

NORTH MAHARASHTRA UNIVERSITY,

‘A’ GRADE NAAC RE – ACCREDITED (3rd CYCLE)

JALGAON – 425001, MAHARASHTRA (INDIA)



SYLLABUS OF M. Sc. BOTANY

THEORY AND PRACTICAL COURSES

M. Sc. – II

(w. e. f. Academic Year 2018 - 19)

NORTH MAHARASHTRA UNIVERSITY, JALGAON
PROPOSED THEORY AND PRACTICAL COURSE FOR
M.SC. BOTANY SCHEME & COURSES

M.SC. PART - II

(w. e. f. Academic. Year 2018 - 19)

SEMESTER - III

- BOT. - 301 : Gymnosperm and Palaeobotany**
BOT. - 302 : Plant Biotechnology and Bioinformatics
BOT. - 331 : Algae special paper - I
BOT. - 332 : Mycology and Plant Pathology Special paper - I
BOT. - 333 : Genetics and Plant breeding Special paper - I
BOT. - 334 : Angiosperm Taxonomy Special paper - I
BOT. - 304 : Practical - I (Based on Bot. - 301 & 302)
BOT. - 305 : Practical - II (Based on Bot. - 331 / 332 / 333/ 334)

SEMESTER - IV

- BOT. - 401 : Developmental Botany**
BOT. - 421 : Algae special paper - II
BOT. - 422 : Mycology and Plant Pathology Special paper - II
BOT. - 423 : Genetics and Plant breeding Special paper - II
BOT. - 424 : Angiosperm Taxonomy Special paper - II
BOT. - 431 : Algae special paper - III
BOT. - 432 : Mycology and Plant Pathology Special paper - III
BOT. - 433 : Genetics and Plant breeding Special paper - III
BOT. - 434 : Angiosperm Taxonomy Special paper - III
BOT. - 404 : Practical – I (Based on Bot. – 401)
BOT. - 405 : Practical – II (Based on Bot. – 421 & 431 /Bot. – 422 & 432 / Bot. 423 &433/ Bot. – 424 &434)
BOT. - 406 : Project work.

Note:

1. Botanical excursions are compulsory for practical courses of each semester.
2. Each theory course consists of total 60 lectures of 60 min. each.
3. Each theory course requires 5 lectures and 1 tutorial per week.
4. Each practical course requires 02 practical per week & each practical requires 4 hours duration. (24 Practical).
5. Practical Bot- 304, Bot- 305, Bot – 404, Bot – 405. Total practical 24 = practical to be taken 20 + 4 practical converted in to project work
6. Duly certified practical journals and tour reports are necessary for appearing all practical examinations.

SEMESTER - III
BOT. 301: GYMNOSPERMS AND PALAEOBOTANY

Total: 60 Lectures

Aims and Objectives:

1. To study the diversity of Gymnosperms in India
 2. To study the evolutionary trends and affinities of living gymnosperms with respect to external and internal features.
 3. To study the important fossil types in different groups of plants and Indian fossil records.
 4. To study applied aspects of Palaeobotany
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(I) GYMNOSPERMS

Chapter I: Introduction (10L)

1. Distinguishing features of Gymnosperms
2. Outline classification of gymnosperms by Chamberlin (1935) and D. D. Pant (1957)
3. Distribution of gymnosperms in India
4. Economic importance of Gymnosperms

Chapter II: General Characters, Morphology, Anatomy, Reproduction, affinities and Evolutionary trends of the following orders (20L)

1. Cycadales
2. Coniferales
3. Taxales
4. Ginkgoales
5. Gnetales

(II) PALAEOBOTANY

Chapter III: Introduction, Scope and importance (2L)

Chapter IV: Geological time scale with prevailing climatic conditions and relevant major Plant groups (3L)

Chapter V: Applied aspect of Palaeobotany (2L)

Chapter VI: Process of Fossilization, conditions favorable for fossilization (3L)

Chapter VII: General characters, affinities in the following orders along with external, internal features of following genera: (15L)

1. Psilophytales : *Rhynia*, *Horneophyton lignieri*, *Psilophyton princeps*
2. Lepidodendrales : *Lepidodendron* (complete reconstruction), *Sigillaria*, *Cyclodendron*.
3. Calamitales : *Calamites*, *Annularia*, *Calamostachys*, *Paleostachya*
4. Sphenophyllales : *Sphenophyllum*, *Bowmanites*
5. Coenopteridales : *Stauropteris*, *Botryopteris*, *Zygopteris*
6. Hydropteridinae : *Salvinia intertrappea*, *Rodeites dakshinii*
7. Lyginopteridales : *Lyginopteris oldhamia*, *Lagenostoma lomaxii*, *Sphenopteris*, *Crossotheca*.
8. Medullosales : *Medullosa*, *Neuropteris*, *Dolerotheca*.
9. Glossopteridales : *Glossopteris*, *Vertebraria*, *Scutum*.
10. Bennettitales : *Williamsonia seawardiana*, *W. spectabilis*
11. Pentoxylales : *Pentoxylon sahnii* (reconstruction).
12. Cordaitales : *Cordaites*(reconstruction), stem, *Cordaitanthus*

Chapter VIII: Fossil Angiosperms: (3L)

1. Monocot: *Palmoxylon*, *Rhizopalmoxylon*, *Cyclanthodendron*, *Tricoccites*.
2. Dicot : *Sahnipushpam*, *Sahnianthus*, *Enigmocarpon*.

Chapter IX: Techniques for fossil study (2L)

1. Petrification: Ground thin section, Peel method, Microtomy, X-ray radiography technique.
2. Compression : Maceration, Transfer technique, Excavation technique

Reference Books:

- Andrews, H.N. (1961) Studies in Palaeobotany, New York, London
- Arnold, C.A. (1947) An Introduction to Palaeobotany McGraw Hill Co., New York, USA.
- Banks, H.P. (1970) Evolution and plants of the Past. McMillan Press Ltd. London, U.K.
- Chamberlain, C.J. (1935) Gymnosperms: Structure and Evolution. Dover publ. INC., New York, USA.
- Ganguli H.C. and Kar A. K. (2001) College Botany Vol. II Book and Allied Press. Ltd. Calcutta, India.
- John Waltan (1953) Introduction to Study of fossil Plants. Adam and Charles Block, London, UK.
- Maheshwari, P and R.R. Konar (1971) Pinus CSIR New Delhi, India.
- Pande B. P. (1994) Gymnosperms. Hand and Co. New Delhi, India.
- Pant D. D. (1973) Cycas and the Cycadales Central Book Depot, Allahabad, India.
- Saxena and Sarabhai, R. M. (1972) Text Book of Botany, Vol. II, Embryophyta Ratan Prakashan Mandir, Agra, India.

- Shukla, A. C. and S.P. Misra (1982) Essentials of Palaeobotany Vikas Publishing House Pvt. Ltd. Delhi, India.
- Seward, A.C.(1969) Fossil Plants Vol. I to IV, Hafner Publ. Co. New York, USA.
- Sporne K.R. (1967) Morphology of Gymnosperms Hutchinson Univ. Library, London, UK.
- Surange K.R. (1966) Indian Fossil Pteridophytes CSIR, New Delhi, India.
- Vashishta, P. C. (1983) Botany for Degree Students Vol V Gymnosperms S. Chand & Co. New Delhi, India.
- Wilson N. Stewart and Gar W. Rothwell (1993) Palaeobotany and Evolution of Plants- II. Cambridge Univ. Press. Cambridge.

SEMESTER - III

BOT. 302: PLANT BIOTECHNOLOGY AND BIOINFORMATICS

Total hours: - 60

Aims and Objectives:

1. To the fundamentals of totipotency, plant tissue culture techniques.
 2. To study transgenic technology for the improvement of quality and quantity of Plant and there by product.
 3. To understand the advantages of in vitro propagation in various areas.
 4. To understand the application and importance of plant tissue culture and transgenic plant in the field of botany
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PLANT BIOTECHNOLOGY

Chapter I: Fundamental of plant tissue culture: (04 L)

1. History, concepts of cell differentiation and totipotency.
2. Requirements of plant tissue culture laboratory. Requirement for basal media.
3. Growth hormones and their role, various media used for tissue culture technique.

Chapter II: In vitro Culture (09 L)

1. Introduction and types of culture, its Importance and application
2. Production of haploids and their application.
3. Somatic and Gametic Embryogenesis, Microporpagation, Meristem culture, Embryo rescue.

Chapter III: Cybrid production: (09 L)

1. Isolation and culture of protoplasts, protoplast fusion and somatic hybridization.
2. Selection systems for somatic hybrids / Cybrids and their characterization.
3. Production of Secondary metabolites by plant cell cultures, commercial production of secondary metabolites synthetic seed production.
4. Somaclonal and Gametoclonal variations, cryopreservation and germplasm storage.

Chapter IV: Blotting techniques: (03 L)

1. Introduction and importance of : Southern blotting, Northern blotting and western blotting

Chapter V: Recombinant DNA Technology: (14 L)

1. Introduction, Cloning vectors for recombinant DNA.
2. Expression vectors and shuttle vectors, Restriction enzymes for cloning.

3. Amplification of DNA and construction of Library:- Basics of PCR, Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors.
4. Alien gene transfer: Agrobacterium biology and biotechnology; Plant - Agrobacterium interactions; direct gene transfer methods: particle bombardment, electroporation, PEG-mediated. Transformation using pollen or pollen tube.

Chapter VI: Transgenic plants: (06 L)

1. Transgenic crops in India, Resistance against Abiotic and biotic stress, Improved crops productivity, Neutraceutical improved crops, transgenic plants for edible vaccine and antibodies.

Bioinformatics

Chapter VII: Bioinformatics: (08L)

1. History, various Web services used as bioinformatics tool for local sequence alignment, multiple sequence alignment and multipurpose analysis, PubMed, bioinformatics institutes and databanks, data mining, limitation of Bioinformatics and data mining.

Chapter VIII: Genomics: (05L)

1. Structural, functional and comparative genomics.
2. Molecular markers, molecular genetic map of grass family legumes and cotton.
3. Physical map of grass family. DNA sequencing.

Chapter IX: Proteomics: (02 L)

1. Definition, functional and structural proteomics, and uses.

Reference Book

- Plant Biotechnology and Agriculture: Prospects for the 21st Century edited by A. Altman, Paul M. Hasegawa, Academic Press, 2012
- Recent Advances in Plant Biotechnology, Ara Kirakosyan, Peter B. Kaufman, Springer Science & Business Media, 2009.
- Elements of Biotechnology, P K Gupta, Rastogi Publications, 2010.
- Plant Biotechnology and Molecular Markers, S. Srivastava, A. Narula, Springer Science & Business Media, Anamaya publishers, New Delhi, 2006
- Plant Biotechnology, B. D. Singh, Kalyani Pub, 2006.
- Plant Tissue Culture: Theory and Practice: Theory and Practice, S. S. Bhojwani, M.K. Razdan Elsevier.
- Plant biotechnology, K .G. Ramavat, S. Chand publication.
- Biotechnology and Genomics P K Gupta, Rastogi Publications, 2006.

