

Syllabus of Botany Courses as per National Education Policy-2020
Department of Botany & Microbiology
H.N.B. Garhwal University
B.Sc. Botany

First Year- Semester I

Title of Paper: DIVERSITY OF LOWER PLANTS (THEORY)

Total No. of Lectures: 60

Credits: 4

U nit 1: Algae (12 Lectures)

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas*, *Oedogonium*, *Vaucheria*, *Fucus*, *Polysiphonia*. Economic importance of algae

U nit 2: Fungi (14 Lectures)

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium*, *Alternaria* (Ascomycota), *Puccinia*, *Agaricus* (Basidiomycota); Symbiotic Associations- **Lichens**: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Unit 3: Introduction to Archegoniate (14 Lectures)

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Bryophytes

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit 4: Pteridophytes (12 Lectures)

General characteristics, classification, Early land plants (*Cooksonia* and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.

Unit 5: Gymnosperms (8 Lectures)

General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Cycas* and *Pinus*. (Developmental details not to be included). Ecological and economical importance.

PRACTICAL**Credits: 2**

4. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Fucus** and *Polysiphonia* through temporary preparations and permanent slides. (* *Fucus* - Specimen and permanent slides)
5. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Alternaria*: Specimens/photographs and tease mounts.
7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
11. *Marchantia*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
- 12.. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
13. *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
14. *Equisetum*- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
15. *Pteris*- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
16. *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
17. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, , l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

Suggested Readings

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw

Hill, Delhi, India.

6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

7. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad

SKILL PAPER: MUSHROOM CULTIVATION TECHNOLOGY

Total No. of Lectures: 30

Credits: 2

Unit 1: (5 Lectures)

Introduction, history. Nutritional and medicinal value of edible mushrooms;

Poisonous mushrooms. Types of edible mushrooms available in India - *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Agaricus bisporus*.

Unit 2: (5 Lectures)

Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag.

Unit 3: (7 Lectures)

Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, Composting technology in mushroom production.

Unit 4: (8 Lectures)

Storage and nutrition : Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickles, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

Unit 5: (5 Lectures)

Food Preparation : Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value.

Suggested Readings

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.

2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.

3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

First Year- Semester II

Title of Paper: MICROBIOLOGY AND PLANT PATHOLOGY (THEORY)

Total No. of Lectures: 60

Credits: 4

Unit 1: (8 Lectures)

History and scope of Microbiology

General account, distribution and classification of microorganisms.

Unit 2: (12 Lectures)

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance;

Unit 3: (12 Lectures)

Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance. Role of microorganisms in Nitrogen metabolism

Unit 4: (14 Lectures)

History of Plant Pathology. Modes of Infection and general symptoms, physiology of parasitism, defense mechanism in plants, role of environment in disease development. Control measures of plant diseases. Disease resistance in plants.

Unit 5: (14 Lectures)

General symptoms and control measures for the following plant diseases: Citrus canker, TMV, wilt of tomato, bacterial blight of rice, mosaic of sugarcane and little leaf of brinjal. Late blight of potato, Wilt of *Cajanus cajan*, Loose smut of Wheat, Covered smut of Barley, Green ear disease of bajra, downy mildew of crucifers, rusts of pea and linseed, smut of bajra,

PRACTICAL

(Credits 2)

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of plant diseases with help of infected plant specimen - TMV, citrus canker, little leaf of brinjal, loose smut of wheat, downy mildew of crucifers, rust of pea, smut of bajra.

