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UNIVERSITY OF MUMBAI

No.UG/ 324 of 2004

CIRCULAR :-

Attention of the Director, Institute of Science and Principals of the affiliated Colleges in the faculty of Science is hereby invited to the Ordinances, Regulations and Syllabi relating to the Master of Science (M.Sc.) (Parts I & II) degree course vide Pamphlet No.175 and to this office Circular No.UG/546 of 2002 dated 23rd December, 2002 and No.UG/248 of 2003 dated 16th June, 2003 respectively and they are hereby informed that the recommendation made by the Board of Studies in Botany at its meeting held on 24th April, 2004 has been accepted by the Academic Council at its meeting held on 18th June, 2004 vide item No.4.22 and that in accordance therewith the syllabi in the subject of Botany at the M.Sc. (Parts I & II) has been divided into Units, each paper comprising two units.

Further that the aforesaid Unit-wise syllabi is as per Appendix and that the same has been brought into force with effect from the academic year 2004-2005.

Mumbai 400 032
9th August, 2004

for I/c REGISTRAR.

To,

The Director, Institute of Science and Principals of the affiliated Colleges in the faculty of Science

A.C.4.22/18.06.2004

No.UG/324-A

of 2004

9th August, 2004.

Copy forwarded with Compliments for information to :

- 1) The Dean, Faculty of Science..
- 2) The Chairman, Board of Studies in Botany.

for I/c REGISTRAR.

Copy to:-

The Director, Board of College and University Development, the Controller of Examinations, the Deputy Registrar (Eligibility and Migration Section), the Director of Students Welfare, the Personal Assistant to the Vice-Chancellor, the Pro-Vice-Chancellor, the Registrar and the Assistant Registrar, Administrative sub center, Ratnagiri for information.

The Controller of Examinations (10 copies), the Finance and Accounts Officer (2 copies), the Registrar (5 copies), Publications Section (5 copies), the Deputy Registrar, Enrolment, Eligibility Migration Section (3 copies), the Deputy Registrar, Statistical Unit (2 copies), the Deputy Registrar (Accounts Section), Vidyanagari (2 copies), the Deputy Registrar, Affiliation Section (2 copies), Director University Computer Center (IDE Building), Vidyanagari, (2 copies) the Assistant Registrar, Academic Authorities Unit (2 copies) and the Assistant Registrar, Management Council (2 copies) They are requested to treat this as action taken report on the concerned resolution adopted by the Academic Council referred to in the above Circular and that no separate Action Taken Report be sent in this connection. the Assistant Registrar Constituent Colleges Unit (2 copies), PUCTU, the Deputy Account. Unit (1 copy), the In-charge Director, Centralize Computing Facility (1 copy), Receptionist (1 copy), the Telephone Operator (1 copy), the Secretary MUASA (1 copy), Superintendent, Post-Graduate Section (2 copies), the Deputy Registrar, Special Cell (one copy).
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UNIVERSITY OF MUMBAI



Syllabus for M.Sc. (Part I & II) (Botany)

(with effect from the academic year 2004-2005)

UNIVERSITY OF MUMBAI
SYLLABUS
FOR
M. Sc. (BOTANY)

(Effective from academic year, 2003-2004)

M.Sc Part I

Theory: 4 papers, each of 75 marks and 3 hours duration.

Practicals: 4 practicals, each of 50 marks and 5 hours duration.

PAPER I : Plant Diversity : Cryptogams.

PAPER II : Plant Diversity: Spermatophyta, Anatomy, Embryology and Palynology

PAPER III : Physiology and Environmental Botany.

PAPER IV : Molecular Biology, Cytogenetics and Medicinal Botany.

M.Sc. Part II

Theory : 4 papers, each of 75 marks and 3 hours duration.

Practicals : 4 practicals, each of 50 marks and 5 hours duration.

PAPER V : Techniques and Instrumentation (Common to all specializations).

PAPER VI : Cell and Molecular Biology (Common to all specializations).

PAPER VII & VIII : Optional papers in any one of the following specializations:

1. Mycology and Plant Pathology.
2. Angiosperms and Phytochemistry.
3. Plant Physiology and Biochemistry.
4. Environmental Botany.
5. Molecular Biology, Cytogenetics and Biotechnology.

Note: Students registering offering for the M Sc degree course (by Research) in Botany from the academic year 2003-2004 shall offer papers I and II prescribed for M Sc part I (by papers)

Field Work: In addition to the requisite number of lectures and practicals, students are required to undertake field excursions to places of botanical interest, under the guidance

of a teacher, one teacher for a batch of ten students. There should be atleast six excursions in year, preferably three in each term, one of these should be outside an area having a different botanical character. The total duration of five local excursions will be considered as equivalent to forty clock hours. The long excursion of four days or more be considered as equivalent to forty clock hours. For purpose of computation of time spent on field excursions towards prescribed work load of 20 periods instruction per week of a teacher be considered equivalent to two periods of 50 minutes each per batch per week per year.