SEMESTER - III
BOT. 331: ALGAE SPECIAL PAPER - I

Total: 60 Lectures

Aims and Objectives:

1. The main objective is to fulfill the knowledge of rapidly expanding branch Algology of Botanical Science.
 2. To know diversity of various algal groups.
 3. To provide a clear and sound background knowledge in respect to morphology; reproduction and interrelationships of Algae.
 4. To study different systems of classification of algae
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Chapter I: General Topics **(12 L)**

1. Introduction, a brief History of Phycology, contribution of Indian algologist.
2. Comparative account of general characters of different groups of algae. (According to F. E. Fritsch's classification).
3. Systems of classification of algae up to orders according to F. E. Fritsch, G. M. Smith, H. C. Bold, and W. J. Wynne.
4. Modern trends in algal systematics

Chapter 2: Discussion of algae with reference to Reproduction, Life Cycle, Evolution, Phylogeny and interrelationships of belonging to the following algal classes (*sensu* F. E. Fritsch). **(36 L).**

1. Cyanophyceae.
2. Chlorophyceae.
3. Euglenophyceae.
4. Xanthophyceae.
5. Bascillariophyceae.
6. Phaeophyceae.
7. Rhodophyceae.

Chapter 3: Brief discussion in relation to the morphology and systematic position of the following groups. **(12 L)**

1. Chrysophyceae.
2. Dinophyceae.
3. Desmophyceae.
4. Prasionophyceae.

5. Cryptophyceae.
6. Chloromonadophyceae

Reference Books

- Anand, N. (1998). Indian Freshwater Microalgae, Bishen Singh Mahendra Pal Singh, Dehradun, India.
- Bold, H and Wynne. M. J (1978) Algal structure and reproduction. Prentice Hall of India pvt. Ltd. New Delhi, India.
- Bony, A.D. (1978). Phytoplankton. Edward Arnold pub. Ltd. London, U.K.
- Chapman, V.J. and Chapman D.J. (1979). The Algae. English Language Book Society and Mc. Millan, Co, London, U.K.
- Daws, C. J. (1981). Marine Botany. Wiley Publication Com. New York, USA.
- Desikachary, T.V. (1959). Cyanophyta. ICAR, New Delhi, India.
- Fritsch, F.E. (1959-1961). The Structure and Reproduction of the Algae. Vol. 1 & 2 Cambridge University Press, U.K.
- Ghandi, H.P. Fresh Water Diatoms of Central Gujrat, Bishen Singh Mahendra Pal Singh Dehradun , India.
- Gonzalves,E. (1981). Oedogoniales. ICAR, New Delhi, India.
- Gordon, F. Leedale (1969). Euglenoid Flagellates Biological techniques series Prentice-Hall, Inc, Englewood, London, U.K.
- Irvine D. E. G. & D. M. John (1984). Systematics of Green Algae (The systematic association special vol. 27), Academic Press, London
- Iyengar, M.O.P. and Desikachary, T.V. (1981). Volvocales. ICAR, New Delhi, India.
- Lee, R.E. (1989). Phycoogy. Cambridge University Press, Cambridge, U.K.
- Misra, J.N. (1966). Pheohyceae in India. ICAR, New Delhi, India.
- Morris, I (1967). An Introduction To The Algae Hutchinson University Press
- Pal, B.P. and Sunderlingam et al. (1962). Characeae. ICAR, New Delhi, India.
- Philipose, M.T. (1960). Chroococcales. ICAR, New Delhi, India.
- Prescott, G.W. (1968). The Algae : A Review. Houghton-Mifflin Co. Boston

- Ramanathan, M.S. (1964). Ulotrichales. ICAR, New Delhi, India.
- Randhawa, M.S. (1959). Zygnemataceae. ICAR, New Delhi, India.
- Round, F.E. (1973). The Biology of the Algae. Edward Arnold, London, U.K.
- Sahoo, Dinabandhu and Debasish Nivedita (2001). The Checklist of Seaweeds of Indian Coast
APH Publishing Corporation, Delhi, India.
- Sarode, P.T. and Kamat N.D. (1984). Freshwater Diatoms of Maharashtra. Saikrupa Pub.
Aurangbad (M.S.), India. (12)
- Smith, G.M. (1950). Freshwater Algae of the United States. Mc.Graw Hill, New York, U.S.A.
- Srinivasan, K.S. (1969). Phycologia Indica. Icones of Indian Marine Algae. Vol. 1 and 2.
Botanical Survey of India, India.
- Venkatraman, G.S. (1969). Vaucheriaceae ICAR, New Delhi, India.

SEMESTER - III

BOT. 332: MYCOLOGY AND PLANT PATHOLOGY SPECIAL PAPER - I

Total: 60 Lectures

Aims and Objectives:

1. To reveal historical development in mycology.
2. To make aware principles, rules and regulations of ICBN.
3. To know ultra-structure of fungal cells.
4. To study different classifications for fungal organisms.
5. To study vegetative structure of various groups of fungi.
6. To study reproductive structure phylogeny, interrelationship and life cycle pattern of various groups of fungi.

Chapter I: History of Mycology (01 L)

Chapter II: (04 L)

1. International code and Botanical nomenclature. Principles, major rules, revisions and recommendations, effective and valid publications, typification, rejection of names of taxa, starting date point, priority and authority.
2. Outline classification proposed by Bessey (1950) Anisworth (1973) Hawksworth *et.al.*, (1995) and Alexopoulos *et al.*,(1996).
3. Ultra structure of fungal cell, cell-wall composition, septa, rhizomorph

Chapter III: Discussion of fungi with reference to vegetative structure, reproductive structure, phylogeny, interrelationship and life cycle pattern of following:

1. **Myxomycotina:** Ceratomyxales, Dictyosteliales, Acrasiales, Labyrinthulales, Trichiales, Stemonitales, Physarales. (08 L)
2. **Mastigomycotina:** Plasmodiophorales, Chytridiales, Blastocladales, Lagenidiales, Saproleginales, Perenosporales. (06 L)
3. **Zygomycotina:** Emtomophthorales, Mucorales, Endogonales (04 L)
4. **Ascomycotina:** Taphrinales, Endomycetales, Protomycetales, Eurotiales, Erysiphales, Meliolales, Clavicipitales, Shaeriales, Xylariales, Pezizales, Laboulbeniales, Myringiales, Hysteriales, Dothidiales, Pleosporales. (16 L)
5. **Basidiomycotina:** Auriculariales, Dacrymycetales, Tulasnellales, Aphyllophorales, Agaricales, Lycoperdales, Nidulariales, Phallales, Podaxales, Ustilaginiales, Uredinales. (15 L)
6. **Deuteromycotina:** Blastomycetes, Hyphomycetes, Coelomycetes. (06 L)

Reference Books

- Ainsworth et. al. (1965-73). The fungi, An advanced treatise Vol. I-IV B, Academic press, London, UK.
- Alexopoulos & Mims (1979). Introductory Mycology, Willey Eastern Ltd. New Dehli, India.
- Alexopolus, Mims and Blackwell (1996) Introductory Mycology (4th Ed.). John. Willey and Sons. Inc New York., USA.
- Aneja K. R., (1996) Experiments in microbiology, Plant pathology, Tissue culture and mushroom cultivation. Vishwa Prakashan New Dehli, India.
- Burnett and Hunter (1972) Illustrated Genera of Imperfect Fungi, Minnesota.
- Barron G. L. (1968). The Genera of Phycomycetes from Soil. Williams and Wilkins, Baltimore.
- Bassey E. A. (1950). Morphology and Taxonomy of Fungi, The Blakiston Ed. Philadelphia
- Bhide et. al (1987). Fungi of Maharashtra, M. A. C. S. Inst. Pub Pune (M. S.), India.
- Biligrani et. al (1979-81). Fungi of India (Part I-II). Today and tomorrow's Pub. New Dehli, India.
- Biligrani K. S. (1991). Fungi of India, International Book House New Dehli, India.
- Bonner J. T. (1996). The culture of Slime moulds Princeton, Univ press
- Borse, B. D., Borse, K. N. , Pawar, N. S. And Tuwar, A. R. (2012) Marine Fungi of India (Monograph), Broadway Book Center Publishers and Distributors, Panjim, Goa Pp. 1-471.
- Borse, B.D., Borse, K. N., Patil, S. Y., Pawara, C. M., Nemade, L. C. And Patil, V. R. (2016) Freshwater Higher Fungi of India, Lulu Publication, USA and Laxmi Book Publisher, Solapur, Maharashtra, India. Pp. 1-636.
- Borse, B. D., Borse, K. N., Chaudhari, S. A., Patil, V. R., Patil, S. Y., Gisavi, S. A. and Borade D. S. (2017) Freshwater and Marine Fungi of India. Lambert Academic Publishing Group, Meldrum Street, Beau Bassin 71504, Mauritius.
- Burnett J. H. (1986). Fundamentals of Mycology, Edward Arnold. London, UK.
- Clemet and Shear (1993). The Genera of Fungi, H. W. Wilson New York, USA.
- Cummins G. B. (1979). Illustrated Genera of Rust Fungi, Burgens Pub. Co. Minnneapolis
- Cummins G. B. (1971). The Rust Fungi of Cereals Grasses and Bamboos, Spinrigles, Verlag New York, USA
- Dayal R. & Kiran U. (1989). Zoosporic Fungi of India Inter India Pub. New York, USA
- Dennis R. W. G. (1977). British Ascomycetes (3rd Ed.) J. Ceamer, Vaduz, Germany
- Ellis M. B. (1971). Dematiaceous Hypomycetes, CMI publication Kew Survey, London
- Gauman E. A. (1928). Comparative Morphology of Fungi McGraw-Hill Pub. New York, USA
- Hawksworth D. L. (1971). Mycologist. CBI, Kew
- Kamat M. N. (1959). Hand Book of Mycology Vol. I-II Prakash Publication. Pune, India.
- Kamat M. N. (1959). Introductory Plant Pathology Prakash Publication. Pune, India

- Khulbe, R. D. (2001) A manual of Aquatic Fungi (Chytridiomycetes and Oomycetes), Daya Publishing House, New Delhi, Pp. 1-255.
- Lakhanpal and Mukherji (1981). Indian Myxomycetes L. Cramer Vaduz.
- Mehrotra and Aneja (1991, 2015). An Introduction of Mycology. Wiely Eastern Ltd. New Dehli, India. 13
- Mundkur and Thirumatcher (1952). Ustilaginales of India. CMI Pub. Kew survey, England.
- Mahadevan and Shridhar (1982). Methods in Physiological Plant Pathology II Ed. Sivakarni Pub. Madras, India.
- Pathak V. R. (1972). Essentials of Plant Pathology. Prakash Pub Jodhpur, India.
- Patahk, Khatri, Pathak. (1996). Fundamentals of Plant Pathology, Agro Botanical Pub. Bikaner, India.
- Sarbhoy A. K. (1983). Advance Mycology, Today's and Tomorrow's pub. New Dehli, India
- Subramanian C. V. (1981). Hypomycetes, Academic Press London, UK
- Tondon R. N. (1968). Mucorales of India ICAR Pub. New Dehli, India.
- Thind K. S. (1977). Myximycetes of India ICAR New Dehli, India.
- Vasudeva R. S. (1961). India Cercosporae ICAR New Dehli, India.
- Webster J. (1980). Introduction to Fungi 2nd ed. Cambridge Uni, press Cambridge.
- Wolf and Wolf (1964-69). The Fungi Vol. I-II, John Wiley and Hafner New York, USA.