Suggested Readings

1. Brock Biology of Microorganisms, 13th edition (2012)
2. Stainier, R.Y. General Microbiology 5th edition (2009) Mc Millan Press Ltd., Hound Mills
3. Talaro, K.P., Chess, B., 2011. Foundation in Microbiology. 8th edition. McGraw-Hill
4. Prescott, Harley and Klein's Microbiology 7th edition (2008). Mc GRAW Hill. Singapore
5. Agrios, G.N., 1988. Plant Pathology, Academic Press, London.
6. Lucas, John, A., 1998. Plant Pathology and Plant Pathogens, Wiley-Blackwell, CRC Press.
7. Singh, R.S. Plant diseases, 9th edition (2009). Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi

Second Year- Semester III

Title of Paper: PLANT PHYSIOLOGY AND BIOCHEMISTRY (THEORY)

Total No. of Lectures: 60

Credits: 4

Unit 1:

Plant-water relations (8 Lectures)

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Unit 2: Mineral nutrition (8 Lectures)

Essential elements, macro and micronutrients; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps. Sugar translocation

Unit 3: Photosynthesis (12 Lectures)

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

Unit 4: Respiration (10 Lectures)

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 5: Plant growth regulators (12 Lectures)

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Plant response to light and temperature (6 Lectures)

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

Unit 6: (10 Lectures)

Enzymes: Structure and properties; Mechanism of enzyme action, coenzymes, allosteric enzyme, isozymes, enzyme inhibition.

Biologically important molecules: Carbohydrates, Amino acids, Proteins and Lipids.

PRACTICAL**(Credits 2)**

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O₂ evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Separation of amino acids by paper chromatography.

Demonstration experiments (any four)

1. Bolting.
2. Effect of auxins on rooting.
3. Suction due to transpiration.
4. R.Q.
5. Respiration in roots.

Suggested Readings

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
4. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007) Biochemistry (Sixth Edition) W.H. Freeman & Company, New York.
5. Cox, M.M. and Nelson DL (2004) Lehninger Principle of Biochemistry (Third Edition) MacMillan Worth Publishers.
6. Dennis, D.T. & Turpin, D.H. (1993) Plant Physiology, Biochemistry and Molecular Biology. Longman Scientific & Technical, England.

MULTI-DISCIPLINARY COURSE I: FLORICULTURE**Total No. of Lectures: 30****(Credits 2)****Unit 1: (2 Lectures)**

Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

Unit 2: (8 Lectures)

Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

Unit 3: (4 Lectures)

Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai.

Unit 4: (8 Lectures)

Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India. Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

Unit 5: (8 Lectures)

Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Liliun, Orchids).
Diseases and Pests of Ornamental Plants.

Suggested Readings

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

Second Year- Semester IV**Title of Paper: PLANT TAXONOMY AND PLANT EMBRYOLOGY (THEORY)****Total No. of Lectures: 60****Credits: 4****Unit 1: Introduction to plant taxonomy (10 Lectures)**

Identification, Classification, Nomenclature.

Taxonomic hierarchy

Ranks, categories and taxonomic groups

Identification

Functions of Herbarium, important herbaria and botanical gardens of the world and India;

Documentation: Flora, Keys: single access and multi-access

Taxonomic evidences from palynology, cytology, phytochemistry and molecular data.

Unit 2: Botanical nomenclature (12 Lectures)

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Classification: Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Biometrics, numerical taxonomy and cladistics

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Unit 3: Taxonomy, important distinguishing characters, classification, and economic importance of the following families: (10 Lectures)

Ranunculaceae, Papaveraceae, Caryophyllaceae, Malvaceae, Rutaceae, Fabaceae, Apiaceae, Solanaceae, Apocyanaceae, Asclepidiaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Poaceae.

Unit 4: Structural organization of flower (14 Lectures)

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Pollination and fertilization: Pollination mechanisms and adaptations; Double fertilization;

Seed-structure appendages and dispersal mechanisms.

Unit 5: Embryo and endosperm (14 Lectures)

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo endosperm relationship.

Apomixis and polyembryony: Definition, types and practical applications.

PRACTICAL

(Credits 2)

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification): Brassicaceae -Brassica, Alyssum / Iberis; Asteraceae -Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax; Solanaceae -Solanum nigrum, Withania; Lamiaceae -Salvia, Ocimum; Liliaceae -Asphodelus / Lilium / Allium.
2. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).
3. Taxonomic treatment of plant species belonging to families mentioned in the syllabus.

