

NORTH MAHARASHTRA UNIVERSITY,
JALGAON - 425 001.

SYLLABUS FOR M.Sc. BOTANY (PART-II)
(From June, 1993)

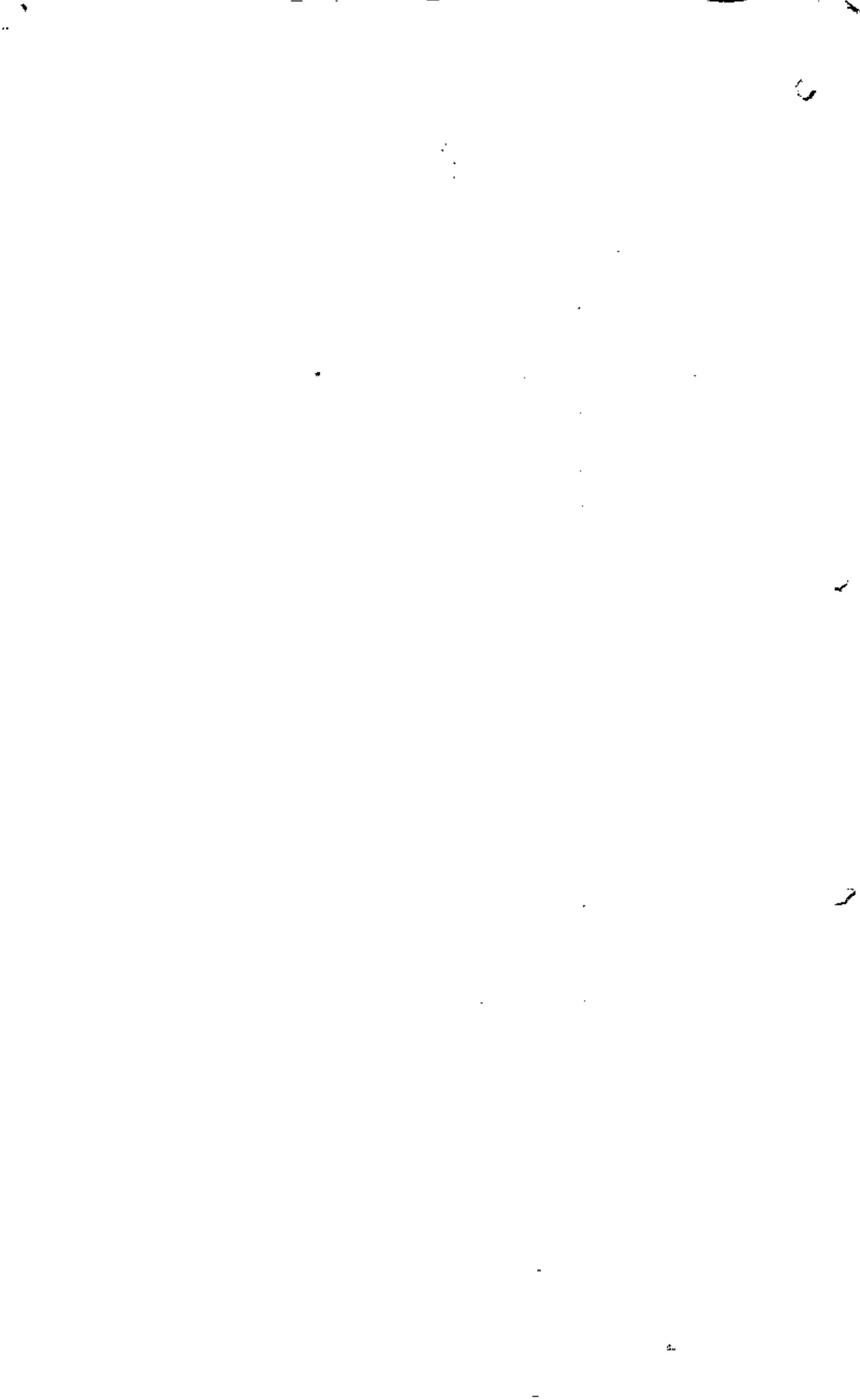
SEMESTER - III

11. BOT 3.1 Plant Biotechnology.
12. BOT 3.2 Gymnosperms and Palaeobotany.
13. BOT 3.31 Algae special paper - I
BOT 3.32 Mycology and Plant pathology
Special Paper-I
BOT 3.33 Angiosperms special paper- I
BOT 3.34 Plant Physiology special paper-I
14. BOT 3.4 Practical on BOT 3.1 and BOT 3.2
15. BOT 3.5 Practical on special paper I
(BOT 3.31 BOT 3.34)

SEMESTER IV

16. BOT 4.1 Developmental Botany.
17. BOT 4.21 Algae special paper II
BOT 4.22 Mycology and Plant pathology special paper-II
BOT 4.23 Angiosperms special Paper-II
BOT 4.24 Plant Physiology special Paper-II.
18. BOT 4.31 Algae special Paper-III.
BOT 4.32 Mycology and Plant pathology special
Paper-III
BOT 4.33 Angiosperms special paper III.
BOT 4.34 Plant Physiology Special Paper-III.
19. BOT 4.4 Practical on BOT 4.1.
20. BOT 4.5 Practical on special papers II and III
(BOT 4.21-4.25 and BOT 4.31-4.35)

NOTE : All Course are University Courses. The examination
for all University Courses will be University :
Examination.



NORTH MAHARASHTRA UNIVERSITY, JALGAON.

M.Sc. Part-II

BOTANY (From June, 1993)

SEMESTER III BOT : 3.1 Plant Biotechnology (48 Lecture)

1. Fundamentals of Biotechnology : Definition, Introduction, Important milestones and application.
2. Fermentation Technology : i) Defination, ii) Aerobic and anaerobic fermentations, iii) Design of fermentors, iv) Parameters of fermentations, v) Schematic representation of fermentation process, primary and secondary metabolites, Alcohol, Organic acids, Vitamins and Antibiotics, vi) Biochemical Engineering.
3. Biomass technology for food, feed and fertilizers : Single cell proteins its: need and applications, Mass culture for proteins, mushroom cultivation. Cultivation of algae on waste as feed. Biofertilizers types, mass production and its advantages over chemical fertilizers.
4. Enzyme technology : (a) Technology of Enzyme production (sources, media, extraction and purification), its industrial applications. (b) Immobilized enzymes and whole cells : definition, methods of immobilization and their uses in water treatment, uses in synthesis of medical products.
5. Biological Fuel technology : Biomass as potential energy source, Energy plantation, utilization of Biomass for ethanol and methane. Animal and industrial organic wastes as Potential source for Fuel, Biological Fuel cell.
- 6) Genetic Engineering : Definition cutting of DNA joining of DNA, restriction endonucleases, ligation, transformation, amplification, application in agriculture & medicine.
7. Biotechnology in Agriculture and Forestry : Plant cell culture, principles and applications, clonal propagation of economically important plants, production of plants of various ploidy levels and fusion, somatic hybridization, suspension culture for production of plant metabolites secondary plant products.

RECOMMENDED BOOKS

1. Atkinson : Cultivation of edible mushrooms.
2. Baker, E.W. and Venkataraman C.V. : A manual on the cultivation and proceeding of algae as a source of Sep.
3. Bhojwani, S.S. and Razdan, M.K. : Development in crop science (5) plant tissue culture theory and practice.
4. Biotechnology Volumes.

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Contributions of Indian Mycologists. International
Mycological Institute (IMI), its services & Publications.

- III) Modern trends in taxonomy of fungi; Ultrastructure, cell-wall composition, Septa, Concept of hyphae, Mycelium, rhizomorphs and fructifications.
- IV) A comprehensive account of structure, development, reproduction, life cycles, classification, Phylogeny interrelationships and evolutionary aspects of Myxomycota, Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deteromycotina and Lichens.