SEMESTER - III

BOT. 333: GENETICS AND PLANT BREEDING SPECIAL PAPER - I

Total: 60 Lectures

Aims and Objectives :

1. To provide advance knowledge of Cytogenetics in relation to cash crops targeting cell division in them different alterations at genome level and their significance.
 2. To study fertilization barriers in cash crops at different genome level.
 3. To provide knowledge of biometrical tools applied in plant breeding.
 4. To provide wholesome review on fundamentals of plant breeding.
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Chapter I: Principles of Cytogenetics

(16 L)

1. Variation in chromosome behavior, endo-mitosis euploidy, aneuploidy, evolutionary significance of chromosome aberrations– balanced lethal and chromosome complexes.
2. Role of polyploidy in plant breeding, evolutionary advantages of autopolyploids and allopolyploids- role of aneuploids in basic and applied aspects of crop breeding, their maintenance and utilization in gene mapping, gene block transfer, allele addition and substitution lines, creation and utilization, distant hybridization. Concept of diploid for development of homozygous line from segregating population.
3. Inter-specific hybridization and allopolyploids, synthesis of new crops Wheat, Triticale and *Brassica* hybrids between species same and different chromosome numbers bridge species.
4. Fertilization barriers in crops plants. *In-vitro* techniques to overcome the fertilization barriers incrop, production and use of haploid, di-haploids and double haploids

Chapter II: Biometrical Genetics

(24 L)

1. Mendelian traits verses polygenic traits, nature of quantitative traits and its inheritance, multiple factor hypothesis analysis of continuous variation, variation associated with polygenic traits- phenotypic genotypic and environmental. Nature of gene action– additive, dominance, epistatic and linkage effect.
2. Principals of analysis of variances (ANOVA) : Expected variance of components random and fixed models, comparison of means and variances for significance.

3. Design for plant breeding experiments: Principal and application, genetic diversity analysis metroglyph, cluster and D2 analysis, association analysis-phenotypic and genotypic correlations path analysis. Parent progeny regression analysis.
4. General mean analysis, mating designs diallel cross partial diallel, ability and gene action. Analysis of genotype and environment interaction adaptability and stability, models of GXE analysis and stability parameters.
5. QTL mapping, desired population for QTL mapping, statistical methods in QTL mapping. Marker assisted selection (MAS) its application in plant breeding.

Chapter III: Plant Breeding

(20 L)

1. **History of plant breeding** : objectives of plant breeding patterns of evolution in crop plants centers of origin concept
2. **Plant introduction** : History, types and procedure of plant introduction. Acclimatization merits and demerits of plant introduction quarantine.
3. **Male sterility and plant breeding** : Introduction, genetic, cytoplasmic male sterility, cytoplasmic-genetic male sterility, Gynoeceous lines, parthenocarpic, monoecious and dioecious nature in crop lines with respect to maintenance and seed development.
4. **Selection in self-pollinated crops**: Introduction, history pure line concept, origin of genetic variation in pure lines, genetic advance in selection.
5. **Selection in cross pollinated crops**: Rapid gain followed by slow response, slow progress for long period, slow response for short period, Rapid gain–plateau–rapid gain response free and potential ability.
6. **Selection methods**: Mass selection, pure line selection pedigree selection, bulk method, backcross method recurrent selection.
7. **Hybrid development** : (Introduction) Development of inbreeds, evaluation of inbreeds

Reference Book

- Allord R. W. (1981). Principles of Plant Breeding, John Wileys & Sons.
- Chopra V. L. (2004). Plant Breeding Oxford and IBH Publications, New Delhi, India.
- Gupta S. K. (2005). Practical Plant Breeding Agribios Publications, India.
- Falconer D. S. and Mackey J. (1998). Introduction To Quantitative Genetics. Long Publishers
- Gupta P. K. Cytogenetics Rastogi Publishers, Meerut, India.
- Gupta P.K. and Tuchsia T (1991). Chromosome Engineering in Plants: Genetics and evolution Elsevier Publishers
- Mather K. and Jinks J. L. (1983). Introduction to Biometrical Genetics. Chapman and Hall.

- Narayanan S. S. Singh P. (2007). Biometrical Techniques in Plant Breeding. Kalyani Publishers, India.
- Natarajan and Gunashekharan M. (2005). Quantitative Genetics and Bio-metrical Techniques in Plant Breeding Kalyani Publishers, India.
- Pohlman Bothafar D.N. (1972). Breeding Asian Field Crops Oxford and IBH, New Delhi, India.
- Robert H. Tamarin (2004). Principles of Genetics 7th Edition McGraw-Hill Companies.
- Roy D. (2003). Plant Breeding Analysis and Exploitation of Variation. Narosa Publication House
- Sharma A. K. and Sharma A. (1988). Chromosome Technique: Theory and practice Butter Worth
- Sharma J. R. (2001). Principles and practice of Plant Breeding. Tata MacGraw Hill, New Delhi, India.
- Singh B. D. (2006). Plant Breeding Kalyani Publishers, India.
- Singh P. (2006). Essentials of plant breeding Kalyani Publishers, India.
- Singh Phundan. (2014). Essentials of Plant Breeding Kalyani Publishers; 5th Edition
- Singh R. K. and Choudhary B. D. (1987). Biometrical methods in quantitative Genetics. Kalyani Publishers, India.
- Singh S. & Pawar (2006). Genetic Bases and Methods of Plant Breeding CBS Publishers, India.
- Swanson, Mertz and Young Cytogenetics MacMillan Co. New York, U.S.A. Khush G. S. (1973). Cytogenetics of Aneuploids Academic Press, London, U.K.

SEMESTER - III
BOT. 334: ANGIOSPERM TAXONOMY SPECIAL PAPER - I

Total: 60 Lectures

Aims and Objectives:

1. To study importance of classification in Angiosperms.
2. To study primitive and advanced groups of Angiosperm.
3. To study taxonomic structure of Angiosperms.
4. To study orders of Engler and Prantl's system of classification.

Chapter I: Classification **(11L)**

1. Need for classification, (ii) Process of classification, (iii) Classification and Aesthetics, (iv) Hierarchical classification, (v) General and special purpose classification, (vi) Horizontal and Vertical classification, (vii) Polythetic and Monothetic classification, (viii) Folk classification, (ix) Phase of Classification.

Chapter II: Discussion of the following with respect to **(12 L)**

1. **Ranales:** A group of most primitive dicotyledons, evolutionary trends.
2. **Amentiferae:** A heterogenous assemblage of moderately advanced dicotyledons, evolutionary trends.
3. **Sympetalae:** Heptaphyletic in origin, evolutionary trends.

Chapter III: Taxonomic structure **(12L)**

1. Taxonomic categories
2. Major categories
3. Minor categories
4. Historical development of concept of species
5. Concept of species
6. Intraspecific categories.

Chapter IV: Discussion of orders as defined in Engler and Prantl's system with reference to **(25L)**

1. Range of floral variation
2. Taxonomy, phylogeny and evolutionary trends in the
Orders: Helobiae, Liliiflorae, Glumiflorae, Scitaminae, Microspermae, Rosales, Contortae, Tubiflorae and Centrospermae

Reference Books

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- Vardhana Rashtra 2009. Taxonomy of Angiosperm. Vol. 1-2, Campus Books International, New Delhi, India.
- Walter S. Judd. Et al . 2002. Plant Systematics- A Phylogeny Approach. Sinauer Associates-Inc. USA

SEMESTER - III
BOT. 304: PRACTICAL - I
(BASED ON BOT.-301 AND BOT.-302)

Aims and Objectives:

1. To study morphology and anatomy of Gymnosperms.
 2. To study plant fossils from various groups.
 3. To develop plant tissue culture technique.
 4. To develop practical and observation skill.
-

Practical 1 - 2: Study of External morphology, wood anatomical features by double stained preparations by taking T.S., T.L.S. and R.L.S. of any six of the followings:

Pinus, Thuja, Cedrus, Cupressus, Araucaria, Agathis, Podocarpus, Cryptomeria, Juniperus and Taxus

Practical 3: Study of External morphology of male and female cones of any six of the Followings:

Pinus, Thuja, Cedrus, Cupressus, Araucaria, Agathis, Podocarpus, Cryptomeria, Juniperus and Taxus

Practical 4: Study of External morphology, anatomy (T.S.) and Morphology of reproductive organs of *Ephedra*

Practical 5: Study of External morphology, anatomy and Morphology of reproductive organs of *Ginkgo* (With P.S./Specimens)

Practical 6: Morphological and anatomical study of the following with the help of P.S. and Specimens

Psilopsida : *Rhynia* (Stem T.S.) *Lycopsidea*

Stem genera : *Lepidodendron*

Leaf cushions : *Lepidophloios*

Fructification : a) *Lepidostrobus* b) *Lepidocarpon*

Practical 7: Sphenopsida (Any 5)

Stem genera : a) *Sphenophyllum* b) *Arthropitys*

Foliage : a) *Annularia* b) *Schizoneura* c) *Phyllothea*

Fructification : a) *Calamostachys binneyana* b) *C. americana*

Practical 8: Coenopteridales (Any3)

a) *Botryopteris tridentata* (Stem and petiole)

b) *B. globosa* (fructifications)

c) *Zygopteris illinoensis* (Stem T.S.)

d) *Stauropteris burstislandica* (Megasporangium)

Practical 9: A] Pteridosperms (Any 5)

Foliage : a) *Pecopteris* b) *Sphenopteris* c) *Neuropteris* d) *Glossopteris*

Stem genera : a) *Lyginopteris oldhamia* b) *Medullosa thompsoni* c) *Vertebraria*

Fructification : *Doleritheca*

Water fern : *Rodeites*

B] Gymnosperm: Coniferales, Ginkgoales, Pentoxylales, Bennettitales

(Any 3)

Foliage : a) *Cordaites* b) *Brachyphyllum* c) *Pterophyllum* d) *Phoenicopsis*

e) *Ginkgo digitata*

Stem genera : a) *Cordaites* b) *Dendroxylon* c) *Pentoxylon*

Fructification : a) *Proaraucaria mirabilis* b) *Cardiocarpus*

Practical 10: Angiosperm fossils (Any 4)

Monocots. : a) *Palmoxylon* b) *Rhizopalmoxylon* c) *Cyclanthodendron*

d) *Tricoccites*

Dicots. : a) Dicot stem b) Dicot leaf impressions

Fructification: a) *Enigmocarpon* b) *Sahnianthus* c) *Sahnipushpam*

Practical 11: Study of various instruments used for plant biotechnology: Laminar air

Flow cabinet, pH meter, Autoclave, Mechanical shaker and Electrophoresis, Spectrophotometer, Centrifuge (any four)

Practical 12: Preparation of stock solutions of MS (Murashige & Skoog, 1962) : Basal medium and plant growth regulator.

Practical 13: Preparation of explants and inoculation on nutrient media for callus induction.

Practical 14: Sub-culture of callus and regeneration of plants from callus.

Practical 15: Hardening techniques of tissue culture plantlets.

Practical 16: Isolation and culturing of anther for haploid production.

Practical 17: Techniques for shoot tip /root tip/ eye bud culture.

Practical 18: DNA separation with the help of gel electrophoresis.

Practical 19: Study of NCBI - BLAST.

Practical 20: Database searching and retrieval of sequence for any plant related gene and protein. (FASTA - NCBI: nucleic acid sequence and protein sequence)

Practical 21-24 : Practical converted in to project work (Four practical)

Note: Botanical excursion for observations is compulsory. Students are expected to visit Indian Botanical Gardens and museum/ Tissue culture/ herbaria.

