

BOT 501: BIOLOGY & DIVERSITY OF BRYOPHYTES, PTERIDOPHYTES & GYMNOSPERMS

Unit I. Bryophytes: Systems of classification, distribution, Economic importance. Habitat, external and internal morphology, reproduction, gametophytes and sporophytes, phylogeny and interrelationships of the orders: Sphaerocarpales, Takakiales, Marchantiales and Jungermanniales, Anthocerotales, Sphagnales, Andreales and Bryales.

Unit II. Pteridophyta: Classification, Origin and evolution, Phylogenetic relationship with Bryophyta. Morphology, anatomy, phylogeny and interrelationships of the orders Psilopsida-Psilotales and Psilophytales, Lycoposida- Lycopodiales, Selaginellales, Isoetales, Equisetopsida – Equisetales and Pteropsida- Filicales.

Unit III. Sporophyte and gametophyte in Pteridophytes, Stellar organization and evolution, Origin of leaf and Telome concept, Sporocarp, Heterospory and seed habit, Comparison of Pteridophyta with Bryophyta and Gymnosperms.

Unit IV. Gymnosperms: Introduction, Classification and distribution of Gymnosperms, Morphology, anatomy, reproduction, phylogeny of the orders Pteridospermales (Caytoniaceae, Medullosaceae) Bennettitales (Williamsoniaceae, Cycadeoideaceae) Cycadales (Cycadaceae) Ginkgoales (Ginkgoaceae) Coniferales (Pinaceae, Araucariaceae) Taxales (Taxaceae) Gnetales (Gnetaceae) and Economic importance of gymnosperms.

Unit V. Paleobotany: Introduction, Contributions of Prof. Birbal Sahani, Geological time scale, Fossils and fossilization, Continental drift/ plate tectonics.

PRACTICALS BASED ON BOT 501: BRYOPHYTES, PTERIDOPHYTES & GYMNOSPERMS

i. **Vegetative Organization:** *Marchantia, Riccia, Anthoceros, Sphagnum, Polytrichum.*

ii. **Anatomical Organization:** *Marchantia, Cyathodium, Anthoceros, Sphagnum.*

iii. **Archegonia and Antheridia and their Organization:** *Riccia, Marchantia, Anthoceros, Sphagnum.*

iv. **Sporophytes:** *Riccia, Marchantia, Pellia, Anthoceros, Funaria, Sphagnum, Polytrichum.*

Pteridophytes: Morphological and anatomical studies of 1) *Psilotum* 2) *Lycopodium*. 3) *Selaginella*, 4) *Isoetes*, 5) *Equisetum*, 6) *Ophioglossum*, 7) *Osmunda*, 8) *Gleichenia*, 9) *Pteris*, 10) *Adiantum*, 11) *Marselia*, 12) *Salvinia*, 13) *Azolla* and additional forms/species collected during study tour.

Gymnosperms : Study of the vegetative and reproductive parts, including anatomy of the following genera : *Cycas, Zamia, Pinus, Cedrus, Taxodium, Cryptomeria, Cupressus, Thuja, Juniperus, Podocarpus, Cephalotaxus, Agathis, Araucaria, Taxus, Ginkgo, Gnetum.*

SUGGESTED READINGS:

- Agashe, S. N. (1995) Paleobotany, Oxford & IBH, New Delhi
- Bir, S. S. (2005) Pteridophytes their Morphology, Cytology, Taxonomy and Phylogeny. Today & Tomorrow's Printers and Publisher.
- Biswas, C. and B. M. Johri (2004) The Gymnosperms, Narosa Publishing House, New Delhi
- Campbell, C. J. (1940) Evolution of land Plants, Stanford University Press.
- Coulter J. M. and C. J. Chamberlain (1978) Morphology of Gymnosperms, Central Book Depot, Allahabad
- Eames, A. J. (1974) Morphology of Vascular Plants- lower groups, Tata Me Graw-Hill Publishing Co. New Delhi.
- Foster, A. S. & F. M. Gifford (1967) Comparative morphology of vascular plants, Freeman Publishers, San Fransisco.
- Kakkar, R. K. and B. R. Kakkar (1995) The Gymnosperms (Fossils and Living) Central Publishing House, Allahabad.
- Kashyap S. R. (1932) Liverworts of Western Himalayas and the Plains. Vol. I & II, The University of Panjab, Lahore.
- Parihar, N. S. (1991) Bryophytes, Central Book Dept., Allahabad.
- Parihar, N. S. (1976) The biology and morphology of the pteridophyta, Central Book Depot, Allahabad.
- PuriPrem (2005) Bryophytes Morphology, Growth and Differentiation- Pulisher- Atmaram and Sons New Delhi
- Rashid, A. (1976) An introduction to pteridophyta, Vikas Publishing House Ltd., New Delhi.
- Sambamurty A. V. S. S. , (2005) A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany, Today & Tomorrow's Printers and Publishers
- Sharma O. P. (2002) Gymnosperms, PragatiPrakashan, Meerut.
- Sharma P. N. and Sahni K. C. (2005) Gymnosperms of India and Adjacent Countries Publisher- Bhisnan Singh Mahendra Pal Singh, Dehradun
- Tewari, Shiv Datt and GiriBala Pant (2005) Bryophytes of Kumaun Himalaya. Publisher-Bhisnan Singh Mahendra Pal Singh- Dehradun
- Siddiqui K. A. (2002) Elements of Paleobotany, KitabMahal, Allahabad.
- Smith, G. M. (1976) Cryptogamic Botany - Vol. II, Tata Me Graw-Hill Publishing Co. Ltd. New Delhi.
- Sporne, K. R. (1976) Morphology of Pteridophyta. Hutchinson University Library, London.