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BOT : 3.33

Angiospermae Special Paper-I (60 Lectures)

- I) Study of Cronquist's system of classification with respect to -
 - a) Salient Features of the system.
 - b) Characterization and critical tendencies of subclasses.
 - c) Discussion on orders, Merits and demerits of the system.
- II) Modern trends in taxonomy :
 - 1. Ultrastructure.
 - 2. Serology.
 - 3. Wood anatomy.
 - 4. Cytochemistry.
 - 5. Biosynthetic pathway.
 - 6. Numerical taxonomy.

III) Biosystematics-

Concept, Aims and objectives of biosystematics categories and methods in biosystematics. Comparison of classical taxonomy and Biosystematics.-

IV) Floristics :

Principles distinction between Flora and Vegetation, Floral composition and elements in the flora of Maharashtra and India.

BOT : 3.34 Plant Physiology Special Paper I
(48 Lectures)

- I Cell organization : Methods of studying cells structure, (gross & Ultra), functions of membrane, cell wall, plasmodesmata, plasma membrane, Mitochondria, plastids, endoplasmic reticulum, Lysosomes, ribosomes, origin and

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evolution of Eukaryotic cells.

- II). Genoma, organisation, structure of DNA, RNA, DNA sequencing, -
Replication of DNA, Transcription, RNA type, RNA processing, genetics code, protein synthesis.
- III) Phytochemistry : Chemistry of organic acids,
phenols, alkaloids, tannins, lignins,
pigments, terpenes, flavonoids, plant
growth substances.
- IV) Bioenergetics : Definition, Bioenergetics of
photosynthesis, Luminescence, chlorophyll
fluorescence.
- V) Instrumentation :
1) Phase contrast microscope.
2) Chromatography (Different types)
3) Electrophoresis.
4) Colorimetry.
5) PH. meter.
6) Spectrophotometer.
7) Conductivity Bridge.

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SEMESTER IV

BOT : 4.1 Developmental Botany (60 Lectures)

A. Anatomy : (24 Lectures)

1. Organization of plant body,
2. Apical meristems & differentiation.
3. Leaf formation and expansion stomata - development and classification.
4. Vascular cambium.
5. Differentiation of Xylem elements and their phylogenetic specialization.
6. Development of sieve tube elements and their ultra structure.
7. Structure of dicot & Gymnosperm Wood.
8. Reaction wood, cause of reaction wood, formation.
9. Development of stems in arborescent monocotyledons.
10. Floral Anatomy - Transition to flowering and development of lateral organs.
11. Structure of fruit and seed.

B. Embryology (24 Lectures)

- B.1 Microsporangium - Development, structure and function of microsporangium, microsporogenesis, male gametophyte.
- B.2 Megasporangium - Development, structure and function of megasporangium, megasporogenesis, female gametophyte different types, nutrition of embryosac.
- B.3 Endosperm : Development structure and function.
- B.4 Embryogenesis - Development of embryo (Monocot and dicot) nutrition embryo, structure of mature embryo Apomixis.
- B.5 Experimental and applied embryology pollen, Anther, pollen, ovule & embryo culture.

C. Palynology (12 Lectures)

- C.1 Introduction - concept, historical account, scope.
- C.2 Pollens : Development of pollen grains - Meiotic and Post-meiotic processes, differentiation of wall layers Exine stratification, polarity, symmetry, NPC, pollen Ultrastructure.
- C.3 Spore/Pollen development in plants - Algae to Angiosperms w.r.t. structure, wall composition, ornamentation, aperture wall composition, Algae to Angiosperms.
- C.4 Applied palynology : - Pharmacopalynology Geopalynology, Aerobiology, Pollen allergy, Palynotaxonomy.

HYDROBIOLOGY :

1. Introduction, Review of Hydrobiological work in India.

2. Lentic environment : General considerations, Physico-chemical factors and their influence. Phytoplankton - quantity and quality, periodicity & succession, vertical distribution, adaptations of planktons. Biological productivity of Inland waters & factors influencing it.

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3. Lotic environment : General considerations, Physico-chemical factors. Phytoplankton, quality, quantity, periodicity & succession, vertical distribution, Productivity & factors influencing on it.

4. Marine environment : General considerations, Physico-chemical factors and their influence. Marine phytoplankton-Density, Diversity, Periodicity & succession, Vertical distribution, Productivity & factors influencing on it.

5. Eutrophication :

1. Definition, factors responsible for eutrophication.

2. Biotic relationships.

3. Effects of eutrophication on water blooms.

4. Control measures of eutrophication & water bloom.

5. Palmer's Index of Pollution and Nygaard's Tropic Indices.

6. Ecology of Algae : Ecological classification of algae :

1) Planktons 2) Benthos 3) Halophytes

4) Thermophytes 5) Cryophytes 6) Soil algae

7) Lithophytes. 8) Epiphytes & endophytes,

9) Symbiotic algae. 10) Parasitic algae.

7. Marine benthic Algae :

General principles, Shore types, zonation pattern, life forms, geographical distribution, marine algae of east & west coast of India.

8. Sewage disposal :

1. Introduction, definition, composition of sewage, necessity of sewage disposal.

2. Nature of sewage - Physical, chemical & biological considerations of sewage treatment.

3. Disposal of solids process & digestion, septic & imhoff tanks.

4. Activated sludge process & digestion.

5. Algal stabilization ponds, flora, succession & periodicity of algae in sewage.
6. Biomonitoring of water quality.

BOT : 4.22 Mycology & Plant Pathology

SPECIAL PAPER II

(48 Lectures)

I. Soil Microbiology :

Structure and types of soils, Biological population, Predation, parasitism, antagonism, mycorrhizal, association Rhizoplane, Rhizosphere, Non-rhizosphere & Phylloplane, Decomposition of organic matter and nitrogen fixation.

II. Industrial Mycology :

Preservations and maintenance of cultures, methods of sterilization, continuous, synchronous and phasecultures, Aerobic and anaerobic fermentations, Parameters of fermentors, Primary metabolites, Alcohol & Alcoholic beverages, organic acids, Secondary metabolites-antibiotics, growth regulators, vitamins, enzymes, Assay-Physical chemical & biological. Cultivation of edible fungi & S.C.P., fermentation of Tea, Coffee, Cocoa & rotting of fibres.

III. Fungal genetics :

Incompatibility systems, Tetrad analysis, Parasexual cycle, genetics of industrial organisms.

IV. Fungal ecology :

Heterotrophy and its consequence, Distribution & Dynamics of fungi in environment, Practical exploitation of saprotrophy.

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BOT : 4.23

Angiosperm Special Paper - II (48 Lectures)

1. Wood Anatomy : Vascular cambium, Hard and Soft woods, elements of wood, their structure and distribution, figure in wood, grain and texture, of wood, properties and uses of Wood in relation to structure and composition, Anatomy and identification of important timbers, chemical composition of secondary plant cell walls, methods of Preparation of Wood for microscopic observation.

2. Embryology : Artificial Pollination, Fertilization, Sexual incompatibility, Endosperm, ultrastructure and histochemistry, Polyembryony, Embryo as reaction system, Homologies, Experimental embryogenesis, different schools of Embryology and their contributions.
3. Palynology : Pollen units, pollen biochemistry and physiology Pollenkitt, Pollen Wall proteins, Pollen germination in Viva and in Vitro, Pollen culture, Pollen storage and viability, Pollen sterility, Pollen morphism, Palynology as basis of angiosperm, Phylogeny, methods of Pollen preparation, Melitopalynology.
4. Morphology : Theories concerning the nature of carpel and stemon in angiosperms.

NOTE : Special Paper - II is of 48 i.e. 4+1 periods are required (4 lectures + 1 tutorial each lecture is of 60 minutes).

BOT. 4.24 Plant Physiology Special Paper-II
(60 Lectures)

1. Water relation of plants : Leaching of substances from plants, Exudates, stomatal physiology, transfer and transport systems in plants, salt stress physiology causes, Physiological processes and phases as affected by salts stress. Parameters for salts resistance screening techniques.
2. Grop Production Physiology : Folier nutrition, fertilizers their uses and limititions. Metabolism - Recent information on Photo-synthesis and chemosynthesis, Respiration, nitrogen metabolism, lipid metabolism, secondary plant products, sulphur metabolism, Interaction between photochemistry and activity of enzyme. Photoassimilation of organic compounds.