4. Study of taxonomic terminology
5. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
6. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous.
7. Female gametophyte: Polygonum (monosporic) type of Embryo sac Development (Permanent slides/photographs).
8. Ultrastructure of mature egg apparatus cells through electron micrographs.
9. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
10. Dissection of embryo/endosperm from developing seeds.
11. Calculation of percentage of germinated pollen in a given medium.

Suggested Readings

1. Simpson, M.G. (2006). Plant Systematics. Elsevier Academic Press, San Diego, CA, U.S.A.
2. Singh, G. (2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.
3. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.

MULTI-DISCIPLINARY COURSE: ETHNOBOTANY

Total No. of Lectures: 30

(Credits 2)

Unit 1: (6 Lectures)

Ethnobotany

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses.

Unit 2: (6 Lectures)

Methodology of Ethnobotanical studies

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

Unit 3: (07 Lectures)

Role of ethnobotany in modern Medicine

Medico-ethnobotanical sources in India; Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) a) *Azadirachta indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern

medicine with special example *Rauvolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*.

Unit 4: (03 Lectures)

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 5: (8 Lectures)

Ethnobotany and legal aspects

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Suggested Readings

- 1) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
- 2) S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
- 3) Lone et al., Palaeoethnobotany
- 4) S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
- 5) S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
- 6) Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
- 7) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996_9).

INDIAN KNOWLEDGE SYSTEM-I: MEDICINAL PLANTS CULTIVATION

Total No. of Lectures: 30

(Credits 2)

Unit 1: (02 Lectures)

History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences;

Unit 2: (08 Lectures)

Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

Unit 3: (05 Lectures)

Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant

Gardens.

Unit 4: (05 Lectures)

Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 5: (10 Lectures)

Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases.

Suggested Readings

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. _Agrobios, India.

Third Year- Semester V

Title of Paper: PLANT ECOLOGY AND ENVIRONMENTAL POLLUTION (THEORY)

Total No. of Lectures: 60

Credits: 4

Unit 1: (10 Lectures)

Introduction to ecology

Abiotic environment: Atmosphere, Temperature, Water, Light and Soil (structure and soil profile)

Unit 2: (12 Lectures)

Biotic environment: Interaction between plants, animals and man; Interactions among plants growing in a community; Interactions among plants and microorganisms. Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.

Unit 3: (12 Lectures)

Plant communities

Characters; Ecotone and edge effect; Ecological Succession; Processes and types.

Phytogeography (3 Lectures)

Principle biogeographical zones; Endemism

Unit 4:

Ecosystem (14 Lectures)

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Unit 5: (12 Lectures)

Environmental pollution: Water Pollution: Sources and kinds, impact of pollution on aquatic ecosystems, eutrophication; Air Pollution: Sources and kinds, impact of air pollution on plants and ecosystems. Soil Pollution: Sources and kinds, impact on plants and ecosystems

PRACTICAL**(Credits 2)**

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (four each).
(b) Study of biotic interactions of the following: Stem parasite (*Cuscuta*), Root parasite (*Orobancha*), Epiphytes, Predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law.

Suggested Readings

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Odum and Barrett, Thomson, Ed. Brooks/Cole, Fundamentals of Ecology, Cengage Learning
4. Singh, Singh and Gupta Ed., Ecology, Environment and Resources Conservation, , Anamaya Pub., New Delhi

MULTI-DISCIPLINARY COURSE II: BEE FARMING**Total No. of Lectures: 30****(Credits 2)****Unit 1: (6 Lectures)**

1. Apiculture: An introduction; traditional, modern and commercial beekeeping.
2. History and future prospects of apiculture.
3. Outline of bee keeping occupation.
4. Importance of apiculture, honeybee products and their values.

Unit 2: (7 Lectures)

5. Brief account on morphology of honeybee body parts, colony organization and division of labour.
6. Species of honey bees and their nesting behaviour.
7. Structure of bee hive and other beekeeping equipments.