BOT 502: ECOLOGY & CONSERVATION

Unit I i. An introduction to plant ecology and its scope.

ii. **Structure of ecosystem:** Abiotic components (climatic factors, Topographic/factors, Edaphic factors); Biotic components (Interactions among organisms, Autotrophs and Heterotrophs) Ecological Pyramids (Pyramid of numbers, Biomass and energy)

iii. **Functions of ecosystem:** Productivity (Primary and secondary productivity, food chains, Grazing and detritus food chains) food webs. Biogeochemical cycles: C, N, P and S.

Unit Ii. Community ecology: Classification, Analysis of communities, characteristics of communities, species diversity, Growth form and structure, origin, development and composition.

ii. Competition and coexistence, intra-specific interactions, interspecific interactions, scramble and contest competition model, mutualism and commensalism, prey-predator interactions.

Unit Ii. Biogeography: Major biomes of the World -Terrestrial, Tundra, arboreal coniferous forests, temperate and tropical grasslands and deciduous forests, Mediterranean and Desert vegetation, Tropical rain forests; Aquatic Ecosystems- Fresh water, Estuarine and marine. Endemism and hotspots of biodiversity.

Unit IV.i. Environmental pollution in relation to air, water and soil. Use of fertilizer, pesticides and other chemicals in agriculture and hygiene and their disposal.

ii. Climate change: Greenhouse gases, their sources, trends and role, Ozone layer and its depletion (Global warming, Sea level rise, UV radiation) acid rain, Bioindicator and biomarkers of environmental health.

iii. Concepts of ecological management and sustainable development.

Unit V. i. Biodiversity: Concept, types and situation in India. IUCN categories.

ii. **Strategies of conservation:** *In situ* conservation, protected regions in India: Sanctuaries, National parks, Wetlands, Sacred groves, mangroves for conservation of wild biodiversity. *Ex situ* conservation: Principles and practices, Botanic gardens- Definitions, Criteria and types; Important Botanic Gardens in India and World, BGCI, gene bank, seed banks, cryobanks.

Unit VI.i. General activities of Botanical Survey of India (**BSI**) and National Bureau of plant Genetic Resources (**NBPGR**) for conservation efforts.

ii. Biological Diversity Act 2002; Forest Conservation Act 1980, Wild Life Protection Act 1972 and related international conventions.

PRACTICALS BASED ON BOT 502: ECOLOGY & CONSERVATION

1. To calculate mean, variance, standard deviation, standard error, coefficient of variation and to use 't' test for comparing two means related to ecological data.
2. To find out relationship between two ecological variables using co-relation and regression analysis.
3. To find out association between important grassland species using chi-square test.
4. To determine minimum size and number of quadrates required for reliable estimate of biomass in grassland.
5. To determine diversity indices (Shannon-Wiever concentration of dominance) for protected and unprotected grass land stands.
6. To estimate IVI of the species in a wood land using point centerquadrate method.
7. To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.
8. To determine the water holding capacity of soils collected from different locations.
9. To estimate the DO content in water samples by Winkeler's method.
10. To estimate chlorophyll content in SO₂ fumigated and non-fumigated plant leaves.
11. Visits to different ecosystems and submission of report.
12. Scientific visits to laboratories / Industries / Research Institutes working in conservation of plants and submission of report.

SUGGESTED READINGS:

Ambasht, R. A. (1990) A text book of Plant Ecology, Students Friends & Co., Varanasi.

Benny Joseph (2005) Environmental Studies, Tata McGraw Hill Publishing Co., Ltd., New Delhi.

Conklin, A. R. Jr. (2004) Field Sampling: Principles and Practices in Environmental Analysis. CRC Press.

Fahey, T. J. and Knapp, A. K. (2007) Principles and Standards for Measuring Primary Production. Oxford.

Grant, W. E. and Swannack, T. M. (2008) Ecological Modeling. Blackwell.

Koromondy, E. J. (2005) Concepts of Ecology. 4th Ed. Prentice Hall of India, New Delhi.

Muller, Dombosis, D. and H. Ellenberg (1974) Aims and methods of vegetation ecology, Wiley, New York.

Mungikar, A. M. (2003) Biostatistical Analysis. Saraswati Printing Press. Aurangabad.

Odum E. P. (1971) Fundamentals of Ecology, Saunders, Philadelphia.

Rajagopalan, R. (2005) Environmental studies, Oxford University Press, New Delhi.

Ramkrishna, P. S. (2001) Ecology and Sustainable Development. National Book Trust, New Delhi.

Sharma, P. D. (2001) Ecology and Environment, Rastogi Publications. Meerut.