SEMESTER - III
BOT. 305: PRACTICAL - II
ALGAE SPECIAL - I
(BASED ON THEORY PAPER BOT.331)

Aims and Objectives:

1. To know diversity of algae from each group.
 2. To know various habitats of algae
 3. To know about range of thallus organization in algae.
 4. To know morphology, taxonomy and anatomy of algae.
 5. To develop observation and practical skill
-

Practical 1-6: Chlorophyceae

A] Volvocales : *Chlamydomonas, Dunaliella, Pandorina, Eudorina, Volvox, and Gonium* (Any 3)

B] Chlorococcales: *Chlorococcum, Chlorella, Trebauxia, Tetraedron, Characium, Charasiophon, Ankistrodesmus, Selenestrum, Oocystis, Botryococcus, Coelastrum, Scenedesmus, Pediastrum, Hydrodictyon, Protosiphon and Crucigenia.* (Any 6)

C] Ulotrichales : *Ulothrix, Uronema, Microspora, Sphaeroplea, Cylindrocapsa, Ulva, Enteromorpha, Schizomeris and Monostroma,* (Any 4)

D] Chaetophorales : *Stigeoclonium, Chaetophora, Draparnaldia, Draparnaldiopsis, Fritschiella, Coleochaete, Trentepohlia, and Cephaleuros* (Any 4)

E] Cladophorales: *Cladophora, Rhizoclonium, Pithophora, Chaetomorpha, and Spongomarpha* (Any 3)

F] Oedogoniales : *Oedogonium, Bulbochaete and Oedocladium* (Any 2)

G] Conjugales: *Spirogyra, Zygnema, Mougeotia, Sirogonium, Sirocladium, Cosmarium, Euastrum, Pleurotaenium, Closterium and Cylindrocystis* (Any 5)

H] Siphonales: *Caulerpa, Bryopsis, Dichotomosita, Codium, Halimeda, Udotea, Chaemodorus, Boergesenia, Valonia, Valoniopsis, Neomeris, Acetabularia and Tydemania* (Any 6)

I] Charales: *Chara and Nitella*

Practical 7-8: A] Xanthophyceae: Vaucheria and Botrydium

B] Chrysophyceae: *Dinobryon* and *Synura*

C] Bacillariophyceae: *Coscinodiscus*, *Melosira*, *Cyclotella*, *Chaetoceros*, *Cymbella*, *Cocconeis*, *Biddulphia*, *Navicula*, *Nitzschia*, *Synedra*, *Pinnularia*, *Fragilaria*, *Gyrosigma*, *Pleurosigma*, *Gomphonema* and *Surirella*. **(Any 8)**

D] Euglenophyceae: *Euglena*, *Phacus*, *Lepocinclis* and *Trachelomonas* (Any available forms)

Practical 9-11: Phaeophyceae: *Ectocarpus*, *Giffordia*, *Sphacelaria*, *Dictyota*, *Padina*, *Stoechospermum*, *Spatoglossum*, *Dictyopteris*, *Iyengaria*, *Colpomenia*, *Hydroclathrus*, *Sargassum*, *Turbinaria*, *Zonaria*, *Rosenvingea*, *Laminaria*, *Fucus*, *Cystoseria*, *Chnoospora*, *Macrocystis*, *Nereocystis* and *Postelsia*

(Any 8)

Practical 12-14 : Rhodophyceae: *Porphyra*, *Compsopogon*, *Batrachospermum*, *Liagora*, *Scinia*, *Gelidium*, *Gelidiella*, *Grateloupia*, *Gracilaria*, *Hypnea*, *Rhodymenia*, *Champia*, *Ceramium*, *Caloglossa*, *Acanthophora* , *Chondrus*, *Laurencia*, *Polysiphonia*, *Asparagopsis*, *Helminthocladia*, *Sebdenia*, *Halymenia*, *Botryocladia*, *Gastroclonium*, *Nemalion* and *Amphiroa* **(Any8)**

Practical 16-18: Cyanophyceae : *Chroococcus*, *Gloeocapsa*, *Gloeothecae*, *Merismopedia*, *Aphanothece*, *Coelosphaerium*, *Microcystis*, *Oscillatoria*, *Phormidium*, *Lyngbya*, *Arthrospira*, *Spirulina*, *Gloeothrichia*, *Cylindrospermum*, *Nostoc*, *Anabaena*, *Nostochopsis*, *Hapalosiphon*, *Stigonema*, *Tolypothrix*, *Rivularia*, *Calothrix* and *Dichothrix* **(Any 10)**

Practical 19-20 : Artificial key of the genera based on Morphology and Reproductive Characters.

Practical 21 to 24 : Practical converted in to project work (Four practical)

Notes:

- (i) Classification of algae should be followed according to F. E. Fritsch
- (ii) Surveys to nearby ponds, rivers, lakes and polluted habitats are compulsory.
- (iii) Students will submit their scientific survey reports at the time of examination.

SEMESTER - III
BOT.305: PRACTICAL - II
MYCOLOGY AND PLANT PATHOLOGY SPECIAL - I
(BASED ON THEORY PAPER BOT. 332)

Aims and Objectives:

1. To know diversity of fungi from each group.
 2. To know various habitats of Fungi
 3. To Know about thallus organization in Fungi .
 4. To know morphology, taxonomy, fruiting body, anatomy and asexual and sexual structures of Fungi .
 5. To develop observation and practical skill
-

(Study of the representative genera belonging to following groups with respect to observations made based on accessory organs, asexual and sexual structures, fruiting body ascocarp/ basidiocarp/ Pycnidia. (Study should be based on genera collected from the regular field trips and outside tours.)

Practical 1-3 : Myxomycotina (Any 10 Genera)

Practical 4-5 : Mastigomycotina (Any 08 Genera)

Practical 6 : Zygomycotina (Any 05 Genera)

Practical 7-11 : Ascomycotina (Any 20 Genera)

Practical 12-16 : Basidiomycotina (Any 20 Genera)

Practical 17-18 : Deteuromycotina (Any 08 Genera)

Practical 19 : Preparation of artificial key based on appropriate characters

Practical 20 : Isolation of aquatic fungi by baiting in the laboratory

Practical 21-24 : Practical converted in to project work (Four practical)

Note: Botanical excursion, collection of fungal specimens, tour report and submission of fungal specimens is compulsory.

SEMESTER - III
BOT.305: PRACTICAL - II
GENETICS AND PLANT BREEDING SPECIAL - I
(BASED ON THEORY PAPER BOT.333)

Aims and Objectives:

1. To introduce advance knowledge of Cytogenetics in relation to cash crops targeting cell division in them different alterations at genome level and their significance.
 2. Introduce to fertilization barriers in cash crops at different genome level.
 3. To provide knowledge of biometrical tools applied in plant breeding.
-

- Practical 1** : Various chemicals to be used in fixation and dehydration
- Practical 2** : Preparation of stains: Acetocarmines, Basic fuschin, ematoxylin.
- Practical 3-4** : Studies of mitosis in Onion, Wheat, and *Aloe-vera* (**Any two examples**)
- Practical 5-6** : Studies of meiosis in onion, cereals, pulses and millets (**Any two examples**).
- Practical 7** : Agents employed for the induction of polyploidy preparation of solution at seed and seedling level.
- Practical 8** : Floral biology in self-and cross-pollinated species.
- Practical 9** : Study of selfing techniques in crops
- Practical 10** : Study of crossing techniques in crops
- Practical 11** : Evolution of breeding materials.
- Practical 12** : Analysis of variance (ANOVA)
- Practical 13** : Estimation of heritability
- Practical 14** : Estimation of genetic advance
- Practical 15** : Maintenance of experimental records
- Practical 16** : Techniques in hybrid seed production
- Practical 17** : Use of male sterility in field crops.
- Practical 18** : Crossing program in oil seeds (**Any one of the following**)
(a)Groundnut, (b) Sesamum
- Practical 19** : Crossing program in food and fiber crops (**Any one of the following**)
(a) Bajara, (b) Maize (c) Cotton
- Practical 20** : Crossing program in pulses (**Any one of the following**)
(a) Mung, (b) Pigeon pea
- Practical 21-24** : Practical converted in to project work (Four practical)

NOTE:

1. During crossing programs of different crop
2. Either line X tester or diallel method should be followed
3. Compulsory visit to Agricultural Research station.

SEMESTER - III
BOT. 305: PRACTICAL - II
ANGIOSPERM TAXONOMY SPECIAL - I
(BASED ON THEORY PAPER BOT. 334)

Aims and Objectives:

1. To study importance of classification in Angiosperms.
 2. To study taxonomic differences in structure of Angiosperms
 3. Introduction to the local flora of angiosperm.
 4. To make an expertise for identification of local angiospermic plants.
-

Practical 1-14 : Study of Angiospermic families locally available in the region covering all orders/series (*Sensu* Bentham and Hooker, at least 30 families).

Practical 15-17 : Preparation of artificial dichotomous keys of (i) indented (ii) bracketed type based on vegetative as well as reproductive (floral) characters.

Practical 18-20 : Identification of plant specimens up to species level with help of flora/s

Practical 21-24 : Practical converted in to project work (Four practical's)

Note:

- (i) Botanical excursion is compulsory and students should submit botanical excursion report.
- (ii) Botanical excursion should be planned for botanically distinctive forests within the state or out of the state of Maharashtra.

SEMESTER - IV
BOT.401: DEVELOPMENTAL BOTANY

Total: 60 Lectures

Aims and Objectives:

1. To study vascular tissues, structure of woods and anomalous secondary growth
 2. To detect adulterations and forensic botany
 3. To study historical development of embryology
 4. To study structure and development of microsporangium, megasporangium, embryo and endosperm.
 5. To study methods of pollination and fertilization
 6. To study applications of embryology in plant tissue culture
 7. To study structure and development of pollen grains
 8. To study applications of palynology in human welfare
-

A. ANATOMY (25 Lectures)

Chapter I : Apical Meristems

(05 L)

1. Classification based on origin and development of initiating cells, plane of division, function and position in plant body.
2. Study of the following theories of zonation and differentiation:
 - i. Apical cell theory
 - ii. Histogen theory
 - iii. Tunica-carpus theory
 - iv. Korper- Koppe theory
3.
 - a. Cytohistological zonation
 - b. Concept of quiescent center

Chapter II: Study of Classification of stomata

(04 L)

- (A) Based on mature structure:
 - a. Classification by Vesque (1889)
 - b. Metcalfe and Chalk (1950)
 - c. Stace (1965)
 - d. Stebbins and Khush (1961)
- (B) Based on ontogeny:
 - Classification by Pant (1965)
 - Classification by Van Cotthem (1970)

Chapter III : Study of classification of Trichomes (02 L)

1. Uphof's Classification (1962)
2. Ramayya's Classification (1972)

Chapter IV: Study of vascular tissues: (04 L)

1. Cambium:
 - a. Origin of cambium
 - b. Structure of cambium
 - c. Types of cambium
2. Differentiation of xylem elements and their phylogenetic specialization
3. Development of sieve tube elements and their ultrastructure.