Plant Diversity: Cryptogams

Unit I (21)

Algae

1. Classification of algae up to orders, according to the system proposed by G.M.Smith. 6
2. Algae in diversified habitats: 6
Freshwater, marine, estuarine, snow & ice, hot springs, terrestrial, epiphytic parasitic and on artificial surfaces.
3. Techniques of culturing algae. 3
4. Fossil algae. 1
5. Fungal collection, culturing and preservation 3
6. Lichens : General account, taxonomy, economic importance and ecological significance 3

Unit II (23)

Fungi:

1. Classification of Fungi, upto orders, according to the system proposed by Alexopolus. 6
2. General account of spore bearing organs and their arrangements in various groups of Fungi; spore release and dispersal. 5
3. Rhizosphere and rhizoplane fungi; their significance. 3
4. Mycorrhiza: types, distribution and significance with reference to agriculture and forestry. 5
5. Study of the following diseases with reference to symptoms, causal organism and disease cycle : 4
 - a) Late blight of potato
 - b) Covered smut of Jowar
 - c) Citrus canker
 - d) Yellow vein mosaic virus

Unit III (22)

Bryophyta and Pteridophyta:

1. Classification of Bryophyta, up to orders, according to the system proposed by G.M.Smith. 6
2. Alternation of generations in Bryophyta. 2
3. Origin and evolution of Bryophyta with reference to habitat and form. 4

4. Origin and evolution of Pteridophyta with reference to alternation of generations, vasculature and spore bearing organs; heterospory and origin of seed habit.

Unit IV (24)

Pteridophyta:

1. Classification of Pteridophyta, upto orders, according to the system proposed by G.M.Smith. 7
2. The Geological time scale and a study of fossil Pteridophytes, with particular reference to *Rhynia*, *Horneophyton*, *Lepidodendron*, *Calamites*, *Cladoxylon*, *Sphenophyllales* *Coenopteridales*. 14
4. Economic importance of Pteridophytes; cultivation and maintenance of ornamental ferns.

Plant Diversity: Spermatophyta, Anatomy, Embryology, and Palynology

Unit I (24)

Spermatophyta:

Gymnosperms:

1. Classification of Gymnosperms according to the system proposed by C.J. Chamberlain. 2
2. Distribution of Gymnosperms in India. 2
3. General characters, affinities and interrelationships of the Cycadofilicales, Bennettitales and Cordaitales. 8
4. Comparison between Pteridophyta and Gymnosperms and Gymnosperms and Angiosperms. 6
5. Origin and evolution of angiosperms; the primitive angiospermic flower; primitive and advanced character in angiosperms. 6

Unit II (20)

Angiosperms:

1. Review of the post-Darwinian systems of classification with special reference to the systems proposed by (i) Engler and Prantle, (ii) Hutchinson and (iii) Cronquist. 4
2. International Code of Botanical Nomenclature (I.C.B.N.): History and basic principles. 2
3. Principles for assessment of relationships, delimitations of taxa and attribution of ranks : a. criteria, b. guidelines, c. practical considerations, d. use of categories. 6
4. Evolution, Variation and Speciation: Biosystematic categories, Biotypes and Ecotypes. 4
5. Concept of characters:- Introduction, types, functional values of taxonomic characters- numerical taxonomy, chemotaxonomy. 4

Unit III (21)

Development and Reproduction

1. Meristems, Definition, types of meristems, apical cell theory, histogen theory and Tunica Corpus theory. 4
2. Structural and functional aspects of epidermis, epidermal coatings and appendages. 5
3. Photosynthetic tissue system: Shape of cells, characters of cell wall, chloroplast anatomy of photosynthetic system, construction of photosynthetic system, influence of light. 8

3. Sensory and tactile tissue system: Tactile sense organs, gravitational and optical sense organs. 4

Unit IV (25)

Development and Reproduction

Embryology :

1. Male gametophyte: Pollen development and gene expression; male sterility, sperm dimorphism and hybrid seed production; pollen germination, pollen tube growth and guidance; pollen storage; pollen embryos. 3
2. Female gametophyte: Types of embryo sacs; structure of embryo sac cells. 3
3. Pollination, pollen-pistil interaction and fertilization: Floral characteristics, pollination mechanisms and vectors; breeding systems; commercial considerations; structure of the pistil; pollen-stigma interactions, sporophytic and gametophytic self-incompatibility(cytological, biochemical and molecular aspects); double fertilization; *in vitro* fertilization. 4
4. Seed development and fruit growth: Endosperm development during early, maturation and desiccation stages; embryogenesis, ultrastructure and nucellar cytology; cell lineage during late embryo development; storage proteins of endosperm and embryo; polyembryony; apomixis; embryo culture; dynamics of fruit growth; biochemistry and molecular biology of fruit maturation. 5