Stiling, Peter. (2004) Ecology- Theories and Applications. 4th Ed. Prentice Hall of India, New Delhi.

Trivedi, P. R. (1999) Encyclopedia of Ecology and Environment. Vol. 1 - 10, Indian National Green Party, New Delhi.

Trivedi. R. K., Goel P. K., Trisal C. L. (1998) Practical Methods in Ecology and Environmental Science: Enviro-media Publisher, Karad

Wilkinson, D. M. (2007) Fundamental Processes in Ecology: An Earth system Approach. Oxford.

Wyse Jackson, P. S. and Sutherland, L. A. (2000) International Agenda for Botanic Gardens in Conservation, Botanic Garden Conservation International (BGCI) UK

Yadav, Manju (2003) Ecology. Discovery Publishing House, New Delhi.

WEBSITES:

www.nbaindia.org

www.envfor.nic.in

www.moef.nic.in

www.bgci.org.uk

www.bsi.nic.in

www.bsienvi.nic.in

www.nbpgr.ernet.in

www.maharashtrastatebiodiversityboard.gov.in

www.iucn.org

www.iucnredlist.org

www.iucnredlistecosystems.org

www.conservation.org

www.biodiversity-a-z.org

BOT-521- (Elective-A)

Crop genetics and Plant breeding-I

Unit I: Crop genetic resources: Importance of genetic Conservation, global network for genetic conservation and utilization in major crops of the world. Institutes engaged in conservation and improvement of crop genetic resources.

Unit II: Food supplies, nutrition and crop breeding: World food situation, nutritional problems, Nutritional objectives.

Unit III: Methods of plant breeding: Introduction, selection, (Pure line selection, W. L. Johansons experiments on beans and their significance, Variety acclimatization, genetic significance of pollination methods, methods of breeding self and cross pollinated crops and asexually and vegetatively propagated crops.

Unit IV: Incompatibility in plant breeding: Types, nature, characteristics genetic and biochemical basis, methods of induction and overcoming, incompatibility as a tool in breeding crops.

Unit V:

1. **Male sterility:** Definition and classification, Male sex expression and chemical Induction of male sterility, perspectives.

2. **Back cross:** Genetic basis, Methodology in selection to character under transfer, Transfer of two or more characters, Inter-varietal. Inter-specific and intergeneric transfer.

BOT 522 – (Elective –A)

Crop genetics and plant breeding - II

Unit I Heterosis breeding: i) Historical aspects, ii) Interbreeding depression, iii) Homozygous and heterozygous balance, iv) Genetic basis of inbreeding, v) Genetic and physiological basis of heterosis, vi) Heterosis and plant breeding.

Unit II. Mutagenesis and Mutation Breeding:

A. **Mutagenesis:** Spontaneous mutations, mutation frequency, Physical mutagens, ionizing and non-ionizing radiations, radio-sensitivity, cytological and genetic effects, chemical mutagens, mutagenic compounds, mode of action, molecular basis of mutations. Ames test. *In - vitro* site directed mutagenesis

B. **Mutation Breeding:** i) Historical perspective, ii) The nature and chemical basis of mutation, iii) Physical and chemical mutagenesis, iv) Mutagenic treatment schedules, v) Screening of mutation in population, vi) Frequency and spectrum of mutants, micro and macro mutants, vii) mutagenic effectiveness and efficiency, viii) environmental mutagenesis repair mechanism, ix) Role of mutations in crop improvement programme.

Unit III.

1. **Resistance breeding:**

A. Disease resistance-nature, mechanism of resistance, methodology problems and achievements.

B. Insect resistance: Nature, mechanism of resistance, methodology, problem and achievements.

C. Drought resistance, importance, types, nature of resistance methods and examples.

2. **Quality breeding:** A. Nature of quality B. Genetic and biochemical basis C. Genetic manipulation of quality and quantity.

Unit IV. Distant Hybridization: a) Importance, b) Interspecific, intergeneric gene transfers, methodology, problem and remedial measures, c) Man made species.

Unit-V. Seed production and distribution: Introduction variety evaluation, variety maintenance, availability of new varieties, seed production and regulation, seeds industry development. Breeding crops with special reference to Marathwada region like wheat. Jowar, Bajra, Cotton, Groundnut, Safflower etc.

PRACTICALS BASED COURSE – BOT 521 AND BOT 522 (ELECTIVE A)

1. Study of floral biology of different crop plants.
2. Demonstration of hybridization technique in self and cross pollinated crops.
3. Study of pollen germination and demonstration of incompatibility.
4. Demonstration of male sterility in Jowar.
5. Study of pollen fertility.
6. Study of pollen viability.
7. Karyotype analysis in crop plants.
8. Aneuploid analysis in crop plants.
9. Induction of polyploidy in crop plants.
10. Study of seed protein profile by native and SDS-PAGE.
11. Estimation of oils from edible oil crops.
12. Estimation of leaf proteins, seed proteins in diploids and polyploids.
13. Mutagenesis: Introduction of mutations through physical / Chemical mutagenic treatments and raising M_1 & M_2 generations. Assess in the effect of mutagens on different M_1 parameters and M_2 chlorophyll viable mutant frequency and spectrum.
14. Study of mutagenesis data published in different journals and arriving at logical conclusions by providing theoretical reasons.
15. Designing of field experiments.