NOTE :- This course is of 60 lectures. Hence six (5+1) Periods (60 minutes each) are required.

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BOT. : 4.31 Algae special Paper III (48 Lectures)

- I. Culturing of Algae : (12 Lectures)
 1. Defination, General requirements for culturing of algae, culture media.
 2. Preparatory culture and Isolation of algae :- Direct,

Isolation, streak culture, Nutritive solutions, Dilution culture technique, enrichment culture, Biphasic culture, (Soil & water culture), solidculture.

3. Axenic culture, (Bacteria free culture).
4. Continuous culture.
5. Synchronous culture.
6. Mass culture : Bubbling culture, stirring culture, shaking culture, closed circulating system, open bubbling system, Different methods for cultivation of nitrogen fixing blue green algae.
7. Cultivation of algae in waste water.

II. Algal Utilization : (10 Lectures)

1. Industrial uses :- The kelp Industry, Agar agar, Alginate, carrageenan & other products of marine algae.
2. Agricultural uses :- Blue green algae as a biofertilizer, organic manure, as a fodder for cattle, poultry feed, sea-weed liquid fertilizer, Biogas from Sea weeds.
3. As a human food :- Fresh water algae as a food, marine algae as a food.
4. Role of algae in Medicine.

III. Algal Physiology :- (14 Lectures)

1. Nutrition :- Nutritional requirements, macro and micronutrients.
2. Nutritional types :- Phototrophic, chemotrophic, Autotrophic, Heterotrophic.
3. Photosynthesis :- Definition, Energy levels in chlorophyll molecules, photochemical changes during absorption of light, light and dark reaction, Glycolate pathway for CO_2 fixation.
4. Respiration :- Definition types pathway of respiration, Kreb's cycle, Glyoxylate pathways cycle.
5. Nitrogen fixation : Definition, mechanism biochemistry of nitrogen fixation, factors affecting.
6. Nitrogen Metabolism :-
7. Movements and rhythms in algae.
8. Calcification & silicification.
9. Polarity & morphogenesis,
10. Bioelectric Phenomenon :- Biological fuel cell
11. Bioluminescence.

IV. Cytology and cytochemistry of algae : , (12 Lectures)

- 1) Cytology :- 1) Nuclear cytology of Chlorophyta, charophyta, Bacillariophyta, Pheophyta, Rhodophyta.
- 2) Genetics of Green algae, Brown algae, Red algae, & Blue-Green algae, plastid - DNA, Algal virus mutation in algae.
- 3) Cytochemistry :- Cell wall, mucilage, Fats, Steroids, pigments, Storage products, Extracellular products of Algae.

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BOT. 4.32 Mycology & Plant Pathology

Special Paper III. (48 Lectures).

I. Physiological Plant Pathology

Concept of plant disease, expression, Inoculum potential, production, & distribution, Mechanism of infection. Effect of environment on multiplication of pathogens and outbreak of disease. Defence mechanism, disease resistance, Physiology of diseased plants.

Plant Diseases :

Important fungal, bacterial, viral, nematode & MLO major plant diseases encountered in Maharashtra, Physical, Chemical, & biological control measures.

III. Medical mycology :

IV. Mycotic infections, dermatophytoses, & deep mycoses.

V. Seed Pathology, Ectophytis & exdophytic microbial associations of seeds, Role of micro-organisms in storage of seeds.

VI. Market Pathology :

Pre & Post harvest micro-organization.

VII. Forest Pathology :

Forest diseases, management and wood decay.

VIII. Nutrition & Physiology of fungi :

Dispersal & germination of spores, growth, protoplast isolation, morphogenesis, & fusion, Nutrition & metabolism of carbon, nitrogen, minerals, vitamins & growth regulators, fungal dimorphism, Dual cultures.

BOT : 4.33 Angiosperm Special Paper - III

(48 Lectures)

1. Ethnobotany : Scope and interdisciplinary approaches. Abstract and concrete Relationships, methods, of ethnobotanical study. Ethnobotany in the context of development and conservation of resources, forest management and national priorities, Ethnobotany of sacred plants of India such as Acgle, Marmolos, species of Ficus, species of Eclipta, santalum album, cynodon dactylon, etc. Plants in magico-religious beliefs and sanskrit literature, Ethno-medicinal Plants in India, Tree and Flora, Motifs
2. Arboriculture :- Objectives in tree planting, selection of tree types on the basis of crown, shape, branching habit, growth rate etc. trees suitable for roadside avenues, After care, need for manuring, maintaining shape and cavity repair,
3. Floriculture and land scape Gardening : Seasonal and perennial types of flowering plants, selection in colour Schemes, some plants varieties for local cultivation, cultivation of Rose and Jasmine. Informal and formal gardens characteristic features and symbolism of i) Japanese ii) Moghal and iii) English gardens.
4. Herbaria and Botanical Gardens : Herbaria and Botanical garden as multipurpose resource institutes, kinds of major herbaria of the World, Botanical gardens of the world.

NOTE :- Special Paper - III is of 48 lectures i.e. 4+1 periods (4 lectures + 1 tutorial each lecture is of 60 minutes) are required.

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BOT : 4.34 Plant Physiology Special Paper-III
(48 Lectures)

1. Plant growth regulation concept of growth regulations.
2. a) Phytochromones :- Distribution, Niosynthesis properties, metabolism, trans location, mechanism of action (at subcellular and molecular level) Chemical and immuns assays.
b) Naturally occurring growth regulators (other than, Phytochromes) such as triacontanol Brassinolides and fusicoccia.
c) Synthetic growth substances.
1. Growth promoters.

2. Morphactins.
 3. Growth inhibitors.
 - a) Applications of plant growth regulators in Agriculture, Horticulture and tissue culture.
 - e) Growth and development,
 1. Concept.
 2. Hormonal regulation of growth.
 3. Assessment of growth.
 4. Polarity.
 5. Uneven growth.
 6. Photomorphogenesis.
 7. Physiological & genetic basis of improving photosynthetic productivity.
 3. Uv.B. (280–320 nm) radiation effect on growth of plants and yield of crop plants. Response of plants to Uv.B. Radiation.
 4. Tissue culture :
"In vitro" conditions, laboratory organisation, Aseptic manipulations, nutrient media, Totipotency of plant cells, types of culture, protoplast culture isolation and purification, growth pattern in tissue culture, organogenesis, embryogenesis, Cytodifferentiation, Application of tissue culture in basic and applied aspects of plant physiology and plant propagation.

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BOT. 3.4 Plant BiotechnologyPracticalsTotal 12 Practicals

1. Citric acid fermentation and assay. (2 Practicals)
2. Algal biomass production on domestic waste water.
3. Mass cultivation of Blue green algae (Biofertilizers). (2 Practicals).
4. Extraction and estimation of single cell protein By. C Lowry's method.
5. Mushroom Cultivation (2 Practicals).
6. Enzyme production and assay.
7. Micropropagation of economically important plant (s).
8. In vitro culture of embryo to raise viable hybrids.
9. Production of secondary metabolites in Vitro (2 Practicals).

NOTE :- Visit to any one of the Biotechnological Research Laboratories is essential.

- A) C.F.T.R.I. - Central food and Technological Research Institute, Mysore.
- B) N.C.L. - National Chemical Laboratory, Pune.
- C) Department of Botany and Biochemistry of Pune University;
- D) H.A. - Hindustan Antibiotics, Pimpri, Pune.
- E) N.I.V. - National Institute of Virology, Pune.
- F) I.T.R.C. - Industrial Toxicology Research Centre, Lucknow.
- G) T.E.R.I.- Tata Energy Research Institute, New Delhi.
- H) N.B.R.I. - National Botanical Research Institute, Lucknow.
- I) C.D.R.I. - Central Drug and Research Institute, Lucknow.
- J) C.B.T. - Centre for Biotechnology, JNU, New Delhi.
Maduraj Kamraj Uni., G.B. Pant Agriculture Uni.,
Pantnager, Harayana, Agriculture Uni, Hissar. M.Phule
Agriculture Uni., Poona (BGA, Mushroom Projects) etc.
- K) IARI - Indian Agriculture Research Institute, New Delhi.
- L) B.A.I.F. - Bhartiya Agro Industrial Foundation, Pune.
- M) I.M.T. - Institute of Microbial Technology, Chandigarh.
- N) C.I.M.A.P. - Centre for Indian Medicinal and Aromatic Plants,
Lucknow.

