte (permanent slide)
7. Study of stellar system in *Lycopodium*, *Selaginella*, *Equisetum*, *Marsilea* and *Pteris*.

7. Gymnosperms

1. Study of vegetative and reproductive structures, T.S. of coralloid root, leaflet and rachis of *Cycas*
2. Study of vegetative, reproductive structures, T.S. of young stem and needle of *Pinus*.
3. Study of vegetative, reproductive structures, T.S. of stem of *Ephedra*

8. Paleobotany

1. Study of museum specimens for different fossil types.
2. Study of museum specimens and permanent slide for external and internal structure of *Rhynia*.

9. Ecology

1. To enumerate plants of the study area.
2. To determine the minimum size of the quadrat by species area curve method.
3. To determine the minimum number of quadrat to be sampled in study area.
4. To determine density of different plant species by quadrat method.
5. To determine frequency of different plant species by quadrat method.
6. To determine coverage of different plant species by quadrat method.
7. To determine importance value index (IVI) of different plant species by quadrat method.
8. To determine pH of various soil samples.
9. To determine texture of given soil samples.
10. To determine humus content of the soil samples
11. To study food web of a pond ecosystem
12. To study food web of a grassland ecosystem.
13. To estimate dissolved oxygen in polluted and non-polluted water samples.
14. To study ecological anatomy of hydrophytes.
15. To study ecological anatomy of xerophytes.