Palynology

1. Special relationships of pollen grains in pollen tetrads. 3
2. Pollen wall morphogenesis , ultrastructure, primexin formation. 5
3. Pollen proteins and allergens 2

Plant Physiology

Unit I (25)

1. Regulation of C3, C4 and CAM pathways of photosynthesis: 12
 Role of light in the activation of dark phase enzymes, regulation of Rubisco, .PEPCase, light effect, modulators and coordination of light, dark phases. C4 photosynthesis: inter and intra- cellular transport of metabolites, carbonic anhydrase, PEPCase, NADP-MDH and PPDK. Regulation of CAM through transport of metabolites.
2. Photosynthesis of prokaryotes : 8
 Pigment systems in bacteria and cyanobacteria, light harvesting mechanisms, reductive TCA cycle.
3. Pentose Phosphate pathway and its importance. 5

Unit II (20)

4. Application of enzymes in industry: Food (baking), beverages, fruit juices, dairy, detergents, textiles, leather, membrane cleaning, medicines; immobilized enzymes, their preparation, and application, biosensors. 8
5. Nitrogen metabolism :Biological nitrogen fixation by non-symbiotic 6
 bacteria, symbiotic nitrogen fixation, nitrogenase, nitrate reductase, nitrite reductase; induction of enzymes in the nitrate reduction pathway and regulation of nitrate assimilation. Enzymes involved in ammonia assimilation into glutamate, glutamine, aspartate and asparagine, light and metabolic control.
6. Proteins : 6
 Primary, secondary, tertiary and quaternary structural features and their analysis – theoretical and experimental; protein folding – biophysical and cellular aspects.

Unit III (20)

7. Seed Physiology : 8
 Physiology and biochemistry of seed germination, mobilization of food reserves, germination and growth factors, seed dormancy, significance with special reference to breweries and agriculture, control and release of dormancy.

Environmental botany:

1. Introduction :

Ecology and environment. Why environmental Botany? Role of botanists in Environmental conservation. 1

2. Water and Water Pollution :

11

Importance of making quantitative inventory of natural cycles. The hydrological cycle and balance of nature with reference to human activity. Requirement of water for different activities like agricultural crops, industries, urban water supply and disposal. Pollution of water due to industries, municipal wastes, thermal pollution, their effects on aquatic populations Aquatic plant communities as indicators of pollution. Diversity indices as suggested by Nygard, Palmer etc. for indication of eutrophic water. LD-50 values. MINAS for water quality for different uses. Case studies – Ganga river, Rivers in Pune and Mumbai environments. Nagin and Dal Lakes, Lakes in Udaipur.

Unit IV (25)

3. Pollution of Air :

6

Causes of the origin of air pollutants, primary and secondary pollutants and their effects on plants. Plants as indicators of pollution. Indices of atmospheric purity. Fate of pollutants in plants, absorption and neutralization, bio-remediation, limits of pollutant neutralization in plants. Basis of green belts. MINAS for air pollutants in different parts of human habitats. Case studies: Mumbai and Delhi.

4. Land and its degradation :

6

Land as a finite resource. Land and forest interactions. Waste lands and wasted lands – Indian Scenario. Soil erosion – causes and effects. Toxicity of excess concentration of elements, including heavy metals. Absorption, accumulation, magnification and mobility of heavy metals in plants. Human impact on soil-compaction and cementation, loosening and dust formation, waste deposition, eutrophication and their effects on plants. Plant indicators of soil conditions.

5. Plant Geography :

8

Vegetation formations on the earth, their productivity and diversity. Forests, grasslands and arid zones of India, diversity of flora in them and their productivity. Major wetlands in India – coastal, inland. Vegetation cartography and contribution of the French Institute, Pondicherry. Distribution of plants on the earth-dispersal, continental drift. Distribution of few important genera in India-Hora's hypothesis. Ancient travel routes. Endemics and exotics in Indian flora. Birth and extinction of species, Generic cycles, endangered and threatened species.

6. Environmental Botany – Present concern

5

Conservation of genetic resources, gene pools, land races, Global warming and coastal Ecosystems. Depletion of forest cover, threats to mangroves. Urbanization and plant cover.