Unit 3: (5 Lectures)

8. Seasonal management of honeybees.
9. Swarming, absconding and robbing and methods to check them.

Unit 4: (6 Lectures)

10. Multiplication of honeybee colonies and their migration.
11. Bee diseases, enemies and their control.

Unit 5: (6 Lectures)

12. Bee flora
13. Bees and pollination.
14. Harmful effects of insecticides on honey bees.

Suggested Readings

1. Abrol, D.P. (1997). Bees and beekeeping in India. Kalyani Publishers, Ludhiana, India.
2. Atwal, A.S. (2001). Essential of Bee Keeping and Pollination. Kalyani Publishers, Ludhiana, India.
3. Atwal, A.S. (2001). The World of Honeybees. Kalyani Publishers, Ludhiana, India.
4. Mishra, R.C. (1995). Honeybees and their Management. ICAR Publications, New Delhi.
5. Tiwari P, Tiwari, J.K. and Rawat, D.S. (2021). Maun Paalan: Parvatiya mahilaon ke liye ek sah-vyawsaay. P.K. Publishers & Distributers, Delhi.
6. Winston, M.C. (1987). The Biology of the Honeybee. Harward University Press, Cambridge.
7. Sammataro, D. and Avitabile, A. (1998). Vth Edition 2021. The beekeeper's handbook. Comstock Publishing Associates, NY.
8. Belsare, D. K., Singh R. K., Belsare, S. D. and Deshmukh, R. H. (2019) A textbook of Apiculture (Beekeeping). Himalaya Publishing House.

INDIAN KNOWLEDGE SYSTEM-I: WILD EDIBLES

Total No. of Lectures: 30

(Credits 2)

Unit 1: (Lecture 10)

Introduction, History, Diversity, Importance: present status of wild edible plants in Uttarakhand. Characteristics and ethno botanical uses, sources, nutritive value, bioactivities and health benefits of wild edibles.

Unit 2: (Lecture 12)

Taxonomic Features of important wild edibles plants of Garhwal Himalaya: *Aegle marmelos* (Bael), *Bauhinia variegata* (kachnar), *Berberis asiatica* (Kingod), *Carissia carandas* (karonda), *Cornus capitata* (Bhamor), *Embilica officinalis* (Amla), *Ficus palmata* (Bedu), *Hippophae salicifolia* (Sea buckthorn), *Myrica esculenta* (Kaphal), *Prunus cerasoides* (panyan), *Pyracantha crenulata* (Ghingharu), *Pyrus pashia* (Melu), *Rubus ellipticus* (Hisar or Hisalu), *Spondias pinnata* (Amoda), *Ziziphus mauritiana* (Ber) etc.

Unit 3: (Lecture 08)

Collection, storage, preservation, processing, value addition and marketing of wild edibles; Conservation measures: integrated approach for conservation and sustainability of wild edibles.

Suggested Readings

AOAC. 1984. Official methods of analysis of the Association of Official Analytical Chemists. AOAC, Virginia.

Badhwar R.L. and Fernandes R.R. 1969: Edible Wild Plants of Himalayas, Delhi.

C Gopalan, BV Ramshastri, S C Balasubramaniam, 1989, Nutritive Value of Indian Foods National Institute of Nutrition, Hyderabad.

Rakesh Shah. Edible Plants of North West Himalaya. (Uttarakhand): M/s Bishen Singh Mahendra Pal Singh.

Rangana S.C. 1979. Manual of analysis of fruit and vegetable products. Tata McGraw Hill Publishing Company Limited, New Delhi.

Shabnum Shaheen, Mushtaq Ahmad, and Nidaa Haroon: Edible Wild Plants: An alternative approach to food security..

Sharma B.D. 2014. Himalayan edible medicinal plants: Science and traditional wisdom.

Bishen Singh Mahendra Pal Singh. Singh H.B. and Arora R.K. 1978. Wild edible plants of India. New Delhi, India: ICAR.