SUGGESTED READINGS

1. Plant Breeding - B. D. Sitigi.
2. Plant Breeding - J. R. Sharma.
3. An Introduction of plant breeding - H. K. Chaudhary.
4. Evolution of crop plants -Edited by Simmonds N. W (1986)
5. Breeding field crops - Poehlrnann and Sleper.
6. Plant Breeding perspectives - Edited by Sheep and Mendnkasen.
7. Crop Breeding, P. B. Vose and S. G. Blixt
8. Genes. Chromosomes and Agriculture. Chrispels and Simmonds.
9. Principles of Genetics - Snusted and Simulants.
10. Manual of mutation breeding by FAO/IAEA.
11. Mutation Research -Aurebach.
12. Chemical mutagenesis - Fishbeiri et al.
13. Discussions in cytogenetics. Burnhan C. R. 1962 -
14. Genetics - Principles and analysis. Khush G. S. 1973 -
15. Genetics Principles and analysis. Haiti and Jones 1998 -
16. Molecular biology of the gene. Watson J. D. 1989

BOT- 521 – (Elective B)

Plant Pathology-I

Unit I. Nature, origin and evolution of parasitism: Interrelationship of parasitism and pathogenicity; physiology of pathogenicity; Natural process of pathogenesis, evolution of parasitism and pathogenicity. Effect of environment on different classes of parasitism; law of host - parasite balance, host genetics in relation to type of pathogenicity; search for effective disease control.

Unit II. Plant disease diagnosis:

Field observations, laboratory investigations, isolation and purification of plant pathogens, Koch's postulates; identification of plant pathogens.

Unit III Classification of Plant diseases:

Based on crop plants, symptoms, causal organisms.

Unit IV. Symptoms, etiology and disease cycle of diseases caused by:

a) Mastigomycotina:

Damping off of seedlings, Rhizome rots of ginger, early blight of potato, white rust of crucifers, Downy mildew of Bajra, Downy mildew of grapes.

b) Ascomycotina:

Stem galls of coriander, leaf spot of turmeric, powdery mildew of grapes, Ergot of Bajra.

Unit V. Symptoms, etiology and disease cycle of diseases caused by

a) Basidiomycotina :

Loose smut of wheat, Bunt of wheat, Kernel bunt of Rice, Head smut of Jowar, Grain smut of Jowar, Whip smut of sugarcane. Rust: Rust of wheat, Rust of Bajra, Rust of groundnut

Unit VI. Symptoms, etiology and disease cycle of diseases caused by Deuteriomycotina:

Early blight of potato, leaf spot of crucifers, tomato and brinjal caused by *Alternaria*, Tikka disease of groundnut, *Helminthosporium* leaf spot on Rice; Blast of Rice, Red rot of sugarcane Die back of chilli, Wilt of Pigeon pea, Panama disease of Banana, Blight of gram, *Rhizoctonia* stem rot of crops.

BOT- 522 – (Elective B)

Plant Pathology-II

Unit I. History: Beginning of modern plant pathology; Contribution of Anton De Bary; Benedict Prevost; J.C. Kuhn; M.S. Woromin; B.C. Stakman; Paul Neergaard, P.H. Gergory, K.C. Mehta. History of the development of plant pathology in India; plant disease clinics.

Unit II. Agents of infections and diseases:

i. Biotic agents: Bacteria, viruses, fungi, mycoplasma, nematodes.

ii Abiotic agents: Air pollution; mineral elements, temperature, toxic effects of improperly used chemicals.

Unit III. Phytoplasma diseases: Symptoms and disease cycle of little leaf of brinjal; Sesamum phyllody, Witches broom diseases, Grassy shoot of sugarcane.

Unit IV. Viral diseases: Symptoms produced by viruses on plants, study of plant virus disease; Tobacco mosaic, leaf curl of tomato, papaya mosaic, yellow vein mosaic of bhendi, Bunchy top of Banana, Tristeza of citrus.

Unit V. Bacterial diseases: symptoms of bacterial diseases on plants. Study of bacterial diseases: Angular leaf spot of cotton, citrus canker, Gummosis,, of sugarcane, Bacterial wilt of solanaceous vegetables. Halo blight of bean, Soft rots of fruits.

Unit VI. Non parasitic diseases: Non infectious diseases of plants, Nutritional deficiencies, Blossom rot of tomato, mango black tip, zinc deficiency of citrus.

Unit VII. Dispersal of plant pathogens: Direct transmission; Indirect transmission; Plant disease epidemiology; Some important epiphytotic; Methods used in plant disease forecasting.

Unit VII. Enzymes of plant pathogens: Cell wall degrading enzymes; Proteolytic enzymes - Macerating enzyme, Polygalacturonase, Pectin esterase; trans-aminase and their role in disease development. Cellulolytic enzymes and their role in disease development.