(Like this any more known institutes which concerns Biotechnological work may also be visited)

BOT : 3.4 Practical-I

Gymnosperms & Palaeobotany (12 Practicals)Gymnosperms - (6 Practicals)1. Cycadales.

- a) External morphology of vegetative parts.
- 1. Entire plant of cycas circinalis, c. revoluta or zamia floridana.
- 2. Foliage - c. circinalis, c. revoluta zamia, Encephalartos.
- b) Megasporangiate strobili & Megasporophylls.
- c) Revoluta, C. circinalis, c. rumphii, Ceratozamia, Zamia & Encephalartos.
- c) Microsporangiate Strobili & Microsporophylls : c. circinalis, Zamia floridana, Ceratozamia, Encephalartos.
- d) Gametophytes - embryogeny
 - 1. Microcycas - free nuclear stage.
 - 2. Zamia - Archegonia & Proembryo.
 - 3. Cycas - Embryo.
- e) Anatomy
 - 1. T.S. Rachis & Pinnae of Cycas & Zamia.

2. Coniferales & Taxales.

Pinus, Cedrus, Cupressus, Aruearia, Agathis, Podocarpus, Taxodium, cephalotaxus & Taxus.

- a) Double stained permanent preparations of wood of any two of the genera.
- b) T.S. of stem - one genus from each family.
- c) T.S., T.L.S. & R.L.S. of wood & preparation of artificial keys at least one genus from each family.
- d) Study of male cones & microsporophylls & Microspores - at least one genus from each family.
- e) Female cones & ovuliferous scales of Pinus, Pseucosuga, Cupressus, Thuja, Aracaria, Cryptomeria, Taxodium, Podocarpus, Taxus.
- f) Gametophytes & embryogeny of Pinus - Archegonia, Proembryo & suspensor.

3. Gnetales : Ephedra & Gnetum only

- a) Habit & external morphology.
- b) Morphology of reproductive parts.
 - 1. Male Strobilus - Microsporophylls, Pollen grains.
 - 2. Female strobilus.
- c) Gametophytes & embryogeny Female gametophyte of Gnetum.
- d) Anatomy - 1. T.S. Stem.
- 2. T.S., T.L.S. & R.L.S. of woods.

PALACOBOTANY (6 Practicals)

Morphological & anatomical study of the following.

1. Psilopsida a) Psilophyton Princeps,
 b) Rhynia (stem T.S.)

2. Lycopsida

- Stem-genera a) Lepidodendron Vasculare,
 b) L.scleroticum.

Leaf cushions - a) Lepidodendron,

 b) Lepidophlois (slides, material & peels)

Roots - Stigmaria ficoides (T.S. Peel)

Fructification - Lepidostrobus, Lepidocarpon.

3. Sphenopsida,

- Stem genera - a) Sphenophyllum
 b) Arthropitys.
 c) Calamodendron.

- Foliage - a) Sphenophyllum.
 b) Annularia.
 c) Schizoneura.
 d) Phyllotheca.

- Fructification - a) Calamostachys binneyana,
 b) C. americana.

4. Coenopteridales,

- a) Botryopteris tridenta. (stem & petiole)
b) Botryopteris globosa. (fructification)
c) Zygopteris illinoiensis. (stem T.S.)
d) Stauropteris burttislandica. (megasporangium)

5. Marattiales & filicales,

- a) Psaronius (T.S. stem)
b) Scolecopteris (fructification)
c) Marattiopsis Macrogyna.

6. Pteridosperms,

- Foliage - a) Peccopteris b) Sphenopteris
 c) Neuropteris d) Glossopteris.

Stem genera - a) Lyginopteris Oldhamia,

 b) Medullosa thompsoni,

 c) Vertebraria (compression specimen)

7. Cordaitales, Coniferales, Ginkgoales, Pentoxyiales & Bennettitales.

- Foliage - a) Cordaitea. b) Brachyphyllum.
 c) Pterophyllum d) Phaenicopsis.
 e) Ginkgo digitata.

3. Stem - a) Cordaites. b) Dadoxylon.
c) Pentoxylon.

- Fructification - a) Proaraucaria. Mirabilis.
b) Cardiocarpus.

8. Angiosperom.

- Monocot - a) Palmoxylon. b) Rhizopalmoxylon.
c) Cyclanthodendron. d) Tricoccites.

- Dicot - a) Dicot stem.
b) Dicot leaf impressions.
c) Enigmocarpon.
d) Sahnianthus.
e) Sahnipushpum.

: REFERENCE BOOKS :

1. Andrews, H.N. - Studies in Palaeobotany.
2. Banks, H.P. - Evolution and Plants of the Past.
3. Dierhorst, D.W. - Morphology of Vascular Plants.
4. Bower, F.O. - Primitive land plants.
5. Campbell, D.H. - Evolution of land Plants.
6. Coulter, J.M. & Chamberlain, C.J. - Morphology of Gymnosperms.
7. Darrah, W.C. - Principles of palaeobotany.
8. Dekeyseras, T. - Morphology and evolution of fossil Plants.
9. Eames, A.J. - Morphology of Vascular Plants.
(Lower groups)
10. Foster, A.S. & Gifford, E.M. - Comparative Morphology of Vascular Plants.
11. Goebel, K. - Organography of Plants.
12. Jeremy, A.O. - Phylogeny and classification of ferns.
13. Maheshwari, P. & Biswas, C. - Cedrus.
14. Maheshwari, P. & Konar, R.N. - Pinus.
15. Ogura, K. - Comparative anatomy of Vegetative organs of Pteridophytes.
16. Pant D.D. & Mehra D. - Cycas.
17. Parihar, N.S. - Biology and Morphology of Pteridophytes.
18. Parihar, N.S. - An Introduction to Embryophyta Vol.II

19. Pearson, H.H.W. - Gnetales.
20. Rashid, A. - An Introduction to Pteridophytes.
21. Seward, A.C. - Plant life through Ages.
22. Smith G.M. - Cryptogamic Botany Vol.II
23. Spore, K.R. - The Morphology of pteridophytes.
24. Spore K.R. - The Morphology of Gymnosperms.
25. Stewart W.N. - Palaeobotany, and the evolution of Plants.
26. Taylor, T.N. - Palaeobotany, an introduction to fossil Plant biology.
27. Walton, J. - Introduction to study of fossil Plants.

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SEMESTER - III

BOT. 3.5 Practical on special paper Algae.

(24 Practicals)

Chlorophyta :

Volvocales :- Chlamydomonas, chlorogonium, Phacus, Gonium
Pandorina, Eudorina, Volvox.

Chlorococcales :- Chlorellaceum, Tetraspora, Chlorella, Trebauxia
Trebauxia, Tetraedron, Chracium, Charasiosiphon,
Ankistrodesmus, Selenestrum, Oocystis, Botryococcus,
Coelastrum, Scenedesmus, Pediasium,
Hydrodictyon, Protosiphon, Crucigenia.

Ulotrichates :- Ulothrix, Uronema, Microspora, Sphaeroplea,
Cylindrocapsum.

Ulvales :- Ulva, Enteromorpha, Schizomeris, Monostroma.

Chaetophorales : Stigeoclonium, Chaetophora, Drapanaldia,
Drapanaldiopsis, Fristchella, Coleochaetae
Trentepohlia, Cephaleuros.

Cladophorales :- Cladophora, Rhizoclonium, Pithophora,
Chaetomorpha, spongomorpha.