Chapter V: Study of Woods: (05 L)

1. Structure of Dicotyledonous and Gymnospermous woods
2. Reaction woods
3. Sap wood and Heart wood
4. Distribution of axial parenchyma:
 - a. Apotracheal
 - b. Paratracheal
 - c. Boundary parenchyma

Chapter VI: Study of Anomalous Secondary Growth (05 L)

- (A) Dicotyledonous stems:
- i. Normal cambium with abnormal activity
 - ii. Abnormal cambium with abnormal activity
- (B) Monocotyledonous stems:
- i. Dracaena
 - ii. Palms

B. EMBRYOLOGY (25 Lectures)

Chapter I : Historical events in embryology (02 L)

Introduction, Contribution of various workers in brief in the development of science of embryology such as; Pliny, Grew, Camerarius, Amici, Schleiden, Hofmeister, Strasburger, Hanstein, Maheshwari, Schnarf's.

Chapter II: Microsporangium (05L)

1. Development and structure of microsporangium.
2. Functions of wall layers. Tapetum, pollenkitt and sporopollenin. microsporogenesis, pollen units,
3. Male gametophyte structure, development and spermatogenesis,

4. study of certain abnormal developments (i) Pollen formation in Cyperaceae (pseudomonad), (ii) Pollen embryosac.

Chapter III : Megasporangium (04 L)

1. Development and structure of megasporangium, megasporogenesis,
2. Types of female gametophytes.
3. Nutrition of embryosac.

Chapter IV: Pollination and fertilization (05 L)

1. Self –pollination, methods of pollination, structure of stigma and style, pollen germination: pollen-tube formation and growth, sperm-cell.
2. pollen-pistil interaction: pollen recognition, acceptance rejection, pollen incompatibility entry of pollen tube into stigma, style and embryo sac, transfer of pollen tube contents into embryosac, fusion of gametes, fusion of nuclei.

Chapter V : Endosperms (03 L)

1. Introduction, development and structure of endosperms.
2. Physiology and cytology of endosperms with suitable examples. Function of endosperms

Chapter VI : Polyembryony (03 L)

1. Introduction, classification of polyembryony and causes of polyembryony.
2. Types of polyembryony: simple polyembryony, multiple embryony, nucellar, integumentary and endothelial polyembryony, zygotic, suspensor and synergial polyembryony,

Chapter VII : Experimental Embryology (03 L)

1. Anther and pollen culture, ovary culture, ovule culture, nucellar culture, endosperm culture, embryo culture

C. PALYNOLOGY (10 Lectures)

Chapter I : Introduction (01 L)

Concept, historical account, scope and Importance.

Chapter II: Pollen grains (03 L)

1. Development of pollen grains – meiotic and post-meiotic processes, differentiation of wall layers, exine stratification, polarity, symmetry,
2. Structure of mature pollen grain.
3. Pollen polymorphism.

Chapter III: Spore/Pollen development in plants (03 L)

1. Algae to angiosperms with respect to wall composition, exine ornamentation, apertural variations.

Chapter IV: Applied Palynology (03 L)

1. Geopalynology, Melittopalynology, Pollen allergy, Aerobiology Palynotaxonomy. Forensic palynology.

Reference Books:

(Anatomy)

- Carlquist, S. (1961) Comparative Plant Anatomy, Hold, Rinehart and Winston, New York, U.S.A.
- Carlquist, S. (1988) Comparative Wood Anatomy : Systematic, Ecological and Evolutionary Aspects of Dicotyledonous Wood. Springer-Verlag, Berlin, Germany
- Cutter, D.F. (1978) Applied Plant Anatomy, Longman, London and New York, USA
- Cutter, E.G.(1969) Plant Anatomy: Experiment and Interpretation. Part-I : Cell and Tissues, Edward Arnold, London, UK.
- Eames, A.J. (1961) Morphology of Angiosperms, McGraw Hill, New York, U.S.A.
- Eames, A.J. and McDaniels, L.H. (1974) An Introduction to Plant Anatomy, IInd Ed. McGraw Hill, New York and London, UK.
- Easu, K. (1960) Anatomy of the Seed Plants, Wiley, New York, U.S.A.
- Easu, K. (1965) Vascular Differentiation in Plants. Hold, Rinehart and Winston, New York, U.S.A.
- Easu, K. (1977) Anatomy of Seed Plants, (IInd Ed.) John, Wiley and Sons, New York, U.S.A
- Fahn, A. (1982) Plant Anatomy, III Ed. Pergamon Press, Oxford U.K.
- Fahn, A. (1995) Secretory Tissues in Plants. Academic Press. London, U.K.
- Foster, A.S. (1949) Practical Plant Anatomy, IInd, Ed. Van Nosrand, New York, U.S.A.
- Lyndon, R.F. (1990) Plant Development. The Cellular Basis. Unnin Hyman, London, U.K.
- M.N.B. (1998) Wood Anatomy and Major Uses of Wood. Faculty of Forestry, University Putra Malaysia, Malaysia.
- Mauseth, J.D. (1988) Plant Anatomy. The Benjamin / Cummings Publ. Co. In. Menio Park, californis, U.S.A.
- Metcalf, C.R. (1960) Anatomy of the Monocotyledons. I Graminae. Clarendon Press, Oxford, U.K.
- Metcalf, C.R. and Chalk, L. (1950) Anatomy of Dicotyledonos Vol.I-II. Clarendon Press, Oxford, U.K.
- Steeves, T. A. and I. M. Sussere (1989) Patterns in Plant Development (IInd Ed.) Cambridge University Press. Cambridge, U.S.A.
- Tomlinson, P.B. (1961) Anatomy of the Monocotyledons-II. Palmae (Ed. C.R.Metcalf), Clarendon Press, Oxford, U.K.

(Embryology)

- Bhojwani S.S. and S.P. Bhatnagar S.P. (1974) Embryology of Angiosperms Vikas Publishing House (P.) Ltd., New Delhi, India.
- Davis, G.L. (1966) Systematic Embryology of Angiosperms, John, Wiley and Sons, New York, U.S.A
- Johri, B.M. (1984 Ed.) Embryology of Angiosperms. Springer-Verlag, Berlin, Heidelberg, New York, U.S.A.
- Maheshwari, P. (1950) An Introduction To The Embryology of Angiosperms, McGraw Hill Book Co. New York, U.S.A.
- Maheshwari, P. (1963 Ed.) Recent Advances In The Embryology of Angiosperms International Society of Plant Morphologists, University of Delhi. Delhi, India.
- Percival, M.S. (1965) Floral Biology, Pergamon Press, Oxford, U.S.A.
- Proctor, M. and Yeo, P. (1973) The Pollination of Flowers, William Collins Sons, London.
- Raghavan, V. (1986) Embryogenesis in Angiosperms ; A Developmental and Experimental Study, Cambridge University Press. Cambridge, U.S.A.
- Raghavan, V. (1997) Molecular Embryology of Flowering Plants, Cambridge University Press. Cambridge, U.S.A.
- Raghavan, V. (1999) Developmental Biology of Flowering Plants, Springer- Verlag, New York , U.S.A.
- Raven, P.H., Evert, R.F. and S. E. Eichhom (1992) Biology of Plants (Vth Ed,) Worth, New York, U.S.A.

(Palynology)

- Erdtman, G. (1966) Pollen Morphology and Plant Taxonomy: Angiosperms, Hafner, New York, U.S.A
- Erdtman, G. (1969) Handbook of Palynology. , Hafner, New York, U.S.A
- Faegri, K. and J. Iversen (1964) Text Book of Pollen Analysis, Hafner, New York, U.S.A
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- Stanley, R.G. and H.F.Linskens (1974) Pollen Biology, Biochemistry and Management, Springer, New York, U.S.A.
- Shivanna, K.R. and Sawhney V.K. (Eds.) (1997) Pollen Biotechnology For Crop Production and Improvement, Cambridge University Press, Cambridge, U.K.

SEMESTER - IV
BOT. 421: ALGAE SPECIAL PAPER - II

Total: 60 Lectures

Aims and Objectives:

1. To know cellular details of prokaryotic and eukaryotic algae.
2. To understand algal physiology, biochemistry and genetics.
3. To know about cultivation of algae and its application.
4. To aware about commercial utilization of algae.
5. Role of algae in industries.

Chapter I: Algal cell biology and Genetics

(15 L)

1. Prokaryotic, Mesokaryotic, Eukaryotic Cell structure, and cellular organelles
2. Cell wall, Flagella, Cell division in algae
3. Type of Chloroplast / Plastids, Structure and arrangement of Thylakoid, Stroma.
4. Endoplasmic Reticulum, Pyrenoids, gas vacuoles, Golgi bodies, Mitochondria
5. The nucleus and nuclear divisions, Cell Division and Chromosomes in algae
6. Extra chromosomal Inheritance
7. Plastid DNA
8. Cyanophages
9. Sexuality (All three types)

Chapter II: Algal Physiology and Biochemistry

(15L)

1. Biochemical characteristics of Algal pigments and Extracellular products
2. Biochemical from algae: Carbohydrates and Proteins in Algae, Essential fatty Acids, Plant growth regulators
3. Algal toxins: Effect of toxins, mode of action, problems and prospects.
4. Nutrition in algae:
 - a) Mineral nutrition: - Macronutrients and Micronutrients
 - b) Types of Nutrition: Phototropic, Chemotropic.
5. Biological nitrogen fixation:
 - a) Role of enzyme nitrogenase, hydrogenase

- b) Mechanism of nitrogen fixation
 - c) Nitrogen fixing blue green algae
 - d) Heterocyst development and site of nitrogen fixation
 - e) Factors affecting on nitrogen fixation
6. Calcification and silicification.

Chapter IV: Basic Biological Features of Phytoplanktonic cells: (06 L)

1. Introduction, General, Recognition of phytoplankton, cell shape, cell dimension, cellwall, mucilage layer, chloroplast flagella, reserve substances,
2. Photosynthetic Prokaryotes (Cyanophytes), and Eukaryotic Phytoplankters general organization,
3. phytoplankters adptivness of form, Environmental influences on forms, Behaviour, Symbiosis, interaction with other organisms
4. Measuring of phytoplankton population and primary productivity

Chapter V: Algal Cultivation (12 L)

1. Definition, General requirements for culturing of algae, types of culture media
2. Preparatory culture, isolation of algae, streak culture, nutritive solution, dilution culture
3. Types of cultures: Enrichment culture synchronous culture, continuous culture, mass culture.
4. Growth measurements
5. Cultivation of algae in waste water
6. Current status of the large scale culture of algae in India

Chapter VI: Marine Algal Cultivation (06 L)

1. Introduction, Necessity of marine algal cultivation.
2. Principle methods of cultivation :
 - a) Vegetative propagation / Eucheuma type mariculture
 - b) Nonmotile spore type / Porphyra type mariculture
 - c) Motile spore (Zoospore) type / The Laminaria type Mariculture.
3. Marine algal cultural status and utilization in India

Chapter VII: Algal Utilization (06 L)

1. Nutritional Value of Microscopic and Macroscopic algae
2. Micro algae industrial raw material.
3. Industrial uses: Agar agar, Alginates, Carragene and other by products of marine algae.

4. Algal fuel: Biogas from algae, algal energy products, Hydrocarbons from algae
5. Cyanobacteria in human welfare: Production of fine chemicals, polysaccharides, bioactive molecules, pigments, antioxidants, and biofertilizer, Reclamations of Usar soils
6. Algae in Pharmacy Iodine, Vitamins, Proteins, Antibiotics.
7. Human food: Role of algae as nutrients supplement,

Reference Books

C. Van den Hoke, D. G. Mann & H.M. Jahns (1995) *Algae An Introduction to Phycology*, Cambridge University Press

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SEMESTER - IV

BOT. 422: MYCOLOGY AND PLANT PATHOLOGY SPECIAL PAPER - II

Total: 60 Lectures

Aims and Objectives:

1. To know the role of microbes in soil.
2. To study fungal toxin, fungal genetics and fungal ecology.
3. To provide thorough knowledge about industrial mycology.
4. To make the students aware about fungal biotechnology.
5. To create foundation for biotechnology in plant pathology.