Practical Course-Bot 521 and 522(Elective B)

1. Collection and preservation of diseases specimens.
2. Symptomology, histopathology of disease given in theory.
3. Virulence test for pathogens.
4. Production and assay of macerating enzymes.
5. Production and assay of polygalactronase, cellulolytic enzymes, amylase.
4. Visits to fields for study of diseases.

Suggested readings Bot 521 and 522(Elective B)

1. Agrios, G.N. (1969) Plant Pathology, Academic Press, New York.
2. Rangaswami, G. and A. Mahadevan (2001) Disease of crop plants in India, Printic Hall of India, Pvt. Ltd., New Delhi.
3. Gupta, V.K. and V.S. Paul (2001) Disease of vegetable crops. Kalyani Publ. Ludhiana,
4. Gupta, V.K. and S.K. Sharma (2000) Disease of fruit crops, Malyani Publ. Ludhiana.
5. Raychaudhari, S.P. and T.K. Nariani (1977), Virus and Mycoplasma disease of plants in India. Oxford and IBK Publ. Corp., New Delhi.
6. Bos L. (1999), Plant viruses, unique and intriguing pathogens. Backhugs Publ. Leiden.
7. Rangaswami, G. and S. Rajagopalan (1973), Bacterial plant pathology, T.N. Agri. Uni. Coimbatore.

TAXONOMY OF ANGIOSPERMS-I

UNIT-I: Taxonomy; Aims and objectives of taxonomy, functions and phases of taxonomy; taxonomy as synthetic discipline (passing remarks), Characteristic features of angiosperms

UNIT-II: Phylogeny of angiosperms: monophyletic and polyphyletic origin of angiosperms, herbaceous origin hypothesis, origin of monocotyledons; molecular evidence to angiosperm origin, cradle of angiosperms.

UNIT-III: Taxonomic hierarchy: it's major, minor and infraspecific categories and ranks
A brief history of Pre-Darwinian and post Darwinian systems of classification with special emphasis on Thorne and Cronquist's systems of classification

UNIT-IV: Concept of taxonomic character: analytical and synthetic, qualitative and quantitative, genetically and environmentally controlled, good and bad character, character weighing, taxonomic coefficient

UNIT-V: Trends in evolution of characters: in flowering plants in habit and habitat, phyllotaxy, stomatal apparatus, nodal anatomy, xylem, phloem, cambium, vascular cambium, inflorescence, flower, androecium, gynoecium, pollination, fertilization, placentation, fruit, seed and seedling.

UNIT-VI: Phylogenetic relationship: Primitive and advanced characters, monophyletic, paraphyletic and polyphyletic, homology and analogy, parallel and convergent evolution, plesiomorphic and apomorphic characters. **Cladistics:** Operational Taxonomic Units (OTU) characters and coding, measuring of similarity, cladograms.

UNIT-VII: History of botanical explorations in Maharashtra and Marathwada. Contributions of Botanical Survey of India.

TAXONOMY OF ANGIOSPERMS-II

UNIT-I: The concepts of species; plant speciation: allopatric/ abrupt/ sympatric/ hybrid/ apomictic speciation and isolation mechanism. Types of speciation: quantum, catastrophic, local, geographic and phyletic. Causes of variation in population, ecotypes and ecads, evolution and differentiation of species, adaptive radiations.

UNIT-II: Botanical Nomenclature: Scientific names: legitimate name, illegitimate name, autonym, homonym, synonym, basionym, tautonym, alternative name, ambiguous name, superfluous name, naked name, conserved name, rejected name; procedure to describe new taxon; Latin diagnosis and description, effective and valid publication, coining of generic names and specific epithets; citation of names of author(s) ; Scientific Journals in plant taxonomy.

UNIT-III: Taxonomic evidences: Morphology, micro-morphology, ultrastructure systematics- SEM and TEM studies, anatomy, embryology, palynology, cytology, ecology, population biology, phyto-chemistry, molecular biology and numerical taxonomy.

UNIT-IV: Herbarium: History, Objectives and function of an herbarium, Types of herbaria, role of herbarium in Systematics, Floristics, Teaching, Research, Assessment and documentation of phyto diversity and Public Education, pests in herbarium and its control. Contribution of "BAMU" Herbarium

UNIT-V: Botanic Gardens: Definition, criteria, history and role of botanic gardens, special types of botanic gardens: Arboretum, Pineatum, Orchidarium, Bambusetum, Fernary. Important Botanic Gardens in India and World.

UNIT-VI: Comparative account on distribution, floral morphology, interrelationships of families belonging to the following order as per Engler's system of classification:

- | | | | |
|-----------------|-----------------|-----------------|-----------------|
| a) Magnoliales, | b) Alismatales, | c) Liliales, | d) Asparagales, |
| e) Poales, | f) Zingiberales | g) Ranunculales | h) Malpighiales |
| i) Fabales | j) Cucurbitales | | |

Practicals based on BOT-521C & BOT-522 (Elective C)