Third Year - Semester VI**Title of Paper: CYTOGENETICS AND EVOLUTIONARY PROCESSES (THEORY)****Total No. of Lectures: 60****Credits: 4****Unit 1: (12 Lectures)**

Cell as a unit of Life: cell theory, germplasm theory.

Ultrastructure of plant cell; Cell Organelles- Mitochondria- Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA; Chloroplast_ Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA;

ER, Golgi body & Lysosomes; Peroxisomes and Glyoxisomes. Cell Wall and Cell Membrane- structure, functions, fluidity and models of membrane. Selective permeability of the membrane;

Unit 2: (12 Lectures)

Nucleus: Nuclear Envelope- structure of nuclear pore complex, chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin; nucleolus and ribosome structure (brief)

Cell cycle: mitosis, meiosis; genetic significance of Meiosis.

Mendel's laws of inheritance: Law of segregation, law of independent assortment, deviations from Mendel's laws (Neo-Mendelism)

Interaction of genes: Intragenic and intergenic interactions, incomplete dominance, lethal genes, complementary genes, supplementary genes, inhibitory genes, duplicate genes, epistatic genes

Unit 3: (8 Lectures)

Linkage and crossing over: Interrelationships and importance, crossing over and meiosis, cytological basis of crossing over, crossing over and linkage map.

Sex determination: Bases of sex determination, chromosome theory of sex determination, sex determination in plants.

Synthetic theory of evolution

Unit 4: (10 Lectures)

Chromosome rearrangements: meiotic configurations and genetic consequences of deletion, duplication, inversion and translocation; permanent translocation heterozygosity

Sources and consequences of numerical variations in chromosomes: Aneuploidy, monosomics, trisomics, nullisomics; Polyploidy-autopolyploids, allopolyploids, segmental allopolyploids, autoallopolyploids.

Mutation and mutagens: Types of mutation, molecular basis of mutation, physical and chemical mutagens and mechanism of their action

Unit 5: (8 Lectures)

Karyotype: Concept and components of karyotype, trends of karyotype evolution,

karyotypic changes in speciation and evolution of plant species

Gene mapping: Physical and genetic maps- deletion, linkage, somatic cell fusion and in situ hybridization, methods of gene mapping

Unit 6: (10 Lectures)

Multiple alleles and multiple genes: Multiple allelism- ABO and Rh blood groups in man, eye colour in *Drosophila*, self sterility in plants; multiple gene inheritance- kernel colour in wheat, skin colour in human beings; quantitative characters.

Cytoplasmic inheritance: Maternal influence- coiling in snail shells, kappa particles in *Paramecium*, plastid inheritance in *Mirabilis jalapa*, petites in fungi.

PRACTICAL

Credits 2

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
2. Study of the photomicrographs of cell organelles
3. To study the structure of plant cell through temporary mounts.
4. Study of mitosis and meiosis (temporary mounts and permanent slides).
5. Study the effect of temperature, organic solvent on semi permeable membrane.
6. Demonstration of dialysis of starch and simple sugar.
7. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
8. Study the structure of nuclear pore complex by photograph (from Gerald Karp) Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
9. Study DNA packaging by micrographs.
10. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.
11. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
12. Chromosome mapping using point test cross data.
13. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
14. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).

Suggested Readings

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
5. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. WileyIndia.
6. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.

7. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings
8. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
9. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning.
10. Stebbins, G.L., Variation and Evolution in Plants.
11. Swanson, C. P., Mertz, T.F. and Young, W.J., Cytogenetics: The Chromosomes in Division, Inheritance and Evolution (2nd Edn).

MULTI-DISCIPLINARY COURSE II: SERICULTURE

Total No. of Lectures: 30

Credits: 2

Unit 1: (5 Lectures)

Introduction to Sericulture: Origin and history of sericulture. Silk route and map of India and World; Environmental impact of sericulture: Employment generation in sericulture and role of women in sericulture.