Chapter I: Soil Microbiology (15 L)

1. Structure of soil, distribution and role of microbes in soil.
2. Humus and its role in agriculture.
3. Rhizoplane and Rhizosphere.
4. Microbial association in soil, Nitrogen fixation.

Chapter II: Industrial Mycology (20 L)

1. Preservation and maintenance of pure culture.
2. Methods of sterilization.
3. Principles of microbial growth, batch, continuous and synchronous cultures.
4. Assay methods for fermentation products, physical, chemical and biological methods.
5. fermentation process for following products: Alcohol, Citric acid, Vitamins, Enzymes, Antibiotics (Penicillin).
6. Mushroom cultivation- important steps involved in cultivation of button (*Agaricus*) and Dhingri (*Pleurotus*) Mushrooms on large scale.
7. Fermentation of Tea, Coffee, Cocoa and retting/ rotting of fibres.

Chapter III: Fungal Toxins (04 L)

1. Fungal toxins affecting man and animals.
2. Mycotoxins of food and feed stuffs, Ergot toxins, Mushroom toxins.

Chapter IV: Fungal Genetics: (08 L)

1. Incompatibility system, Tetrad analysis.
2. Parasexual cycle.
3. Industrial Strain improvement in *Penicillium*, Yeast and Mushroom.

Chapter V: Fungal Ecology (05 L)

1. Fungi in extreme environment, Thermophilic and Psychrophilic fungi.
2. Heterotrophy and its consequences, practical exploitation of saprotrophy.
3. Fungi as control agents-Entomogenous, Nematophagous and Mycoparasites.

Chapter VI: Fungi and Biotechnology (04 L)

1. Industrial fungi, Mycoprotein, Growth hormones, Miscellaneous products – Zeralenone, Mycoinsecticides, Mycoweedicides.
2. Mycorrhiza mass cultivation and its uses in agriculture and forest.

Chapter VII: Application of Biotechnology in Plant Pathology (04 L)

1. Importance of tissue culture.
2. Protoplast fission in plant pathology.
3. Engineering plants for resistance to disease and pest.
4. Somaclonal variance as a source of disease resistance.

Reference Books

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- Singh B. D. (1998) Biotechnology Kalyani Pub. New Dehli.
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- Subba Rao N. S. (1977) Soil Microorganisms and plant growth, Oxford & IBH Publ. Co. New Dehli.
- Thoma R. W. (1977). Industrials Microbiology, Strpoudshurg, Pennsylvania.
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SEMESTER - IV

BOT. 423: GENETICS AND PLANT BREEDING SPECIAL PAPER - II

Total: 60 Lectures

Objectives:

1. Acquaint students from modern strategies applied in Genetics and Plant Breeding to sequence and analyze genomes.
 2. To study cell differentiation and abnormalities in human cells with respect to oncogenesis.
 3. To provide detail knowledge about modern strategies applied in Plant Breeding targeted with specific character improvement.
 4. To provide detail knowledge about exploitation of Heterosis, hybrid and variety development and their release
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Chapter - I: Molecular Genomics and Development

(20 L)

1. Molecular mapping, molecular polymorphism, RFLP, RAPD, STS, AFLP, SNP MARKERS, construction of genetic and physical map, gene mapping and cloning. Introduction to DNA micro-array.
2. Genome and comparative genomics : High throughput genome sequencing in Arabidopsis, Rice and Human genome. Genome annotation, synteny, Gene search and comparison tool.
3. Functional genomics and proteomics: Approaches to analyze differential expression of genes ESTS, SAGE, Micro-arrays and their application, Gene tagging, Gene trapping, Gene silencing, knock out mutants, Approaches to proteome analysis, Dynamic modulation of protein structure and function, Structure to function-virtual organism.
4. Differentiation of specialized tissues: Stem cell differentiation, Blood cell formation, Fibroblast and their differentiation, Cellular basis of immunity. Differentiation of cancerous cell and role of Proto-oncogenes.

Chapter-2: Advanced Plant Breeding

(40 L)

1. Breeding for resistant to a-biotic stresses : a) Drought resistance b) Salinity tolerance c) Heat and cold resistance.
2. Breeding for resistant to biotic stresses : A) Disease resistance, B) Insect resistance.
3. Ideotype concept in crop improvement : Concept, types, Development of ideotypes, identification of traits for analysis. Determination of the value of a traits, ideotypes of selected crops - Maize, cotton.
4. Breeding for quality :

- a) Protein quality, Quality traits for cotton, Wheat, elimination of toxic substances, protein content and quality, genetic control of nutritional traits.
- b) Breeding for oil quality: Introduction to oil seed crops, Oil quality, breeding approaches.
- 5. Mutation breeding: Introduction, Effect of mutations mutagenic agents, physical mutagens, chemical mutagens, procedure for mutation breeding through chemical mutagens for oligogenic traits, application of mutation breeding.
- 6. Heterosis breeding prediction of heterosis, study of F₂ and segregating population, genetic distance and heterosis, development of heterotic pool. Use of male sterility in heterosis. Hybrid seed production system 1, 2, and 3 line system. Inbred and parental A, B, R lines. Maintenance of hybrid lines. Male sterile line creation, heterosis breeding in cotton, maize, pearl millet okra and oil seed crops.
- 7. Breeding of cotton and groundnut–Breeding objectives, characters associated with breeding, commercial hybrid development and seed production, Evaluation procedure for Bt cotton. Oil quality characters in groundnut.
- 8. Release of new varieties: Evaluation, identification of entries for release at state and national level, multiplication.
- 9. Quality seed production: a)Seed industries in India, b)The Indian seed act 1996, c) Classes of improved seeds, d) Requirements for certified seeds, e) Operations essentials to a seed industry, f) Quality seed production, processing and seed certification, g)Certified seed production in Maize and Cotton.
- 10. Organization for crop improvement in India: ICAR, IARI, CICR, Sugar cane breeding institute (SBI), NBPGR.
- 11. Organization for crop improvement at international level Introduction, CIMMYT, IRRI, ICRISAT, IPGRI.

Reference Books

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- Karp G.(2004)Cell and molecular Biology concepts and experiment. John Wiley, New Delhi, India.
- Klug W. S. & Cammings M. R.(2003). Concepts Genetics Scoot Forman & Co
- Lodishh. Berk A & Zipursky S. L.(2004)Molecular Cell Biology 5thedition W. H. Freemon and Co.
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- Singh P. (2014) Essentials of Plant Breeding Kalyani Publishers, New Delhi, India.
- Singh P. (2008) Plant Breeding at a Glance Kalyani Publishers

SEMESTER - IV

BOT. 424: ANGIOSPERM TAXONOMY SPECIAL PAPER - II

Total: 60 Lectures

Aims and Objectives:

1. To study biosystematics.
 2. To study the numerical taxonomy of angiosperms.
 3. To study chemotaxonomy of Angiospermic plants.
 4. To study Cronquist's system of classification of angiosperms
 5. To study ultrastructural systematics.
 6. To study Angiospermic Phylogeny Group System.
-

Chapter I: Biosystematics: (05 L)

1. Concept, aims and objectives, categories, methods in biosystematics, ecotypic variations, scope and limitations, comparison of classical taxonomy and biosystematics.

Chapter II: Numerical Taxonomy (10 L)

1. Phenetic methods in taxonomy (Taxometrics), Principles, Construction of taxonomy groups, OUT's, Unit character, measurement of resemblances, cluster analysis, phenons and ranks.
2. Discrimination, nomenclature and numerical taxonomy.
3. Applications, merits and demerits,
4. Cladistics and cladogram, Parsimony analysis, cladistics and classification

Chapter III: Chemotaxonomy (08 L)

1. Origin of chemotaxonomy.
2. Classes of compounds and their biological significance.
3. Stages in chemotaxonomic investigations, techniques,
4. Uses of chemical criteria in plant taxonomy, protein and taxonomy, seed proteins.

Chapter IV: Study of Conquest's system of classification (1968, 1988) with reference to (25L)

1. Outline of the system.
2. Refinements over his earlier system of 1968
3. Salient features of the system
4. Merits and demerits of system

5. Description, characterization and critical tendencies of the subclasses
6. Discussion on the following orders (*Sensu* Cronquist): (1) Piperales, (2) Hamamelidales, (3) Caryophyllales, (4) Dilleniales (5) Euphorbiales, (6) Asterales, (7) Najadales, (8) Arales, (9) Cyperales, (10) Zingiberales, (11) Liliales

Chapter V: Ultrastructural Systematics (05 L)

1. SEM and TEM studies and plant systematics.
2. SEM and plant surface structure, TEM and dilated cisternae of endoplasmic reticulum and sieve element plastids.
3. Applications of data in the classification of higher taxa.

Chapter VI: Angiosperm Phylogeny Group System (APG) (07 L)

1. Introduction, History and Development of Classification.
2. Principles, APG-I System (1998), APG-II System (2003), APG-III System (2009) and APG-IV System (2016).

Reference Books

- Angiosperm Phylogeny Group (1998) An ordinal classification for the families of flowering plants (APG I) *Ann. Missouri Bot. Gard.* 85: 531-553.
- Angiosperm Phylogeny Group (2003) An update of the Angiosperm Phylogeny Group Classification of the Orders and families of flowering plants. (APG II) *Bot. J. Linn. Soc.* 141: 399-436.
- An Update of Angiosperm Phylogeny Group Classification (2009) (APG III) *Bot. J. Linn. Soc.* 161:105-121.
- An Update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG IV. (2016) *Bot. J. Linn. Soc.* 181:1-20.
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- Vardhana Rashtra 2009. Taxonomy of Angiosperm. Vol. 1-2, Campus Books International, New Delhi, India.
- Walter S. Judd. Et al . 2002. Plant Systematics- A Phylogeny Approach. Sinauer Associates-Inc. USA

SEMESTER - IV
BOT. 431: ALGAE SPECIAL PAPER - III

Total: 60 Lectures

Objectives:

1. To study ecological classification of algae.
 2. To understand those environmental factors which control their survival growth, distribution and causal mechanisms
 3. To helps in bio-monitoring the water bodies and pollution control.
 4. To know phycological techniques in algae, from water supplies.
 5. To study the role of algae in sewage disposal.
-

Chapter I: Ecological Classification of Algae

(08 L)

1. Phytoplankton
2. Benthic algae
3. Cryophilic algae
4. Thermophilic algae
5. Soil Algae
6. Epiphytic algae
7. Lithophytes
8. Endophytic algae
9. Symbiotic algae
10. Parasitic algae

Chapter II: Fresh Water Bodies

(10 L)

1. Lentic and Lotic environment: - General considerations physical and chemical factor and their influence, Types of Lakes, Zonation types of Lentic and Lotic water bodies, phytoplankton nature, adaptation, periodicity and succession.
2. Flora of Lentic and Lotic series and its feature

Chapter III: Marine Environment

(10 L)

1. General considerations, physical and chemical factors, marine phytoplankton nature, seasonal growth cycles, productivity.
2. Marine benthic algae, shore type Zonation patterns and factors governing them, Zonation pattern of East and west Coast of India

Chapter IV: Algae and Sewage Disposal (08 L)

1. Necessity of sewage disposal
2. Composition of sewage (Physical, chemical biological)
3. Treatment of waste water: Pretreatment, secondary biological treatment.
4. Types of algal stabilization ponds
5. Algal flora their periodicity and succession in sewage stabilization ponds.