TAXONOMY OF ANGIOSPERMS I & II

1. Description of species based on many specimens to study intraspecific variation.
2. Study of morphology and general evolutionary trends in flowers, stamens and carpels of primitive families viz. Magnoliaceae, Papaveraceae, Nymphaeaceae, Lauraceae
3. Study of different types of ovules, placentation and evolutionary trends therein
4. Exercises on nomenclature problems: Author citation, principle of priority, transfer of taxa, effective and valid publication.
5. Describing new taxon, deposition of type, Latin diagnosis and abbreviations used in citations.
6. Semi-permanent pollen preparations by acetolysis method and study of different pollen morphotypes.
7. Taxonomic distribution of special units of pollen dispersal- bi celled pollen, tetrads, polyads and pollinia and pollen types.
8. Study of plant surface attributes with the help of SEM photographs.
9. Descriptions, sketching, classification and identification of at least 30 families represented in local flora.
10. Classification and identification of at least 5 species of some of the genera like *Alysicarpus*, *Amaranthus*, *Cassia*, *Chlorophytum*, *Commelina*, *Cyperus*, *Euphorbia*, *Indigofera*, *Leucas*, *Sida*, *Solanum*.
11. Several One-day botanical excursions to botanically rich locations.
12. Botanical excursion of about one week to any botanically rich location preferable outside the State.

SUGGESTED READINGS:

1. AHMEDULLAH, M., AND M. P. NAYAR. 1987. Endemic Plants of the Indian Region. Vol. I. Botanical Survey of India. Howrah.
2. BHOJWANI, S. S. AND BHATNAGAR, S. P. 1984. Embryology of Angiosperms. Vikas Publ. House, New Dehli.
3. BILGRAMI, K. S. AND J. V. DOGRA. 1990. Phyto-Chemistry and Plant Taxonomy. New Delhi, CBS Publishers
4. CRONQUIST, A. 1988. The Evolution and Classification of Flowering Plants (2nd ed.) Allen Press, U. S. A.
5. DANIEL, M. 2009. Taxonomy: Evolution at work. Narosa Publishing House Pvt. Ltd. New Delhi.

6. DAVIS, P. H., AND V. H. HEYWOOD. 1991. Principles of Angiosperm Taxonomy. Today and Tomorrow Publications, New Delhi
7. DOBSON, A. P. 1996. Conservation and Biodiversity. Scientific American Library. New York, U. S. A.
8. ERDTMAN, G. 1986. Pollen Morphology and Plant Taxonomy: Angiosperms An Introduction to Palynology. Netherland, E. J. Brill, Leiden.
9. FORMAN, L. AND D. BRIDSON. 1989. The Herbarium Handbook. Royal Botanic Gardens, Kew, U. K.
10. GRAHAM, L. E. 1993. Origin of Land Plants. John Wiley & Sons. Inc. New York.
11. GREUTER, W, (Ed.) 2007. International Code of Botanical Nomenclature. (VIENNA CODE) KoeltzVesentific Books. Germany.
12. GROOMBRIDGE, B, (Ed.) 1992. Global Biodiversity: Status of the Earth's Living Resources. Chapman and Hall. London.
13. HENRY, A. N., M. CHANDRABOSE. 1980. An Aid to International Code of Botanical Nomenclature. Today & Tomorrow's Printers and Publishers. New Delhi.
14. HEYWOOD, V. H. 1995. Global Biodiversity Assessment. Cambridge University Press, Cambridge, U. K.
15. HUTCHINSON, J. 1973. The Families of Flowering Plants. 3rd Edition. Oxford University Press. Oxford.
16. JAIN, S. K. and R. R. RAO. 1977. A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi.
17. JOHRI, B. M. 1994. Botany in India: History and Progress. Vol-I. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
18. JONES, S. B., AND A. E. LUCHSINGER. 1987. Plant Systematics. 2nd Edition. McGraw-Hill Book Company. New York.
19. JUDD, W. S, C. S. CAMPBELL, E. A, KELLOG, P. F. STEVENS AND N. J. DONOGHUE. 2008. Plant Systematics. Sinauer Associates, INC, Publishers. Sunderland, Massachusetts, USA.
20. LAWRENCE, G. H. M. 1951. Taxonomy of Vascular Plants. The Macmillan Company. New York.
21. MABBERLEY, D. J. 2005. The Plant-Book, A portable dictionary of the vascular plants. Cambridge University Press, United Kingdom
22. MANILAL, K. S. AND M. S. MUKTESH KUMAR [ed.] 1998. A Handbook of Taxonomic Training. DST, New Delhi.