Unit 2: (5 Lectures)

Textile fibers: Natural and Synthetic fibers: Advantage of silk fiber over other fibers: International demand of silk. Function Central Silk Board; Role of State Department of Sericulture (Karnataka, Tamil Nadu, Andhra Pradesh, West Bengal).

Unit 3: (8 Lectures)

Silkworm taxonomy & life-cycle, Silkworm morphology and anatomy, Silkworm crop protection, diseases and pests, Silkworm rearing. Methods of egg storage, incubation. Industrial seed, reproductive seed, certified seed.

Unit 4: (7 Lectures)

Biology of Mulberry: Botanical description of mulberry. Economic importance of mulberry Plant; Morphology and anatomy of mulberry plant, Mulberry crop protection, diseases and pest management.

Unit 5: (5 Lectures)

Non- mulberry Sericulture: Scope, mulberry vs. non-mulberry sericulture; Non-mulberry silkworms (Tasar, Muga, Eri silk) and their distribution in India and other countries. Taxonomy of food plants of non-mulberry silkworms: Life cycle of Tasar, Eri and Muga silkworm.

Suggested Readings

1. Ganga, G., And J. Sulochana Chetty. (1991) An Introduction To Sericulture. Oxford & Ibh

Publishing Company.

2. Hasao Aruga (1994). Principles Of Sericulture (Translated From Japanese) Oxford & Ibh Publishing Co., Pvt. Ltd. New Delhi.
3. Kichisaburo M. (1997) Moriculture – Science Of Mulberry Cultivation. Oxford & Ibh
4. Krishnaswami, S.; Narasimhanna, M.N.; Suryanarayan, S.K And Kumararaj, S. (1973) Sericulture Manual-2 - Silkworm Rearing. Agriculture Service Bulletin, Fao, Rome.
5. Mulberry Crop Protection, Central Silk Board, Bangalore, India
6. Rajanna, L., Das, P.K., Ravindran, S., Bhogsha, K., Mishra, R.K., Singhvi, N.R., Katiyar, R.S. And Jayaram, H. (2005) Mulberry Cultivation And Physiology. Central Silk Board, Bangalore

Fourth Year- Semester VII

Title of Paper: COMPARATIVE STUDIES OF CRYPTOGRAMS (THEORY)

Total No. of Lectures: 60

Credits: 4

Unit 1: Algae

Classification (Fritsch's system) of algae and general characteristics of major classes; Pigmentation and storage products; Thallus organization and evolutionary tendencies; Reproduction and life history types with reference to Chlorophyceae, Phaeophyceae, Rhodophyceae and Cyanophyceae

Unit 2: Fungi

General features of fungi and their classification; Structure, reproduction and life cycle of representative classes of fungi; Types of fungal spores and mode of their liberation; Evolutionary trends in fungi; Economic importance of fungi

Unit 3: Bryophytes

Life histories of bryophytes with reference to *Cyathodium*, *Notothylus*, *Sphagnum* and *Polytrichum*; Vegetative propagation in bryophytes; General account of evolution of sporophyte.

Unit 4: Pteridophytes

Classification of pteridophyta; Stellar evolution in pteridophyta ; Life history of *Psilotum*, *Isoetes*, *Adiantum*, *Ophioglossum*, *Marselia* .