Unit I (25)

Cytogenetics :

1. Extra nuclear genetic systems 10
Plasmids, transposons, and its elements in bacteria, jumping genes in maize, AC-DC elements. Transposon tagging of characters.
2. Microbial genetics 15
Molecular basis of transformation. Transduction, conjugation; fine structure of the gene, T4 Phage, complementation analysis, deletion mapping, cis-trans tests.

Unit II (25)

3. Recombinant DNA technology and DNA manipulation. 25
Gene cloning, construction of genomic libraries, chromosome libraries and cDNA libraries, DNA sequence analysis; Polymerase chain reaction, application of recombinant DNA technology for production of herbicide resistant plants, insect resistance, improving seed storage proteins and designer plants.

Unit III (20)

Medicinal Botany

1. Biological source, geographical distribution, macroscopic and microscopical, characters, chemical constituents and medicinal uses of *Vasaka* (leaf), *Fennel* (fruit/seeds), *Cinnamon* (bark) and *Acorus* (rhizome). 10
2. A general account of important drugs from plants of different taxonomic groups with emphasis on their therapeutic effects with reference to *Menispermaceae* (*Tinospora cordifolia* and *Cissampelos pereira*), *Apocynaceae* (*Holarrhena antidysenterica* and *Rauwolfia serpentina*), *Euphorbiaceae* (*Embilica officinalis* and *Ricinus communis*), *Zingiberaceae* (*Zingiber officinalis* and *Curcuma longa*). 10

Unit IV (20)

3. Essential oils (*Cinnamon*, *Eucalyptus* and *Citronella*), fatty oil (*Sesamum*, *Safflower* and coconut), vegetable fats (Cocum butter and Mahua butter) and their medicinal use. 10
4. Dietetics; therapeutic value of Indian plant foods: a) Rice, wheat; b) gram, green gram, black gram; c) lemon, grapes and bananas; d) ginger, turmeric, coriander, garlic, asafoetida, cumin and clove.
Plant foods in the treatment of disease with plants for anorexia, arthritis, constipation, diarrhoea, diabetes, exhaustion, hypertension, memory and piles 10

Practical I

Algae:

1. Study of the following types with reference to their systematic position, thallus and reproductive structures:

Scytonema, Lyngbya, Anabaena, Volvox, Scenedesmus, Ulothrix, Enteromorpha, Pithophora, Closterium, Caulerpa, Nitella, Padina, Gracilaria and Hypnea.

2. Extraction of algal pigments and their separation by paper chromatography.
3. Preparation of algal herbaria.

Fungi

1. Study of the following types with reference to their systematic position, thallus and reproductive structures:

Stemonitis, Saprolegnia, Phytophthora, Syncephalastrum, Xylaria, Phyllachora, Peziza, Melampsora, Auricularia, Daedalea and Trichoderma.

2. Study of AM(arbuscular mycorrhiza) from Panicum/maize/ any other suitable material by staining using Gerdemann and Nicholson's method(1968).
3. Study of the diseases mentioned in the syllabus (theory) with reference to the symptoms, causal organisms and disease cycle.

Bryophyta

1. Study of vegetative and reproductive structures in *Targionia, Plagiochasma, Fimbraria, Pellia and Pogonatum.*

Pteridophyta

1. Study of vegetative and reproductive structures in : *Isoetes, Ophioglossum, Pteris, Angiopteris, Lygodium and Azolla.*
2. Study of Fossils: *Sigillaria, Calamites, Rhynia, Sphenophyllum and Glossopteris.*

Practical II : Spermatophyta

Gymnosperms: A study of the following types:

Cordaitea (fossil), *Auracaria*, *Thuja*, *Podocarpus* and *Juniperus*.

Angiosperms: A study of the following plant families, their morphological peculiarities and economic importance of Menispermaceae, Portulacaceae, Guttiferae, Passifloraceae, Rhamnaceae, Sapindaceae, Lythraceae, Bignoniaceae, Boraginaceae, Chenopodiaceae, Scitamineae, Cyperaceae.

Identification of genus and species with the help of flora volumes. In addition to the above mentioned families, all families studied in undergraduate classes are included.

Anatomy

Study of wood elements in *Annona*, *Michelia*, *Sterculia* and *Thuja*, using the maceration technique.

Study of the following leaves with respect to leaf surface characters (wax, cuticle, epidermis, stomata, epidermal outgrowths): *Pistia*, *Ficus*, *Avicennia* and *Peperomia*.

Photosynthetic system in *Pinus* (arm palisade), *Cyperus*, *Ficus*, *oxalis*.

Embryology

A study of

1. Microsporogenesis and megasporogenesis with the help of permanent slides
2. *In vitro* germination of pollen grains, effect of temperature on pollen viability and short term storage.