Oedogoniales :- Oedogonium, Bulbochaetae, Oedocladium,

Zygnematales :- Spirogyra, Zygnema, Cylindrocystis,
Mougeotia, Sirogonium, Sirocladium, Cosmarium,
Eustrom, Pleurotaenium, Closterium,

Siphonales + Caulerpa, Bryopsis, Dichotomosiphon, Codium,
Halimeda, Boergesenia, Valonia, Neomeris,
Accta-bularia, Chamaedoris.

CHAROPHYTA - CHARA, NITELLA.

Euglenophyta :- Euglena, Phacus, Lepocinellis, Trachelomonas.

Xanthophyta :- Vaucheria, Botrydium.

Chrysophyta :- Dinobryon, Synura.

Bacillariophyta :- Coscinodiscus, Melosira, Chaetoceros,
Bidulphia, Nitschia, Synedra, Planktonicella.

Dinoflagellates :- Ceratium,

Phaeophyta :- Ectocarpus, Sphaerelaria, Dictyota, Padina,
Stoechospermum, Spathoglossum, Dictyopteris,
Colpomenia, Iyengaria, Sargassum, Turbinaria,
Zonaria, Rhosenvingia, Laminaria, Fucus,
Cystosiera, Chnoospora.

Rhodophyta :- Porphyra, Compsopogon, Batrachospermum,
Liagora, Scinia, Gelidium, Gelidiella,
Grateloupia, Gracilaria, Jania, Hypnea,
Rhodymenia, Champia, Ceramium, Caloglossa,
Acanthophora, Chondrus, Laurentia, Polysiphonia,
Aspargopsis, Halymina, Botrycladia.

Cyanophyta :- Chroococcus, Gleocapsa, Gleothecae, Merismopedia,
Aphanothecae, Microcystis, Oscillatoria,
Phormidium, Lyngbya, Arthrospira, Spirulina,
Aulosira, Scytonema, Tolypotrix, Calothrix,
Rivularia, Gleotrichia, Cyindrospermum, Nostoc,
Nostocopsis, Stigonema, Halosiphon, Anabaena.

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BOT. 3.5 Practicals -II

(on BOT. 3.32 Mycolgy and Plant Pathology Special
Paper-I)

(24 Practicals)

Myzomycotina :

Ceratiomyxa, Licea, Lycogala, Trichia, Hemitrichia,
Stemonitis, Lamproderma, Physarum, Arcyria, Fuligo,
Craterium, Diderma Didymium.

Plasmodiophoromycetes :-

Plasm diophora, Spongospora.

Mastigomycotina :

Synchytrium, Physoderma, Saprolegnia Achlya,
 Olpidium, Albugo, Pythium, Phytophthora, Plasmopara, peronospora,
 Bremia, Sclerospora,

Zygomycotina :

Rhizopus, Mucor, Zygorhynchus, Pilobolus
 Entomophthora, Choanephora.

Ascomycotina :

Protomyces, Taphrina, Eurotium, Chaetomium, Erysiphe,
 Uncinula, Phylactinia, Sphaerotheca, Podosphaera, Microsphaera,
 Meliola, Phyllachora, Daldinia, Xylaria, Hypoxylon,
 Claviceps, Balanisia, Peziza, Pseudopeziza, Morchella
 Rhytisma, Usnea, Parmelia, Pyxine, Parodiella, Elsinoe,
 Dagnisiella, Hysterium, Pleospora, Leptosphaeria, Didymosphaeria.

Basidiomycotina :

Melampsora, Dasturella, Puccinia, Ravenelia, Uromyces,
 Monosporidium, Cystopsora, Cerotelium, Olivera, Chaconia,
 Phragmidium, Hemileia, Catenulopsora, Endophyllum,
 Trichodium, Massella, Gambleola, Hapalophragmopsis,
 Graphiola, Ustilago, Spacelotheca, Tolyposporium,
 Doessansia, Georgetischeria, Enthioma, Tilletia, Auricularia,
 Calocera, Tremella, Polyporus, Porin Fomes, Schizophyllum,
 Lenzites, Ganoderma, Clavaria, Daedalia, Hymenochaete, Hexagonia,
 Sternum, Irpex, Hydnus, Agaricus, Coprinus, Lepiota,
 Pleurotus, Phallus, Dictyophora, Itajahya, Lycoperdon,
 Geaster, Cyathus, Nidularia.

Deuteromycotina :

Fusarium, Curvularia, Alternaria, Cladosporium,
 Cercospora, Beltrania, Penicillium, Aspergillus, Phoma,
 Phylosticta, Pestalotia, Colletotrichum, Ciliochorella.

- NOTE : 1) Short local tours.
 2) One long tour.

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BOT : 3,5

Angiosperm special practicals (24 Practicals)

1. Botanical description of plants.
2. Identification of plant specimens upto species level (with the help of Flora/Floras).
3. Preparation of artificial dichotomous keys of
 - i) Indented Key ii) Bracketed Key types based on different

morphological characters.

4. Study of Angiospermic families locally as well as available in the region covering all the orders/series according to Bentham and Hooker's system.
5. Chemical testing of floral pigments in caryophyllales, curvembryaceae and fecoidales.
6. Study of Vessel elements by maceration method (different types of vessel elements).
7. Study of epidermal appendages and prepare a dichotomus key to differentiate.

Students should undertake one short and one long Botanical excursion, submission of forty herbarium specimens alongwith tour report is compulsory.

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BOT : 3.5. Practical II (on BOT 3.31)
on Special Paper-I
(24 Practicals)

1. Extraction and separation of organic acids by two dimensional paper chromatography.
2. Extraction and separation of sugars by two dimensional paper chromatography.
3. Extraction and separation of amonoacids by two dimensional paper chromatography.
4. Estimation of ascorbic acid.
5. Extraction and separation of alkaloids by two dimensional paper chromatography.
6. Estimation of oxalic acid.
7. Extraction and separation of liquids by thin layer chromatography.
8. Estimation of Lignins.
9. Estimation Polyphenols.
10. Determine the activity of enzyme ployphenol oxidase.
- 11 & 12. Colorimetric estimation of DNA & RNA.
13. Isolation of DNA from cauliflower.
14. Isolation of RNA from yeast.
- 15 & 16 Isozymepattern of peroxidase enzyme under different conditions using gel electrophoresis.
- 17 & 18. Isolation of Mitochondria from plant material & demonstration of succinic dehydrogenase activity.

19. Isolation of chloroplasts and demonstration of Hill reaction
- 20.& 21. Separation of proteins on the basis of molecular weight using SDS - PAGE - electrophoresis.
22. Colorimetric estimation of nitrogen from plant material
23. Estimation of amino nitrogen from plant material.
24. Extraction and estimation of total alkaloids from plant material.

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BOT : 4.4 Practical on BO, 4.1 (Developmental Botany)
 (24 Practicals)

A. Anatomy (8 Practicals)

1. Study of stomatal types from fresh preparation by students.
2. Isolation and study of wood - elements by acid maceration method. preparation of permanent slides by students.
3. Diagnostic study of gymnosperm woods at least two conifer fer types by study of Transverse section, Radial longitudinal section, Tangential section Double - stain preparation by students.
4. Diagnostic study of dicotyledon woods, at least 4 type by T.S. and T.L.S. Double stain preparation by students.
5. Study of Xylem parenchyma types permanent. preparation by students.
6. Study of abnormal secondary growth. 3 dicot types ; & 1 monocot type.

NOTE : Submission of permanet slide preparation at least of 2 woods and 2 whole mount of wood maceratain is necessary

B. Embryology (8 Practicals)

1. Study of the development of microsporangium microspores, male gametophyte of angiosperms. with the help of permanent slides,
2. i) Study of development stages of magasporangium (from permanent slides) ii) Study of types of ovules (vertical sections from microslides) 3) study of megasporogenesis. and female gmetophytess of angiosperms, at least types. (from permanet slides).
4. Study of endosperm types and 2 midifications.

- C 5. Study of embryogenesis. (from permanent slides).
6. Dissection and mounting of (a) Globular embryo with haustorium in Cucumis seeds. (to be done by students).
 b) Multiple embryos in Citrus seeds.