23. MINELLI, A. 1993. *Biological Systematics: The State of the Art*. London, Chapman & Hall.
24. MONDAL, A. K. 2005. *Advanced Plant Taxonomy*. New Central Book. Agency Pvt. Ltd. Kolkata.
25. MOORE, R., W. D. CLARK, K. R. STERN AND D. VODOPICH. 1995. *Botany: Plant Diversity*. Wm. C. Brown Publishers. London.
26. NAIK, V. N. 2000. *Taxonomy of Angiosperms*. Tata McGraw-Hill Publishing Company Limited, New Delhi.
27. Nair, P. K. K. 1966. *Pollen morphology of Angiosperms*. Periodical Expert Book Agency, New Delhi.
28. NAYAR, M. P., 1996. "Hot Spots" of Endemic plants of India, Nepal and Bhutan. Tropical Botanic Garden and Research Institute, Thiruvananthapuram, India.
29. NAYAR, M. P., AND R. K. SASTRY. 1987-1990. *Red Data Book on Indian Plants*. Vols. I - III. Botanical Survey of India. Howrah.
30. QUICKE, D. L. J. 1993. *Principles and Techniques of Contemporary Taxonomy*. Chapman and Hall. London.
31. RADFORD, A. E., W. C. DICKISON, J. R. MASSEY, AND C. R. BELL. 1974. *Vascular Plant Systematics*. Harper & Row. New York.
32. RAVEN, P. H., R. F. EVERT, AND S. E. EICHHON. 1992. *Biology of Plants*. 5th Edition. Worth Publishers. New York.
33. SANTAPAU, H. AND H. A. HENRY. 1994. *A dictionary of the flowering plants in India*, CSRI, New Delhi.
34. SHARMA A. AND A. SHARMA. 1980. *Chromosome Technique: Theory and Practices (3rd ed.)* Butterworths, London.
35. SHIVANNA, K. R. AND N. S. RANGASWAMY. 1992. *Pollen Biology- A Laboratory Manual*. Springer-Verlag
36. SIMPSON, M. G. 2006. *Plant Systematics*. Elsevier Academic Press, California, USA.
37. SINGH, G. 2005. *Plant Systematics – Theory and Practice*. Oxford and YBH Publishing Co. Pvt. Ltd., New Delhi.
38. SIVARAJAN, V. V. 1989. *Introduction to Principles of Plant Taxonomy*. Oxford and IBH Publishing Co. New Delhi.
39. SOLTIS, D. E., P. S. SOLTIS, P. K. ENDRESS AND M. W. CHASE. 2005. *Phylogeny and Evolution of Angiosperms*. Sinauer Associates, Inc, Massachusetts, USA.
40. STACE, C. A. 1989. *Plant Taxonomy and Biosystematics*. Edward Arnold, London.
41. STUESSY, T. F. 2002. *Plant Taxonomy*. Bishen Singh Mahendra Pal Singh, Dehra Dun, India.

42. SUBRAMANIAM, N. S. 1995. Modern Plant Taxonomy. Vikas Publishing House. New Delhi.
43. TAKHTAJAN, A. 1997. Diversity and Classification of Flowering Plants. Bishen Singh and Mahendra pal Singh, Dehra Dun, India.
44. TAYLOR, D. V. AND L. J. HICKEY. 1997. Flowering Plants: Origin, Evolution and Phylogeny. CBS Publishers & Distributers, New Delhi.
45. WILEY, E. O. 1981. Phylogenetics: The Theory and Practice of Phylogenetic Systematics. New York, John Wiley & Sons.

BOT 521 (Elective D)

Advanced Plant Physiology and Biochemistry-I

Unit I. Plant Composition : Structure and biochemical role of major plant constituents, carbohydrates and its derivatives, structure and classification of proteins, glycoproteins, peptidoglycans, lipids and glycoproteins, lipid and triglycerides, fatty acids, vitamins and nucleic acids.

Unit II. Pigments: chlorophylls, phycobiliproteins, phenolics, sterols, alkaloids, carotenoids, phytochrome, anthocyanine, phenolics, sterols, alkaloids, porphyrins, organic acids, possibilities of isolating these chemicals for human welfare.

Unit III. Principles and applications of colorimeters, photometry flame photometers, spectrophotometry, chromatography (ion exchange, affinity, thin layer, high pressure liquid) gel filtration, electrophoresis, electro focusing and ultracentrifugation,

Unit IV. Application of radioactive tracer technique in biology, radioactive isotopes

Autoradiography, Biophysical methods X ray diffraction, fluorescence UV, NMR and ESR Atomic absorption spectroscopy

Unit V. Growth analysis: Growth, growth curve, lag, log and senescence phase, growth rates AGR, RGR, NAR, LAP, LAI, CGR and LAD productivity potential of dwarf varieties, causes of dwarfism, morphological and physiological factors in relation to height. Yields of dwarf plants,

BOT 522 (Elective D)

Advanced Plant Physiology and Biochemistry - II.

Unit I Photosynthesis and plant productivity C₃, C₄ and CAM pathways and photorespiration in relation to crop productivity, soil and water conservation methods, weed biology herbicides, biological weed control, intensive cropping, zero tillage use of plant growth regulators and bio-fertilizers in agriculture, Nitrogen use efficiency, optimum economic dose of nitrogen fertilizers green manuring.

Unit II Biomass : The concept of Biomass, Biomass production, Utilization of biomass as a energy agricultural. Residue and their management HDEF energy forests energy crapping hydro carbon, plants biomathylation biogas, biogas plants, biogas production from soils city wastes.

Unit III. The practice of green manuring and preparation of compost NADEP and other methods, Utilization of solid wastes for composting recent trends in solid waste management and production sources.