Palynology

Study of the morphology of the pollen (using Chitale's method) from the families: Malvaceae, Asteraceae, Convolvulaceae, Labiatae and Graminae using Chitale's Method.

Practical III : Plant Physiology and Enviromental Botany

Physiology

Major experiments

1. Enzyme kinetics : Determination of K_m and V_{max} fo the enzyme amylase (purified amylase).
2. Extraction of cellulase from a suitable fungal culture and study of enzyme activity by DNSA method.
3. Immobilisation of yeast cells and study of invertase activity.
4. Quantitative study of diurnal fluctuation in titratable acid number (TAN) in a CAM plant.
5. Extraction and estimation of GOT and GPT from suitable plant material.
6. Estimation of the total nitrogen content of a plant using Kjeldahl's method.

Minor experiments

1. Separation of organic acids by paper chromatography.
2. Separation of sugars by paper chromatography.
3. A study of the enzyme polyphenol oxidase, from potato peels.
4. Solvent extraction of chlorophyll a/b, xanthophylls and study of absorption pattern.

Environmental Botany

Practical exercises are planned for better understanding of the state of environment, rather than 5-hour units. Field exercises are expected to be completed during excursions and field diaries maintained for submission during tests. Other practical work can be carried out in the laboratory with the help of plant and soil samples collected from the field.

Major exercises

1. Determination of Nygard index of algae in a water body.
2. Determination of dust load on leaves of roadside plants.
3. Comparison of two populations of a species collected from two areas.
4. Determination of primary production of an area by harvest method.
5. Determination of primary production of an area by chlorophyll method.
6. Determination of primary aquatic production by chlorophyll method.
7. Determination of mechanical composition of soil by international pipette method.

Minor exercises

1. Determination of Stomatal Index of leaves.
2. Determination of epidermal architecture of leaves.

3. Determination of LAI of different types of trees.
4. Assessment of pollution in ambient air, on the basis of injured leaf area.

Field exercises

1. Assessment of erosion status of land along a 'stream' on a 'slope' or on flat land.
2. Assessment of status of a waste land, on the basis of its appearance and visible plant growth.

Assessment of degradation of a forest on the basis of its canopy cover and height, strata and species diversity.

Practical IV Molecular Biology, Cytogenetics and Medicinal Botany

Cytogenetics :

1. Preparation of cytological stains, fixatives and pretreatment agents.
2. Squash preparation from pretreated root tips (colchicine / Paradichlorobenzene / Aesculin)
3. Squash preparation from EMS treated root tips for the study of aberrations.
4. Smear preparation from any suitable plant material.
5. Study of genetic phenomenon with the help of photographs / photomicrographs / specimens / slides : Incomplete dominance, jumping genes in Maize, Plastid transmission, tetrad analysis in *Neurospora*, Restriction map analysis and construction.

Medicinal Botany:

1. A study of the macroscopic and microscopic characters and identification of active ingredients of drugs mentioned in the syllabus for theory by means of chemical tests / TLC.
2. Identification of medicinally important plants like *Tinospora*, *Holarhena* and Ginger with respect to their morphological and anatomical characters for authentication.
3. Estimation of FW/DW ratio and total ash content from any medicinal plant material as per Indian Pharmacopeia standards.

A study of the following medicinal plants / plant parts with respect to their morphological, anatomical and biochemical characters for authentication of the drug source : *Tinospora cordifolia*, *Holarrhena antidysenterica*, *Ricinus communis*, *Zingiber officinalis*.

4. Morphological identification of plants with similar nomenclatures in the Ayurvedic system of medicine.
 - a) Brahmi – *Centella* and *Baccopa*
 - b) Asoka – *Saraca* and *Polyalthia*
 - c) Karanj – *Caesalpinia bonducalla* and *Pongamia*

Paper V: Techniques and Instrumentation

Unit I

1. Principles, working and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy. Flow cytometry. (10)
2. Principles of biophysical methods for biopolymer structures, X-ray diffraction and NMR. (10)

Unit II

3. Principles and applications of chromatography, of gel filtration, ion exchange and affinity, high pressure liquid chromatography. Electrophoresis, electrofocussing, ultracentrifugation. (20)

Unit III

4. Principles and applications of Atomic absorption, Plasma emission spectroscopy and Flame Photometer. (15)
5. Principles and applications of tracer techniques in biology, radioactive isotopes, autoradiography, Geiger Muller and liquid scintillation counter. (10)

Unit IV

6. Principles and applications of statistical methods in biological research, samples and populations, averages, coefficient of correlation, regression analysis, tests of significance, analysis of variance, use of computer for data analysis, introduction to excel and application. (25)

Practical V :

Biostatistics

1. Hypothesis testing, Normal deviate test.
2. Test of significance of means, paired and unpaired t test.
3. Application of analysis of variance (ANOVA)
4. Graphical representation of data using Excel : calculation of mean, standard deviation, insertion of error bars, coefficient of correlation.