Chapter V: Algae in Water Supplies (08 L)

1. General considerations
2. Common algae in water supplies
3. Phytoplankton counts methods.
4. Filter clogging algae.
5. Algae causing odour, taste, colour, and slime in water.
6. Algae causing corrosion
7. Uses of algae in water supplies
8. Control of algae in water supplies.

Chapter VI : Eutrophication and Biomonitoring of Water Quality (10L)

1. Definition of pollution
2. Types of water pollutants
3. Eutrophication Definition, Process of eutrophication, Effects of eutrophication and algal bloom, Controls of water blooms pollution tolerant genera.
4. Saprobic zones (Kolwevitz and marson 1909)
5. Saprobic zones (Partick 1977)
6. Algae in organically polluted waters and home sewage
7. Diatoms as indicators of water pollutions
8. Nygaard's tropic state indices.
9. Palmer's pollution index
10. Water pollution monitoring and management bodies,
11. Important organizations involved in water pollution control and monitoring in India and role of NGO's in water pollution management
12. Some international phycological societies and journals

Chapter VII: Phycological Techniques

(06 L)

1. Field Collection procedure for marine and freshwater algae, phytoplankton
2. Ecological Field Methods: Macro algae
3. Preservation, preparation of herbarium and permanent slides
4. Histochemical and general methods, stains and fixatives

Reference Books

- Abbasi, S.A. (1998) **Water Quality Sampling and Analysis**. Discovery Publishing House New Delhi, India.
- Agrawal, S.C. (1999) **Limnology**. APH Publishing Corporation, New Delhi, India.
- Anand, N. (1989) **Handbook of Blue Green Algae**. Bishen Singh Mahendra Pal Singh, Dehradun, India.
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- Trivedi, R.K. and Goel P.K. (1986) **Chemical and Biological methods for Water Pollution Studies**.Environmental Pub., Karad (M.S.), India.

SEMESTER - IV

BOT. 432: MYCOLOGY AND PLANT PATHOLOGY SPECIAL PAPER - III

Total: 60 Lectures

Objectives:

- i. To know the development of plant pathology in India.
 - ii. To study physiological plant pathology.
 - iii. To provide thorough knowledge about medical mycology, seed pathology.
 - iv. To make the students aware about market pathology and forest pathology.
 - v. To study abiotic and biotic diseases of plants.
 - vi. To create foundation for control fungal disease.
-

Chapter I: History of Plant Pathology in India (01 L)

Chapter II: Physiological Plant Pathology (15 L)

Concept of plant disease, expression, inoculum potential, production and distribution, mechanism of infection, effect of environment on multiplication of pathogens and outbreak of disease, defense mechanism, disease resistance, physiology of diseased plants.

Chapter III: Specific plant diseases and their control (16 L)

- a) Abiotic : environmental factors that cause disease – temperature, moisture, oxygen , light and mineral deficiency.
- b) Biotic: plant diseases caused by Viruses: Leaf curl of Tomato, Yellow vein mosaic of Bhendi Mycoplasma: Little leaf of Brinjal, Grassy shoot of Sugarcane Bacterial: Citrus canker, Angular leaf spot of Cotton.

Fungi: Downy mildews of crucifer, Downy mildew of Grape, Powdery mildew of Grapes, Rust of Wheat, Smut of Jowar, Red rot of Sugarcane.

Nematode: Root knot of vegetables, Soyabean cyst nematode.
- c) Physical, Chemical and Biological control measures.

Chapter V: Medical Mycology: (04 L)

Mycotic infections, dermatophytes and deep mycoses

Chapter VI: Seed Pathology: (05 L)

Methods of study, external and internal seed born diseases, quarantine laws and seed certification, storage mycoflora and toxins.

Chapter VII: Market Pathology: (03 L)

Post harvest fungal diseases of fruits and vegetables.

Chapter VIII: Forest Pathology : (04 L)

Forest diseases, management and wood decay.

Chapter IX: Enzymes and toxins in plant diseases: (12 L)

Composition of cell wall material, mode, action, classification, assay of pectolytic, cellulolytic, lignolytic and protolytic enzymes, classification, mode of action of host specific and non specific toxins, role of toxins in disease development.

References Books :

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SEMESTER - IV

BOT. 433: GENETICS AND PLANT BREEDING SPECIAL PAPER - III

Total: 60 Lectures

Aims and Objectives:

1. Acquaint students about principles, methodology and application Plant Biotechnology to improve crops.
 2. To provide detail knowledge about intellectual properties and different issues, GMO, current techniques applied in Molecular Plant Breeding for future challenges in crop improvement.
-

Chapter I: Plant Biotechnology for Crop Improvement

1. Biotechnology and its relevance in agriculture, definitions, terminologies and scope in plant breeding. (02 L)
2. Tissue Culture: History, Callus culture, Suspension culture, Micro propagation, Somatic embryogenesis, Anther culture, Somatic hybridization, Meristem Culture, Ovary culture, Embryo Culture. Cryo-preservation, somaclonal variation and secondary metabolite production. (06 L)
3. Molecular mapping, Tagging of Agronomically important traits, Statistical tools in marker analysis. Marker assisted selection for qualitative and quantitative traits. QTL analysis in crop plants, gene pyramiding. (06 L)
4. Marker assisted selection and molecular breeding, genomics and genomic information for crop improvement. Integrating functional genomics information on agro-nomically important traits in Plant Breeding. Marker assisted back cross breeding for rapid introgression (06 L)
5. Recombinant DNA technology, Trans-genes. Methods of transformation selectable markers, vector mediated gene transfer, via agro-bacterium. physical methods of gene transfer production of transgenic plants in field crops Cotton, Wheat, Maize, Rice, Soybean, soil seeds Sugarcane and Brinjal their commercial release (08 L)
6. Application of plant transformation for productivity and performance, herbicide resistance, disease resistance, post-harvest losses, long shelf life of fruit and flower (04 L)

Chapter II: Modern Trends in Genetics and Plant Breeding

1. Genetically modified organisms. International regulation of bio-safety issues of GMOs, regulatory procedures in India, ethical, legal and social issues.

2. Intellectual property rights (IPR) and its management. Historical perspectives and need for the introduction of intellectual property rights regime. TRIPS and various provisions in TRIPS agreement. IPR and their benefits, Indian legislations for the protection of various types of intellectual properties fundamentals of patent, copyrights, geographical indications designs and layout, trade secrets trademarks. (05 L)
3. Protection of plant varieties and formers right, biodiversity protection, protectable subject matter, protection in biotechnology, period of protection international treaty on plant genetic resources for food and agriculture's licensing of technologies, material transfer agreements research collaboration agreement, license agreement. (05 L)
4. Functional genomics using micro-array technology SNP detection, environmental agent's detection micro-array design, experimentation with micro-array computational analysis of micro-array data. Proteome analysis, electrophoresis, iso-electical focusing HPLC, MASS spectroscopy in proteomics MALDITOF, electro-spray ionization, MUDPIT and protein arrays. (09 L)
5. Protein Structural Genomics–introduction, determination of gene function by comparison of sequences through conserved protein structure. Approaches to protein structural genomics and protein expression. Protein interactions, their screening and informatics tools. (09 L)

Reference Books

- Chopra V. L. and Nasim A. (1990) Genetic engineering and Biotechnology concepts, methods and applications Oxford and IBH, New Delhi, India.
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SEMESTER - IV

BOT. 434: ANGIOSPERM TAXONOMY SPECIAL PAPER - III

Total: 60 Lectures

Aims and Objectives:

1. To study wood anatomy of Angiospermic plant.
 2. To study ecological anatomy of Angiosperms.
 3. To study embryology of Angiospermic plant.
 4. To study palynology of Angiospermic plant.
 5. To trace origin of Angiosperms.
-

Chapter I: Wood Anatomy (07 L)

1. Hard and soft wood.
2. Elements of wood, their structure and distribution.
3. Properties and uses of wood in relation to structure and composition.
4. Anatomy and identification of important timbers.

Chapter II: Ecological Anatomy (08 L)

1. Hydrophytes: (i) Submerged, (ii) Free floating, (iii) Anchored floating, (iv) Amphibious.
2. Xerophytes: (i) Microphyllous, (ii) Sclerophyllous, (iii) Trichophyllous, (iv) Malacophyllous
3. Halophytes
4. Parasites
5. Epiphytes

Chapter III: Embryology (10 L)

1. Different schools of embryology and their contributions,
2. Artificial pollination, fertilization,
3. Sexual incompatibility,
4. Endosperm, endosperm – ultra structure and histo-chemistry.
5. Embryo as a reaction system, homologies, experimental embryogenesis,
6. Embryo-endosperm relationship,
7. Embryology in relation to taxonomy,
8. Fertilization in *Tambourissa* and *Butomopsis* and their significance

Chapter IV: Palynology (15 L)

1. Pollen units, pollen biochemistry and physiology.
2. Pollen kitt, pollen wall proteins, pollen germination *in vivo* and *in vitro*.
3. Pollen storage and viability, pollen sterility.
4. Pollen polymorphism, palynology on the basis of angiosperm phylogeny.

Chapter V: Origin of Angiosperms (20 L)

1. Time of origin of angiosperms
2. Cradle of angiosperms
3. Theories of origin of Angiosperms with respect to time, place and possible ancestors:
 - a. The *Isoetes* – monocotyledon theory,
 - b. The Coniferales- Amentiferae theory,
 - c. The Gnetales- Angiosperm Theory,
 - d. The Anthostrobilus- (Bennettitalean) Theory,
 - e. The Caytonialean Theory,
 - f. The Stachyosporia- Phyllospereae Theory,
 - g. The Pteridosperm Theory,
 - h. The Pentoxylales Theory and The Durian Theory

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SEMESTER - IV
BOT. 404: PRACTICAL - I (BASED ON BOT.401)

ANATOMY

- Practical 1-2** : Study of stomata types by peeling methods
- a. Types in Dicotyledons
 - b. Types in Monocotyledons
- Practical 3** : Study of Trichomes covering different types.
- Practical 4** : Isolation and study of wood elements by acid maceration method. (Preparation of permanent slides by students)
- Practical 5-6** : Double stained preparation of woods:
- a. Dicot. woods (Covering all types)
 - b. Gymnospermous wood (Any two coniferous woods)
- Practical 7** : Study of anomalous structures in stem from permanent or prepared slides:
- i) *Bignonia*
 - ii) *Aristolochia, Tinospora* (Any one)
 - iii) *Boerhavia, Mirabilis, Chenopodium* and *Amaranthus*(Any two)
 - iv) *Achyranthes*
 - v) *Salvadora* and *Combretum* (Any one)
 - vi) *Dracaena*
- Practicals 8-9** : Double stained preparation of permanent slides using microtomy. (Using any suitable plant parts. leaf, stem, root, flower, etc.)

EMBRYOLOGY

- Practical 10** : Types of flowers (P.S.).
- Practical 11** : Types of development of microsporangium, microsporogenesis microspores, male gametophyte of angiosperms with the help of permanent slides
- Practical 12** : Study of megasporogenesis and female gametophytes of angiosperms From permanent slides.
- Practical 13** : Study of endosperm types (P.S.)
- Practical 14** : Study of Stages of embryo development (permanent slides)
- Practical 15-16:** Dissection and mounting of different stages of embryo development using suitable materials (e.g. *Cyamopsis tetragonaloba* and *Cucumis* and multiple embryos in *Citrus* seeds.)