C. Palynology (8 Practicals)

1. Study of pollen development, Tetrad types, pollen units (monad, diad, tetrad, polyad, pollinia)
2. Pollen spore preparation by acetolysis technique.
 - 3 Slides angiosperm types.
 - 1 Slides gymnosperm type,
 - 1 " Bryophyte type.
 - 1 " Pteridophyte type.
3. Study of pollen morphology polarity, symmetry shape side sporoderm stratification ; aperture, N.P.C.
4. Pollen analysis from honey by acetolysis.
5. Demonstration - Aerobiological study.

C NOTE :- Submission of five palynological slides is compulsory.

RECOMMENDED BOOKS :

1. Cutter, E.G. : Plant Anatomy Vol. I and II.
2. Esau, K. : Anatomy of Seed plants.
3. Fahn, A : Plant Anatomy (2nd ed.).
4. Zimmermann, M.H. : Formation of wood in Forest Trees.
5. Jane, F.W. : Structure of Wood.
6. Maheshwari, P. : An introduction to embryology of Angiosperms.
7. Maheshwari, P. and Johri, B.M. : Recent Advances in the Embryology of Angiosperms.
8. Johansen, D.A. : Plant embryology.
9. Bhojwani, S.S. I : The embryology of angiosperms.
 Bhatnagar, S.P.
10. Johri, B.M. : Experimental embryology of Vascular Plants.
11. Johri, B.M. : Embryology of Angiosperms.
12. Ertzman, G. : Hand book of palynology Pollen morphology and plant taxonomy.
13. Heslop-Harrison : Pollen-Development and Physiology.
 J.
14. Nair, P.K.K. : Recent advances in Pollen and pollen Research Vol I, II and III.
15. Kremp, G.O.W. : Morphological encyclopedia of Palynology.
16. Rowlry J.R. (1977) : Geophytology 7 (i) 1-23 and Prijanto, B.

17. Rowley, J.R. and (1983) : Biology and Implication for
J.S. Rawley
Publishing Co.
18. Rowley, J.R. (1981) : Norw Jour Bot 1 : 357-380
19. Rowley J.R. and : Observation of one pollen grain by SEM.
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BOT : 4.5 (Practicals on BOT 4.21 & BOT 4.31)
Algae Special (24 Practicals)

1. Isolation and establishment of laboratory culture of Algae.
2. Algal Biomass (Total chlorophyll, packed cell volume, fresh wt. and dry wt.)
3. Algae of unusual habits.
Epiphytes, epizoic, Epiphloophytes, Endophytes, algal aeroflora.
4. Soil and paddy field algae.
5. Algae of polluted water.
6. Algae of puddles, ponds, lakes, streams, rivers.
7. a) Algae of west coast and east coast of India.
(Marine plankton and seaweeds).
b) Extraction of agar-agar and alginic acid. (Demonstration practical).
8. Water analysis : P.H. Temperature, Turbidity, D.O. CO_2 BOD, COD, Nitrate, Phosphate, Alkalinity, Chlorides, Total Hardness, Silicates (any ten).
9. Quantitative studies of phytoplankton using standard methods viz : (Simple drop method or Haemocytometer method (any one)).
10. Extraction and separation of aminoacid of algae by paper chromatography.
11. Extraction and separation of carbohydrates of algae by paper chromatography.
12. Immobilization Technique for algal cells.
13. Cytological studies of :

Chara, Cladophora, Rhizoclonium, Rithophora Oedogonium and Spirogyra Hydrodictyon

N.B. :- Students should visit atleast any one of the following Research Institutes and submit the report.

1. C.F.T.R.L. - Central food and Technological research Institute, Mysore.

2. I.A.R.I. - Indian Agricultural Research Institute, New Delhi.
(National Facility for Blue Green Algae).
3. C.S.M.C.R.I. - Central Salt and Marine Cultivation Research Institute, Bhavnagar & Dwarka.
4. CMFRS - Central Marine Fisheries Research station, Mandapam.
5. MCRC - Murugappa Chettiar Research Institute, Tharamani, Madras (Spirulina culture)
6. KIA - Krishnamoorthy Institute of Algology, Madras.
7. NFMEGA - National Facility for Marine Blue Green Algae.
8. NIO - National Institute of Oceanography, Goa.
9. RRI, - Rice Research Institute, Cuttack, Orissa.
10. CIMAP - Central Institute of Medicinal & Aromatic Plants Lucknow (U.P.)
11. Tamil Nadu Agricultural University, Coimbatore.
12. NEERI - National Environmental Engineering Research Institute, Hyderabad, Nagpur.
13. NBRI - National Botanical Research Institute, Lucknow.
14. CDRI - Central Drug Research Institute, Lucknow, (U.P.).
15. NRLC - National Research laboratory for conservation of cultural property, Lucknow (U.P.).

: RECOMMENDED BOOKS :

(BOT.3.31 , BOT 4.21 and BOT 4.31)

1. Bold, H. & Wynne M.J. - Algae Structure and reproduction.
2. Boney A.D. - A. Biology of marine Algae.
3. Brain Moss - Aquatic Ecology.
4. Boney A.D. - Phytoplankton.
5. Chapman V.J. - Seaweeds & their uses.
6. Chapman V.J. - The Algae.
7. Carrs and Whittton - Biology of Blue-green Algae.
8. Dawes C.J. - Marine Botany.
9. Dawson E.Y. - Marine Botany.
10. Desikachary T.V. - International symposium on Taxonomy of Algae.
11. Dixon P.S. - Biology of the Rhodophyta.
12. Fritsch F.E. - The Structure and production of algae Vol. I & II.
13. Godward M.B.E. - Chromosomes of Algae.

14. Irrine D.E.G. & H.John, D.M. - Systematics of the green algae.
15. Kacharoo P. - Sympsium on Algology.
16. Krishnamurthy R. - Symposium and plants.
17. Lewin - Genetics of algae.
18. Lewin - Algal Physiology & Biochemistry.
19. Lewis J.R. - The ecology of rocky shores.
20. Lee R.E. - Phycology.
21. Morris I. - An Introduction to the Algae.
22. Newton - Seaweed Utilization.
23. Prescott G.W. - Algae.
24. Pringshim - The Algal culture.
25. NAC - Methane Generation From waste.
26. D.Mara - Sewage treatment in hot climate.
27. Dacey A. - Sanitation in Developing Countries.
28. Reddy M. - Rural technology.
29. Reid and Wood - Ecology of Inland Waters & estuaries.
30. Rosowski J.R. - Selected papers in Vol. I & II
Saha & Porker B.
31. Shastree N.K. - Current trends in limnology
Vol. I & II.
32. Saha S.K. - Limnology of thermal springs.
33. Smith V. - Biomass Energy.
34. Smith G.M. - Fresh water Algae of United states
35. Singh H.R. - Advances in Limnology.
36. Smith G.M. - Manual of phycology.
37. Stephanson & Stephenson - Life between tide marks.
38. Stewart W.D.P. - Algal Physiology & Biochemistry.
39. Tilden J.E. - Algae & their life relations.
fundamental of Phycology.
40. Round F.E. - Ecology of algae.
41. Venkataraman G.S. - Cultivation of Algae.
42. Welch P.S. - Limnological Methods.
43. Welch P.S. - Limnology.
44. Wetzel R.G. - Limnological analysis, (1991)
45. Wetzel R.G. - Limnology ed. (1983)

: ICAR MONOGRAPHS ON INDIAN ALGAE :

1. Desikachary, T.V. - Cyanophyta.
2. Gonzalves, E. - Oedogoniales.
3. Iyengar, M.O.P. & Desikachary T.V. - Volvocales.
4. Misra J.N. - Phaeophyceae.
5. Philipose M.T. - Chlorococcales.
6. Ramanathan, K.R. - Ulotrichales.
7. Balakrishnan, M.S. - Rhodophyta.

8. Randhawa, M.S. - Zygnemataceae.
9. Pal, B.P. and Sundarlingam et al - Characeae.
10. Venkataraman, G.S.- Vaucheriacae.