C) Project Work based on the specialization (papers VII and VIII) Report and presentation.

Projects should be well planned and executed meticulously. They should relate to an environmental problem in a nearby / familiar area, should attempt a multi-disciplinary approach, should consist of reference to literature of relevance and should be in of the nature of 'problem solving'. The hypothesis should be neatly spelt out, objectives should be clear, material and methods precise, collected data treated statistically and presented in a graphic manner. Results should bring out achievements of the project executed and identify avenues for further work in the subject.

Paper VI : Molecular Biology

Unit I

1. Organisation of transcription- Mechanism of transcription in prokaryotes and Eukaryotes, RNA processing (capping, polyadenylation, splicing, introns and exons), structure of mRNA, genetic code and protein synthesis. (25)

Unit II

2. Regulation of gene expression: Attenuation and antitermination, operon concept, lytic cascade and lysogenic repression, DNA methylation, heterochromatisation, antisense RNA, transposition, protein targeting, post translational modification of proteins signal hypothesis, environmental control. (25)

Unit III

3. Principles of genetic engineering: Gene targeting, DNA transformation techniques, applications in agriculture, health care, medicine and industry, hybridoma technology.(10)
4. Molecular biology of nitrogen fixation, genetic engineering of nitrogenase cluster, genetic engineering of nodulation genes. (10)

Unit IV

5. Principles of techniques of nucleic acid hybridization and cot curves, sequencing of proteins and nucleic acids, Southern, Northern and Western blotting techniques. Dot and Slot blots, .DNA foot printing. (20)

Practical VI : Molecular Biology

1. Aseptic techniques, safe handling of microorganisms, establishing pure cultures, streak plate method, Maintenance of cultures – Paraffin embedding, Lyophilization.
2. Preparation of culture medium, stock solutions and growth curve, determination of viable cells, determination of cell number.
3. Isolation of plasmid DNA.
4. Quantification of plasmid DNA
5. Agarose gel electrophoresis separation of plasmid DNA.
6. Restriction enzyme digestion and separation of fragments.
7. Southern blot transfer technique.
8. Transformation of E. coli cell by plasmid DNA
9. β -galactosidase expression and assay.
10. Immobilisation of enzymes

Paper VII : Plant Biotechnology

Unit I

1. Plant improvement through somaclonal variations, anther cultures. (10)
2. Plant cell cultures as chemical factories: Cell suspensions, enhancement of product formation, elicitation, immobilization, permeabilization and product recovery. (15)

Unit II

3. Studies on *Agrobacterium* mediated transformed root cultures (5)
4. The quest for commercial production from plant cell scaling up of cell cultures, important factors for bioreactor design, pneumatically agitated bioreactors, comparison of bioreactors, operating mode, batch, fed batch, semicontinuous, two stage operation, continuous cultivation, example: Shikonin production by *Lithospermum erythrorhizon* cell cultures. (20)

Unit III

5. Environmental Biotechnology: Solid waste, reuse, recycling and disposal mechanism (case study fertilizer production from vegetable waste). (5)
6. Bioremediation and Phytoremediation: Detoxification of xenobiotics, chemical modification, compartmentation, superaccumulators. (10)
7. Safety regulations in handling of genetically engineered organisms, Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology. Writing a patent specification, information sources in patent search. (5)

Unit IV

8. Food Biotechnology: Factors affecting spoilage, quality control of food detection systems, enzyme immunoassays (ELISA), radioimmunoassay (RIA), monoclonal antibodies and DNA probes. (10)
9. Introduction to bioinformatics: Use of INTERNET and WWW and data searches. Tools used in Bioinformatics related to Biotechnology- NCBI data model. Services offered by NCBI and EBI. (10)

Practical VII: Plant Biotechnology

1. Various sterilization techniques, preparation of stock solutions, preparation of MS medium.
2. Seed sterilization, callus induction and regeneration, hardening and field transfer of any suitable plant material.
3. Encapsulation of axillary buds.
4. Establishment of callus of any suitable material and estimation of biomass accumulation and any one measurable product as a function of time.
5. Separation of proteins by PAGE electrophoresis.
6. Visit to industry/research lab to see various types of fermenters.
7. Extraction and detection of active constituents from *Mentha* (leaf), *Aloe* (leaf) *Datura* (seeds), *Withania* roots.
8. Use of INTERNET and WWW and data searches.
9. Tools used in Bioinformatics related to Biotechnology- NCBI data model. Services offered by NCBI and EBI.