PALYNOLOGY

- Practical 17** : Study of pollen development, tetrad types, pollen units: monad, dyad, tetrad, polyad, pollinia

Practical 18-19: Pollen/ Spore preparation of the following using acetolysis or any Other suitable method:

- i. Angiosperms pollens
- ii. Gymnosperms
- iii. Bryophytes types
- iv. Pteridophytes types.

Practical 20 : Pollen analysis from honey samples using acetolysis or any other Suitable method and permanent slides preparation

Practical 21-24: Practical converted in to project work (Four practical)

Note:

- i) Submission of permanent slide preparation at least two dicot woods and Two Gymnosperm woods and two whole mounts of wood maceration is necessary.
- ii) Submission of permanent slides at least one vegetative/ floral part.
- iii) Submission of Five palynological slides is compulsory.

SEMESTER - IV
BOT.405: PRACTICAL - II
ALGAE SPECIAL

(BASED ON THEORY PAPER BOT.421 AND BOT.431)

- Practical 1** : Preparation of culture media (De's modified Beneck's medium for Blue Green Algae)
- Practical 2** : Isolation and cultivation of algae by dilution and streak culture technique
- Practical 3** : Mass culture of blue green algae as bio-fertilizer
- Practical 4** : Biomass estimation, total chlorophyll / fresh and dry weight
- Practical 5-6** : Extraction and separation of amino acids and carbohydrates of algae by chromatography methods
- Practical 7-8** : Algae of unusual habitats
- (a) Epiphytic algae,
 - (b) Epizoic and Endozoic algae,
 - (c) Symbiotic algae,
 - (d) Endophytic algae,
 - (e) Benthic algae,
 - (f) Aerialalgae
 - (g) phytoplankton
- Practical 9-10** : Algae of east & west coast of India
- Practical 11-12** : Qualitative and quantitative studies of phytoplankton using standard Methods Lacky's simple drop method and haemo-cytometer method.
- Practical 13** : Study of Palmer's pollution index for assessing the water quality of any polluted habitat
- Practical 14 -16** : Water analysis pH, Turbidity, Total dissolved solids dissolved oxygen, Free CO₂, BOD, COD, Carbonate, Bicarbonate, Total Alkalinity, Chlorides, Hardness, Calcium, Magnesium, Nitrate, Sulphate, Phosphate(any 6)
- Practical-17** : Cytological studies of Chara, Hydrodictyon, Cladophora, Spirogyra, Oedogonium (any 1)
- Practical 18** : Extraction of Mucilage from algal material.
- Practical 19** : Extraction of Agar-Agar, Extraction of Algenic acid from Marine algae
- Practical 20** : Extraction and Estimation of algal proteins from unpolluted waters and polluted water bodies.
- Practical 21-24** : Practical converted in to project work (Four practical)

- Note** : i. Compulsory Botanical excursion of marine and fresh water habitats
- ii. Compulsory Botanical excursion Visit to nearby ponds rivers lakes and polluted habitats.
- iii. Submission of algal photomicrograph and tour report is essential.

SEMESTER - IV
BOT. 405: PRACTICAL - II
MYCOLOGY AND PATHOLOGY SPECIAL
(BASED ON BOT. 422 AND BOT.432)

(20 Practical)

- Practical 1** : Basic techniques in plant pathology.
- Practical 2** : Isolation of fungal plant pathogens.
- Practical 3-4** : Isolation and enumeration of microorganisms from soil by serial dilution plate method.
- Practical 5** : Isolation of mycorrhiza from soil.
- Practical 6** : Isolation of *Rhizobia* from root nodules.
- Practical 7** : Isolation of fungal pathogen from seeds.
- Practical 8** : Isolation of post harvest fungal pathogens from fruits.
- Practical 9** : Study of forest diseases (any three).
- Practical 10** : Study of diseases caused by bacteria and viruses (any two), Mastigomycotina and Plasmodiophorales (any three).
- Practical 11** : Study of diseases caused by Ascomycotina (any three)
- Practical 12** : Study of diseases caused by Basidiomycotina (any three)
- Practical 13** : Study of diseases caused by Deuteromycotina (any three)
- Practical 14-15** : Biochemical studies of diseased plants by paper chromatography (sugar / amino acids)
- Practical 16-17** : Biochemical studies of diseased plants (enzymes /proteins/ polyphenol).
- Practical 18** : Citric acid fermentation and assay.
- Practical 19** : Alcohol fermentation and distillation.
- Practical 20** : Spawn preparation and mushroom cultivation.
- Practical 21-24** : Practical converted in to project work (Four practical)

Note: Visit to fermentation industries, research institutes, Agriculture University etc. Long and short tours for collection of phytopathological organisms are compulsory

SEMESTER - IV
BOT. 405: PRACTICAL - II
GENETICS AND PLANT BREEDING SPECIAL
(BASED ON THEORY BOT.423 & BOT.433)
(Any 20 Practical)

- Practical 1** : Isolation of DNA
- Practical 2** : Quantification of plant DNA by DPA method
- Practical 3** : Quantification of RNA by orcinol method
- Practical 4** : Isolation and purification of proteins from plant materials
- Practical 5** : Protein or iso-enzyme gel electrophoresis
- Practical 6** : Agarose gel electrophoresis of DNA
- Practical 7** : PCR amplification of DNA
- Practical 8** : Study of mutagenesis in crops
- Practical 09-10** : Study of salinity stress on Coriander
a) Morphological changes b) Anatomical changes c) Biochemical changes with respect to (i) Protein content, (ii) Proline content
- Practical 11** : Study of protein content by Lowry's method from the plant samples of different lines which are recovered from crossing program carried in Semester III practical schedule
- Practical 12-13** : Study of enzymes defines stress tolerance in crops. (any two)
- Practical 14-15** : Study of correlation and regression from given data.
- Practical 16-17** : Statistical analysis of F1 populations and finding out their results and conclusion, finding of GCA and SCA with gene action
- Practical 18-19** : Study of cluster and path analysis.
- Practical 20** : Visit to Agricultural research station
- Practical 21-24** : Practical converted in to project work (Four practical)

SEMESTER - IV
BOT.405: PRACTICAL - II
ANGIOSPERM TAXONOMY SPECIAL
(BASED ON THEORY PAPER BOT. 424 & 434)
(Any 20 Practical)

- Practical 1** : Identification of six important timbers with the help of anatomical characters.
- Practical 2-9** : Study of anatomical features of ecological interest of the following:
 Hydrophytic leaves (Any two) : *Potamogeton*, *Ceratophyllum*, *Hydrilla*, *Ottelia*, *Vallisneria*, *Typha*, *Limnophila*, *Phylla nodiflora*, *Bacopa monieri*, *Nymphaea*, *Nelumbo*.
 Hydrophytic stem or petiole (Any two): *Limnophila*, *Hydrilla*, *Potamogeton*, *Bacopa monieri*, *Nymphaea*, *Nelumbo*.
 Xerophytic leaves (Any two): *Euphorbia nerifolia*, *Calotropis sp.*, *Pentstemon sp.*, *Nerium sp.*, *Ficus bengalensis*.
 Xerophytic stem (Any two): *Casuarina equisetifolia*, *Tamarix sp.*, *Capparis deciduas*, *Caralluma sp.*, *Euphorbia tirucalli*, *Sarcostema sp.*
 Specialized structure (Any one) : (a) Cladode of *Asparagus sp.*, (b) Phyllode of *Acacia auriculiformis*
 Parasites (Any one): *Striga gesneroides*, *Cuscuta chinensis*.
 Epiphytes: Study of velamen tissue (either from root material or permanent slide)
- Practical 10** : Embryology: Dissection and mounting of stages of embryo development, multiple embryos and endosperm from locally available materials.
- Practical 11-14** : Palynology:
 i) To observe pollen fertility.
 ii) To study pollen polymorphism.
 iii) Palynotaxonomy of some selected taxa (either family or a genus).
- Practical 15-20** : Study of the families with respect to morphological characters using botanical terms, floral formula, floral diagram and classification. (*Sensu* Bentham and Hooker's system at least 10 families)
- Practical 21-24** : Practical converted in to project work (Four practical)

EQUIVALENCE OF PAPERS

SEMESTER - III (Old Course)

- BOT – 3.1 : Gymnosperm and Palaeobotany**
- BOT – 3.2 : Plant Biotechnology and Bioinformatics**
- BOT – 3.31 : Algae special paper – I**
- BOT – 3.32 : Mycology and Plant Pathology Special paper - I**
- BOT – 3.33 : Genetics and Plant breeding Special paper - I**
- BOT – 3.34 : Angiosperm Taxonomy Special paper - I**
- BOT – 3.4 : Practical – I (Based on Bot – 301 & 302)**
- BOT – 3.5 : Practical – II (Based on Bot – 331 / 332 / 333/ 334)**

SEMESTER - III (New Course)

- BOT – 301 : Gymnosperm and Palaeobotany**
- BOT – 302 : Plant Biotechnology and Bioinformatics**
- BOT – 331 : Algae special paper – I**
- BOT – 332 : Mycology and Plant Pathology Special paper - I**
- BOT – 333 : Genetics and Plant breeding Special paper - I**
- BOT – 334 : Angiosperm Taxonomy Special paper - I**
- BOT – 304 : Practical – I (Based on Bot – 301 & 302)**
- BOT – 305 : Practical – II (Based on Bot – 331 / 332 / 333/ 334)**

SEMESTER - IV (Old Course)

- BOT – 4.1 : Developmental Botany**
- BOT – 4.21 : Algae special paper - II**
- BOT – 4.22 : Mycology and Plant Pathology Special paper - II**
- BOT – 4.23 : Genetics and Plant breeding Special paper - II**
- BOT – 4.24 : Angiosperm Taxonomy Special paper - II**
- BOT – 4.31 : Algae special paper – III**
- BOT – 4.32 : Mycology and Plant Pathology Special paper - III**
- BOT – 4.33 : Genetics and Plant breeding Special paper - III**
- BOT – 4.34 : Angiosperm Taxonomy Special paper - III**
- BOT – 4.4 : Practical – I (Based on Bot – 401)**
- BOT – 4.5 : Practical – II (Based on Bot – 421 & 431 /Bot – 422 & 432 / Bot – 423 &433/ Bot – 424 &434)**

SEMESTER - IV (New Course)

- BOT – 401 : Developmental Botany**
- BOT – 421 : Algae special paper - II**
- BOT – 422 : Mycology and Plant Pathology Special paper - II**
- BOT – 423 : Genetics and Plant breeding Special paper - II**
- BOT – 424 : Angiosperm Taxonomy Special paper - II**
- BOT – 431 : Algae special paper – III**
- BOT – 432 : Mycology and Plant Pathology Special paper - III**
- BOT – 433 : Genetics and Plant breeding Special paper - III**
- BOT – 434 : Angiosperm Taxonomy Special paper - III**
- BOT – 404 : Practical – I (Based on Bot – 401)**
- BOT – 405 : Practical – II (Based on Bot – 421 & 431 /Bot – 422 & 432 / Bot – 423 &433/ Bot – 424 &434)**
- BOT – 406 : Project work**