PERIODICALS. :

1. Phykta
2. Journal of Phycology.
3. Phycologia.
4. Cryptogamie Algologica.
5. Japanese Journal of Phycology.
6. British Phycological Journal.
7. Botanical Marina.
8. Hydrobiologia.
9. Archive Hydrobiologia.

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DOT : 4.5 Practicals - II (on DOT 4.22 & DOT 4.32)
(24 Practicals)

1. Isolation and reinoculation of fungal pathogens.
2. Isolation and reinoculation of Bacterial pathogens.
3. Isolation of Nitrogen fixers and in vitro growth of nodules.
4. & 5. Evaluation of minimum inhibitory concentration (MIC) of fungicides (two practicals).
6. Pathology of seeds.
7. Pathology of fruits.
8. Isolation of soil microorganisms.
- 9.& 10. Screening of microorganisms for primary & secondary metabolites.
11. & 12 Citric acid fermentation & assay.
13. Penicillin bio-assay (organism - Bacillus).
- 14 & 15 Alcohol fermentation & distillation.
16. Spawn preparation & mushroom cultivation.
17. Study of diseases caused by Bacterial viruses MLO's & nematode (one form each group).
18. Study of diseases caused by Mastigomycotina & Plasmodiophorales (Any three).
19. Study of diseases caused by Ascomycotina (Any three).
20. Study of diseases caused by Basidiomycotina (Any three).
21. Study of disease caused by Deuteromycotina (Any three).
22. Biochemical studies of diseased plants chromatography (Sugars & amino acids).
24. Biochemical studies of diseased plants poly phenols/ enzymes/ RNA+DNA.
23. Biochemical studies of diseased Plant Proteins.

NOTE :

visit to a fermentation industry, Research institute, Agricultural University etc. Long & Short tours for Collection of Phytopathogenic organisms are essential.

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PERIODICALS / JOURNALS.

1. Kavaka. Madras India.
2. Indian Phytopathology - New Delhi, India.
3. Nova Hedwigia - Germany.
4. Mycologia U.S.A.
5. Mycotaxon U.S.A.
6. Trans, British, Mycological Soc. U.K.
7. Trans, Mycological Soc. Japan, Tokyo.
8. Phytopathology - U.S.A.
9. Mycological Research U.K.
10. The Mycologists. U.K.
11. Systema Ascomycetum, Sweden.
12. Canadian Journal of Botany.

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13. Biological Abstracts. U.S.A.
14. Sydowia.
15. Botanica Marina, Berlin, New York.
16. Review of Plant Pathology, C.M.I. U.K.
17. Bibliography of Systematic Mycology C.M.I. U.K.
18. Index of Fungi. C.M.I. U.K.
19. Mycological Papers C.M.I. U.K.
20. Phytopathological Papers. C.M.I. U.K.
21. International biodeterioration C.M.I. U.K.
22. C.M.I. Description of Pathogenic Fungi and Bacteria.

-x-x-x-x-x-

cont..37

dbs./-

Angiosperm special Practicals (24 Practicals)

- 1-4) Anatomical characterization of wood (T.S., T.L.S., R.L.S. and muceration) - qualitative and quantitative (any four)
- 5) Preparation of artificial key to distinguish woods on the basis of important anatomical and physico - Chemical characters.
- 6) Anatomical analysis of reaction wood knots.
- 7) Anatomical examination of secondary thickening in Monocotyledons. (any one)
- 8) Histochemical examination of dicotyledons woods (any three)
- 9) Locating the polysaccharides and proteins in dissected endosperm (any two).
- 10) Dissection and mounting of multiple embryos.
- 11) Dissection and exposure of peculiar embryological characters Bicelled, pollen, Hypostase, free nuclear endosperm, suspensor haustoria.
- 12) To study Nodal Anatomy (different types of nodes).
- 13) To study of Pollen units in mimosae.
- 14) To study of Pollen units in Asclepidaceae and orchidaceae.
- 15) To study of Pollen units in Cyperaceae.
- 16) To test the Pollen fertility.
- 17) To study of Pollen Morphism.
- 18) Pollen analysis of honey's locally available (unifloral & multifloral).
- 19) Biochemical analysis of pollen grains.
- 20) Polynotaxonomy of a selected taxa of Leguminosae/ Acanthaceae or any other suitable taxa.
- 21) To study the development of male Gametophyte.
- 22) To study the course of Pollen tube through stigma style and ovary to ovule in naturally pollinated plants.
- 23) Pollen germination in Vitro.
- 24) Pollen preparation techniques.

Note:- Each practical is of 4 clock hours duration.

X-X-X-X-X

Angiosperm Special Reference Books and periodicals.

(Bo. 3.33, 4.25, 4.33)

1. Arber A. Silice and formation in plants.
2. Arber A. Monocotyledons.
3. Bailey I.W. Contribution to plant anatomy.

4. Benson L. Plant classification.
5. Benson L. Plant taxonomy.
6. Bhojwani S.S. and Bhatnager S.P. The embryology of Anagiosperms treatise.
7. Carlquist S. Ecological strategies of xylem evolution.
8. Choudhury and Ghosh - Indian Woods Vol.I
9. Core E.L. Plant Taxonomy.
10. Cronquist A. The evolution and classification of flowering plants.
11. Cuttler E.G. Plant Taxonomy Vol. I and II.
12. Davis G.B. Systematic embryology of Angiosperm.
13. Davis P.H. and Heywood V.H. Principles of Angiosperms Taxonomy.
14. Dehlgren R.M.T. Families of the monocotyledons and others.
15. Dehlgren R.M.T. and Clifford H.T. (1982) The monocotyledons- A comparative study.
16. Eames A.J. Morphology of the angiosperms.
17. Erdtman G. Handbook of palynology, pollen morphology, and plant taxonomy.
18. Fahn A. Plant Taxonomy.
19. Frogin I. Text book of pollen analysis.
20. Hall M.A. Plant structure function and
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23. Hatchimson J. (1969) - The evolution classification of flowering plants.
24. Haller J.M. -----
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26. Hutchinson J. Families of flowering plants vol.I & II.
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28. Jain S.K. (1981) Glimpses of Indian Ethnobotany oxford and IBH publishing Co. New Delhi.
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30. Jain S.K. (1987) A manual of Ethnobotany Scientific Publishers, maan Bhavan, Ratanadu road, Jodhpur-342 001.
31. Jain S.K. (1991) Dictionary of Indian folk medicine and Ethnobotany Deep publications, A-3/27 A, DDA plants, puschim Vihar, NEW DELHI-110 063, (India).
32. Jain S.K. (1991) Contribution to Indian Ethnobotany, Scientific publishers, 5-A New pali road, P.B.91, JODHPUR-342 001.(India).

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34. Jones. Plant Biosystematics.
35. Jain S.K. and Rao R.R. Handbook of field and Herbarium methods.
36. Jane F.H. Structure of Hood.
37. Johri B.M. (ed.) Experimental embryology of vascular plants.
38. Jodhri B.M. (ed.) Embryology of angiosperms.
39. Kenneth E.F. Ecology and Resources management.
40. Kunitaki K. (1977) plant systemic and evolution.
41. Kuijt J. The biology of parasitic flowering plants.
42. Lawrence G.H.M. Taxonomy of vascular plants.
43. Maheshwari P. An Introduction to embryology of Angiosperms.
44. Maheshwari P. and Johri B.M. Recent advance in the embryology of Angisperms.
45. Malik C.P. (ed) Physiology of sexual reproduction in flowering plants.
46. Malcamy D.L. and other Biotechnology and ecology of pollen.
47. Metcalfe C.R. and Chalk. -Antomy of the dicotyledons Vol. I and II.
48. Metcalfe C.R. Antomy of the monocotyledons Vol. V., Cyperaceae.
49. Mitra J.N. An introduction to systematic Botany and ecology.
50. Nair P.K.K. Advances in plant Science.
51. Nair P.K.K. Recent advances in pollen spore research Vol.I,II and III.
52. Nail V.N. Taxonomy of Angiosperms.
53. Prione P.P. Tree maintenance.
54. Pandey B.P. (1989) Plants for Human kind sacred plants of India.
55. Redford A.E. and others. - Vascular plant systematics.
56. Raghavan V. Experimental embryogenesis in Vascular plants..
57. Rao C.V. Proteaceae.
58. Rendle A.B. The classification of flowering plants, vol. I and II.
59. Robards W. Dynamic aspects of plant ultra-structure.
60. Randhawa G.S. and Mukhopandhyay A. (1986) Floriculture in India, Allied pub. (P) Ltd. NEW DELHI, Bombay.
61. Sagreiya K.P. Ornamental trees their planting and care.
62. Sculthorpe C.D. Biology of aquatic Vascular plants.
63. Shivanna K.R. and Jodhri B.M. The angiosperms pollen structure and function.
64. Sporne K.R. The mysterious origin of flowering plants.