Paper VIII : Cytogenetics

Unit I

1. Cell membranes and permeability: Molecular models of the cell membrane, cell permeability. Differentiation of the cell membrane, intercellular communications and gap junctions. Cell coat and cell recognition, cell surface (10)
2. Ultrastructure of cell organelles: Endoplasmic reticulum, Peroxisomes, lysosomes, golgi complex, mitochondria, chloroplast. Mitochondrial and chloroplastic genomes and their use in genetic engineering of useful traits. (10)

Unit II

3. Cell cycle and its control, cell differentiation and development, cell signaling apoptosis, ageing. (05)
4. Cancer Biology: Cancer cells : Characteristics, division, spread, treatment, Course of cancer cell formation, carcinogens: radiations, chemicals, oncogenic virus. Cancer and mutations, reproductive properties of transformed animal cells in culture, oncogenes, protoncogenes and their conversion. Oncogenes and growth factors. (10)
5. Conservation of germplasm, Gene banks (5)

Unit III

6. Genetic system of Yeast and Neurospora (07)
7. Immune systems: Phylogeny of immune systems, innate and acquired immunity, nature and biology of antigens, major histocompatibility complex cells of immune system, regulation of immune response, cell mediated toxicity, hypersensitivity, tumor immunology. Production of antibodies by plant cells and organs. (10)
8. Genetic disorders, genetic counseling and gene therapy: Biochemical disorders, sex linked disorders, cardiovascular disorders (5)

Unit IV

9. DNA based molecular markers aided breeding: RAPD, RFLP, AFLP, STS, ISSR, Microsatellites. (10)
10. Transgenic plants: Artificial (Direct DNA uptake by protoplast, electroporation, liposome mediated, and particle gun transformation) and Natural method of gene transfer (*Agrobacterium* and virus). Transgenic plants for improving seed quality protein, insect resistance (Bt genes), and golden rice, Edible vaccines. (10)
11. Plant Breeding: Distant hybridization in nature, barriers to the production of distant hybrids- intraspecific incompatibility, unilateral incompatibility, physiological and biochemical aspects, passive rejection, role of incompatibility in plant breeding and evolution, breeding for quality like protein content, disease resistance. 08

Practical VIII: Cytogenetics

1. Effect of PDB on cytological changes in the cells (Onion root tips), preparation of permanent slide.
2. Study of meiosis in *Tradescantia*, *Chlorophytum* or any other Liliaceae member.
3. Study of mitotic index
4. Culturing of *Drosophila* and study of genetic traits
5. Field trials : Randomised block design, Latin square.
6. Blood group testing
7. Cytological identification of normal and cancerous cells.
8. Demonstration of culturing of blood cells and Giemsa's staining.
9. Identification of genetic diseases by chemical tests.
10. Case studies of genetic disorders by visiting hospitals/clinics/ mental asylums

Paper VII : Biochemistry and Phytochemistry

Unit I

1. Enzyme isolation and purification, measurement of enzyme activity, specific activity, turnover number, enzyme kinetics, Allosteric enzymes, feedback inhibition, Isozymes. (07)
2. Vitamins and coenzymes: Structure. Occurrence, nicotine acid, riboflavin, biotin, thiamine, B6 group, folic acid, B12, Pantothenic acid, ascorbic acid, vitamins A, D, E and K, cytochromes and ferredoxin. (13)

Unit II

3. Lectins and storage proteins in plants, protein digestion and absorption of Amino acids and peptides, transamination, oxidative deamination and urea cycle. (13)
4. Nucleotide metabolism: purine ribonucleotide metabolism, biosynthesis and its regulation, pyrimidine deoxyribonucleotide metabolism, biosynthesis and its regulation. (07)

Unit III

5. Biochemical regulation: Coarse metabolic controls, fine metabolic controls, variation in substrate, pH, pacemaker enzymes, allosteric regulation, covalent modification, subunit association/ disassociation. Role of ATP, calcium, calmodulins. (10)
7. Secondary metabolism: Biosynthesis and role of Phenols, Phenylpropanes, Coumarins, lignins, flavonoids, alkaloids, tannins, steroids and terpenes. (15)

Unit IV

6. Cytosolic carbon metabolism: The central role of hexose phosphate, sucrose synthesis and breakdown, starch synthesis and breakdown, regulation of glycolysis, glucogenesis. (10)
8. Mitochondrial metabolism: The catabolic role of the TCA cycle: oxidation/reduction of carbohydrate, lipid, protein and amino acids, the anabolic role of the TCA cycle, utilization of intermediates, anapleurotic CO₂ fixation, provision of acetyl CoA for biosynthesis, control of TCA. (15)