Unit IV. Green crop fractionation: The GGF system and advantages of GCF. Mechanical fractionation, plants suitable for GCF, Machinery recommended for mechanical fractionation, products, pressed crop residue (PCR) Juice, leaf protein concentrate and deproteinized Juice (DPJ)

Unit V. Green Crop Fractionation: Use of PCR in animal nutrition preparation of silage, silage fermentation, use of leaf juice as a milk replacer, Preparation of LPC, chloroplastic and cytoplasmic LPC, Nutritive value of LPC, and its suitability in human nutrition as a source of protein and vitamin - A, preservation of LPC, DPJ as a replacer of tissue culture media, LPC compared with algal protein SCP, the possibility of increasing protein productivity through green crop fractionation. Bidkin Process.

Practical Based on BOT 521 & BOT 522 (Elective-D)

1. Estimation of B - carotene with column chromatography.
2. Estimation of reducing sugars by Folin – Wu tube.
3. Estimation of cellulose by crampton and Maynord Method.
4. Estimation of free fatty acids.
5. Estimation of nitrates.
6. Thin layer chromatographic technique.
7. Techniques of flame photometry: estimation of sodium and potassium.
8. Estimation of gross energy by chromic acid oxidation method.
9. Estimation of N by micro – Kjeldhal's method.
10. Estimation of crude protein, crude fat and crude fiber.
11. Estimation of ash acid soluble / insoluble ash, Nitrogen free extracts and total carbohydrates.
12. Estimation of cell wall constituents, ADF, NDF, cellulose, hemicellulose, lignin etc.
13. Estimation of calcium by titration method.
14. Estimation of phosphorus by SubbaRao and Fiske Method,
15. Growth analysis: AGR, RGR, NAR, LAR, LAI, CGR and LAD.
16. The process of GCF and extractability of dry matter and Nitrogen.
17. Preparation of LPC, by heat coagulation, acid coagulation and fermentation.
18. Preparation of cytoplasmic and chloroplastic LPC by differential heat coagulation.
19. Preparation of TCM using DPJ and Inoculation of explant.

Suggested Readings

- 1) Hess, D. Plant Physiology, Narosa Publishing House, New Delhi.
- 2) Mukharji, S. and Ghosh, A. K. Plant Physiology. New Central Book Agencies, Kolkatta.
- 3) Noggle, G. R. and Fritz, G. S. Introductory plant physiology, Prentice Hall, U. S. A.

- 4) Vaidya, V. G., Sahasrabuddhe, K. R. and Khupse, V. S. Crop production and field experimentation, Continental Prakashan, Pune - 30.
- 5) ICAR Handbook of Agriculture, ICAR, New Delhi.
- 6) Mungikar, A. M. Bibliography of leaf protein in Marathwada University.
- 7) Pine, N. W. (1971) Leaf protein, its preparation, quality and use, Blackwell Scientific Publ. U. K.
- 8) Telek, H. and Graham, LT. (1983) Leaf protein concentrates, AVI, Publishing Co., USA.

Service Course- I

BOT 525

(Basic Plant Tissue Culture)

Unit-I (Introduction to Plant Tissue culture): Introduction to Plant Tissue culture, Terms and definitions, Historical background, Laboratory organization, Tools and techniques, methods of sterilization. Laboratory contaminants- it's control and measures.

Unit-II (Media Preparation and dynamics of Growth): Introduction to tissue culture: Media composition, Preparation, Phytohormones and their usage, selection of media for specified applications, initiation of tissue culture, cellular totipotency, media for initiation of callus, dynamics of callus growth, organogenesis and factors controlling it, genome instability in relation to morphogenesis, somaclonal variation and its applications.

Unit-III (Culture techniques): Cell and organ culture: Plant organ culture; shoot tip, Micropropagation, shoot apical meristem, root, leaf, flower and ovary culture, embryo rescue, somatic embryogenesis, factors influencing embryogenesis, synthetic seeds, suspension culture in stationary and stirred tank reactors,

Unit-IV (Advance Culture techniques): Isolation of single cells and their culture, measurement of growth, protoplast isolation, culture, regeneration and fusion of protoplasts, generation of cybrid and hybrids, cryopreservation of plant cells. Role of Ovary and ovule in *In-vitro* Fertilization in production of agricultural and horticultural crops. Hardening techniques

Unit-V (Recombinant Techniques in Tissue Culture): Recombinant DNA technology: Gene cloning, principles and techniques. Techniques for gene transfer. Marker genes. Applications of tissue culture: Applications in agriculture and industry.

SUGGESTED READINGS

1. Kalyankumar De. Introduction to Plant Tissue culture,
2. Bhojwani, Plant Tissue Culture.
3. Dubey. R. C. a Textbook of Microbiology
4. Montell. S. H. Mathews, J. A., Meker, R. A. Principles of Plant Biotechnology.
5. Glover, D. M. and Hanes, B. D. (eds.) 1995. DNA cloning 1: A practical approach, core techniques, 2nd edition, PAS, IRL press at Oxford University Press.
6. Purohit Plant Tissue Culture
7. Plant cell culture protocols. Humana Press, Inc. New Jersey, USA.
8. Shaw, C. H. (ed.) 1998, Plant Molecular Biology. A practical approach IRI Press, Oxford.

9., R. H. 2000. Plant Tissue culture: Techniques and Experiments. Academic Press, New York.

10. Rajdan : An introduction to plant tissue culture.

11. SandhyaMitra: Genetic engineering.