65. Stace C.A. : Plant Taxonomy and Biosystematics.
66. Stanney R. by Inis K.H.F. : polten, Biology Biochemistry management.
67. Steward F.C. : Growth and organization in plants.
68. Street H.E. : Essay in Plant Taxonomy.
69. Subrahmanyam K. : Aquatic angiosperms.
70. Swingle D.B. : Text book of Botany.
71. Sivarajan V.V. : Introduction to principles of plant Taxonomy.
72. Sporne K.R. : The Morphology of Angiosperms, the structure evolution of flowering plants.
73. Stebbins G.L. (1974) : Flowering plant Evolution above the species level.
74. Takhtajan A. : Flowering plants origin and dispersal.
75. Tiyagi and Kshetrapal. - : Taxonomy of Angiosperms.
- 76 Thorpe Trevor A.C. : Plant tissue culture : Methods and applications.

X-X-X-X-X

BO 4.5 on BO 4.26 and BO 4.30 (24 practicals)

RECOMMENDED BOOKS :

1. Bergman, A.A. : Laboratory investigations in cell Biology.
2. Bonner, J. & Varner, J.E. : Plant Biochemistry Academic Press New York.
3. Bryant J.A. : Molecular aspects of gene expression in plants.
4. Burgess, J. : An Introduction to plant cell development.
5. Butenko, B.G. : Plant tissue culture and plant morphogenesis.
6. Coombs, J. Hall, D.O. Long, S.P. and Scurlock, M.O. : Techniques in Biopductivity and photosynthesis Oxford New York, Toronto Sydney Frankfurt.
7. Burton, W. : Post harvest physiology of fruit and vegetables.
8. David, I.N. : Biochemistry of nucleic acids.
9. De Robertis, D.D.M. and EMT De Roberti. : Cell and Molecular Biology.
10. Dodds J.H. and Robert, L.W. : Experiments in tissue culture.
11. Edwards, G. & Walker, D. : C3-C4 mechanism and cellular and environmental regulation, of photosynthesis.
12. Epsrein E. Mineral nutrition of plants. : Principles and properties John wiley & sons INC. New Youk, London.
13. Gibos, M. and Latzko, E. : Encyclopaedia of plant physiology vol. 6, Photosynthesis II Springerverlay Berlin, Heidelberg.

14. Giese, A. : Cell physiology (Eins)
15. Gauch, H.G. : Inorganic plant nutrition.
16. Gunning E.S. and Steer, M.W. : Plant cell Biology and ultrastructural approach.
17. Graham, C.F. and Warcing P.B. : Developmental control in Animals and plants.
18. Hall, J.L. Flowers, T.J. and R.M. Roberts. : Plant cell structure and metabolism 2nd London, New York.
19. Hall, M.A. : Plant structure, function & adaptation.
20. Halliwell, B. : Chlorophast metabolism.
21. King B. : Cell Biology.
22. Kruse, P.G. and Patterson, M.K. : Tissue culture.
23. Lehninger, A. : Principles of Biochemistry.
24. Leopold. : Plant growth and development.
25. Levitt, J. : Physiological ecology responses of plants to environmental stresses Academic, Press New York, London.
26. Lewin. : Genes Wiley-estern Ltd.
27. Lewin. : Gene Expression Vol. 1,2,3, Wiley inter Science.
28. Macmillion J. : Encyclopedia of plant Physiology, New series Vol.9 Hormonal regulation of plant development. Springer verlag, Berlin Heidelberg New York.
29. Metile, R.H. : Lytic compartment of plant cells.
30. Marcelle, R.Clijsters, H.Van Poucke M. : Biological control of photosynthesis martinus Nishoff publishes.
31. Morris. : Secondary metabolism in plant cell cultures.
32. Mussel H. and Staples R.C. : Stress physiology in crop plants Wiley interscience.
33. Nickell L.G. : Plant growth Regulatirs National Academy of Sciences India Golden Jubilee Comemoration volume. Biotechnological applications of plant.
34. Paley L. and Aspinall O. : Physiology and Biochemistry of drought resistance in plants. Academic press New York.
35. Pilet, Paul Emile : Plant growth regulation.
36. Preston R.D. : Physical Biology of Plant cell walls.
37. Pitt D. : Lysosomes and cell function.
38. Pitt D. : Lysosomes and function.
39. Quinn, P.J. : Molecular Biology of cell membranes.
40. Raghavan V. : Experomental embryogenesis in vascular plants.
41. Rainert J. : Results and Problems in cell differentiation Vol.10

Chloroplasts.

42. Rainert J. and Bajaj,
Y.P.S. : Plant cell tissue organ culture.
43. Taylor. : Molecular Genetics Vol.I
Academic Press.
44. Terms A and Arron M. : Encyclopaedia of plant physiology
Vol.5 Photosynthesis I. Springer
verlag Berlin Heidel Berg.
45. Wareing P.F. : Plant growth substances.
46. Wareing P.F. and
Philips I.D.J. : The control of growth and
differentiation in plants.
47. Watson J.D. : The molecular Biology of gene W.H.
Benyamin and co.
48. White P.B. : The cultivation of animal and
plant cells.

X-X-X-XBOT. 4.5 Practical II (on BOT. 4.24 & BOT. 4.34)

(24 Practicals)

01. Determine activity of RUBP case in C₃, C₄ & CAM plants by spectrophotometric method (Leaves of spinach & Archis of sugarcane and Aloe of Bryophyllum)
02. Determine the activity of PEP case in C₃, C₄ & CAM plants by Spectrophotometric method (spinash or Archis, maize or Archis, maize or sugarcane, Aloe or Bryophyllum.)
- 03& 4: Estimation of the activity of nitrate reductase.
(Leaves of any leguminous plants.)
05. Deturmine the activity of emzyme glycolate oxidase in C₃ & C₄ Plants. (leaves of any one C₃ & C₄ plants)
05. Deturmine activity of lipase by spectrophotometric method during various stages of germination in oil seeds(Ear-thamus, sunflower, Ricinus etc. any one.)
07. Det ermine the activity of enzymes catalase and peroxidase and study the invintro effects of salts (NaCl, Na₂ So₄ KCL, MgCl₂, etc.) on the activities of the enzymes (Leaves of Ipomoea, Caranthamus, spinach etc. any one plant material)
08. Estimation of proline from plant parts under control and stress (drought and salt) conditions.
09. Estimation of free and bound aminoacids form plant material (Leaves of lettuce or of any leguminous plant)
10. Study of change in organic cirstituents during senescence in leaves.
11. B roassy for auxin.
12. Culture of plant tissues invitro.

13. Assessment of growth in invitro cultured cells tissues.
14. Study of stomatal physiology.
15. Study of deficiency symptoms.
16. Effects of deficiency on chlorophyll biosynthesis.
17. Effects of Ga_3 on activity of anykase (bartey)
18. Changes in organic constituents during ripening of fruits.
19. Changes in organic constituents during flowering.
20. Estimation of proteins by lowry etal method.
21. Estimation of carbohydrates (reducing, non-reducing sugars, total sugars and starch.)
22. Demonstration of photosystem II activity.
23. Determine the activity enzyme IAA oxidase.
24. Study of suspension sulture.

THE END.

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