PRACTICAL

Credits 2

1. Study of representative genera of Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina.

2. Symptomatology of at least one diseased specimen of plant pathogens belonging to various fungal classes i.e. Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina,
3. Morphological study of representative members of algae: *Microcystis*, *Lyngbya*, *Cylindrospermum*, *Gloeotrichia*, *Scytonema*, *Pandorina*, *Eudorina*, *Scendesmus*, *Pediastrum*, *Hydrodictyon*, *Ulva*, *Enteromorpha*, *Drapernaldiopsis*, *Stigeoclonium*, *Fritschiella*, *Coleochaete*, *Bulbochaete*, *Cosmarium*, *Caulerpa*, *Nitella*, *Dictyota*, *Gelidium*, *Gracillaria*, *Batrachospermum* and *Polysiphonia*.
4. Study and identification with suitable preparations of bryophytes- *Ricciocarpus*, *Targionia*, *Cyathodium*, *Plagiochasma*, *Asterella* (*Fimbriaria*), *Dumortiera*, *Sewardiella*, *Pellia*, *Fossombronia*, *Porella*, *Calobryum*, *Notothylas*, *Sphagnum*, *Polytrichum* and *Funaria*,
5. Study and identification with suitable preparations of the following pteridophytes *Psilotum*, *Isoetes*, *Ophioglossum*, *Osmunda*, *Polypodium*, *Azolla*, *Salvinia* and important fossil types.

Suggested readings:

1. Gangulee, H.C. and Kar, A.K., 2011, College Botany Vol. II (Algae+Fungi+Bryophyta+Pteridophyta), New Central Book Agency, Kolkata
2. Singh, Pande, Jain, 2010, A Text Book of Botany (Algae+Fungi+Bryophyta+Pteridophyta), Pub. Rastogi Publication, Meerut
3. Rashid, A., 2011, An Introduction to Pteridophyta, 2nd edition, (Reprint), Pub. Vikas Publishing House Pvt. Ltd., Noida.

Fourth Year- Semester VIII

Title of Paper: COMPARATIVE STUDIES OF PHANEROGAMS (THEORY)

Total No. of Lectures: 60

Credits: 4

Section A: Gymnosperm

1. General account of morphology and reproduction of the following: *Zamia*, *Ginkgo*, *Biota* and *Gnetum*.
2. General account of *Williamsonia* and *Pentaxylon*.
3. Phylogenetic trends in Gymnosperms
4. Distribution of living Gymnosperms in India

Section B: Angiosperm

1. Classification of Angiosperms (Hutchinson) and general account of numerical and chemotaxonomy
2. Distinguishing characters of the following families and their economic importance: Annonaceae, Rutaceae, Asteraceae, Convolvulaceae, Scrophulariaceae, Verbenaceae, Polygonaceae, Euphorbiaceae, Zingiberaceae, Liliaceae, Cyperaceae
3. Embryology: General account of polyembryony, apomixis and experimental embryology

with reference to anther and embryo culture

PRACTICAL

Credits 2

1. Study and identification with suitable preparations of the following gymnosperms: *Cycas*, *Ginkgo*, *Abies*, *Cedrus*, *Cryptomeria*, *Cupressus*, *Podocarpus*, *Cephalotaxus*, *Araucaria*, *Taxus*, and *Gnetum*.
2. Palaeobotany: Study of available fossil flora through specimens and slides, etc.
3. Taxonomy
 - a. Identification and description of locally available plants belonging to families included in the syllabus from fresh specimens, herbarium or preserved materials. After identification up to family level any suitable regional Flora may be provided for generic identification if required.
 - b. Description of a species based on various specimens to study intra specific variation.
 - c. Studies to find out the location of key characters and preparation of keys at generic level.
 - d. Field trips, compilation of field notes, the preparation of herbarium sheets and submission of herbarium and museum specimens and/or live potted specimens of taxonomic interest and submission of the excursion report.

Suggested readings:

1. Singh, V. and Jain, D.K., Taxonomy of angiosperms. Rastogi Publication, Meerut
2. Sporne, K.R., Morphology of Gymnosperms, B.I. Publication, New Delhi
3. Bhojwani, S.S. and Bhatnagar, S.P., Embryology of Angiosperms, Vikash Publishing House, New Delhi
4. Singh, Gurucharan, Plant Systematics- Theory and Practices, Oxford and I.B.H. Publishing Co. New Delhi
5. Judd, W.S., Christopher, S., Campbell., Kellogg, A.E., Stevens, P.F., 1999. Plant Systematics: A Phylogenetic Approach. Sinauer Associates Inc. Publishers.
6. Simpson M. G. 2006, Plant Systematics. Elsevier Academic Press.