Practical VII Plant Physiology : Biochemistry and Phytochemistry

1. Estimation of reducing, non reducing and total sugars from suitable plant material.
2. Extraction and estimation of lipid content using Soxhlet apparatus
3. Colorimetric estimation of fatty acids
4. Extraction and assay of enzyme bromelain from pineapple waste
5. Extraction and assay of enzyme papain from Papaya fruits.
6. Study of enzyme kinetics of enzyme amylase: Effect of pH, enzyme concentration, substrate concentration and temperature.
7. Colorimetric estimation of vitamin C.
8. Estimation of poly phenols from plant material.
9. Extraction of Aloe gel and separation using TLC.

Paper VIII : Plant Physiology

Unit I

1. Water relations of plants: The concept of the chemical potential and water potential, transpiration, antitranspirants, modern methods of improving crop productivity. (10)
2. Post harvest technology: Physiological changes during ripening, fruit preservation, role of ethylene in post harvest technology. (10)

Unit II

3. Stress Physiology: Drought – Types of drought, morphological and cellular adaptations, mechanisms of drought tolerance, theories of drought tolerance, drought tolerant crops, role of betaines, proline and other stress metabolites in stress resistance. (10)
4. Salinity : Salt accumulation and exclusion, salt avoidance and tolerance/resistance in halophytes and halobacteria. Chloride and sulphate halophytes, salt tolerant, effects of salt on metabolic process. Adaptation to salinity enzymes, proton pumps, Na and K ATPases and regulation of ion transport. (15)

Unit III

5. Modulation of plant genome by natural and synthetic PGR's (15)
Phytoremediation: Role of various enzymes in phytoremediation, super accumulators, Phytoextraction. Phytochrome and Photomorphogenesis : The photochemical and biochemical properties of phytochrome, phytochrome induced whole plant response, cellular and molecular mode of action. Molecular basis of flower organization : MADS box genes
6. and their expression. (10)

Unit IV

7. Phytochrome and Photomorphogenesis : The photochemical and biochemical properties of phytochrome, phytochrome induced whole plant response, cellular and molecular mode of action. Molecular basis of flower organization : MADS box genes and their expression. (20)

Practical VIII: Plant Physiology

1. Treatment of plants to stress: drought or salinity and study of chlorophyll content, protein content and proline content from control and treated plants.
2. Study of enzyme ATPases
3. Extraction and estimation of Pectin from fruit wastes.
4. Preparation of acid extract from young and senescent leaves of a halophyte and estimation of sodium and potassium by using flame photometer.
5. Preparation of soil acid extract of saline soil sample and estimation of sodium , potassium, Calcium and Magnesium content of the soil.
6. Study of effect of various concentration of Indole butyric acid on rooting of stem cuttings of suitable tree species.
7. Extraction and separation of proteins from suitable plant material by Polyacrylamide gel electrophoresis.

ANGIOSPERMS

PAPER VII- ANGIOSPERMS I

Unit I

1) HISTORY OF PLANT TAXONOMY

20

- 1) History and Development of Plant Classification.
- 2) The effects of evolutionary theory on systematics, monographic and Floristic development:
 - a. Primitive verses advanced
 - b. Homology and Analogy
 - c. Parallelism and Convergence
 - d. Phylogeny, phylogenetic and Phynetic ontogeny
 - e. Monophyly and polyphyly
 - f. Character weighing
 - g. Grades and Clades

Unit II

- 3) Contemporary Systems of classification with reference to systems of Angiosperm classification proposed by a) Robert Torne b) G.L.Stebbin c) Rolf M.T.Dahlgren 5

4) Progress and advancement in angiosperm taxonomy in India.

10

Contributors towards the progress and advancement:

- a) Universities, BSI and Other organizations
- b) Collection, Collation and dissemination of information

Through media: i) conferences; seminars, workshops etc.

ii) Internet (computers)

iii) Publications

iv) Exhibitions and talks

5) Present status and future scope of taxonomy in India

10

Present status: An Overview

Future scope: Opportunities existing in the following fields.

- a) Biodiversity study of any area.
- b) Vegetational survey.
- c) Floristics
- d) Revisionary and Monographic studies
- e) Ethnobiological studies
- f) Aerobiological survey
- g) Development and Establishment of New Herbaria
- h) Development and maintenance of bare areas
- i) Cultivation and maintenance of medicinal gardens
- j) Consultancy services: Agricultural, Horticulture, Forestry, Pharmaceuticals, Industries, Academic institutions and organizations
- k) Collaborative projects with other branches of science: Zoology, Geology, Chemistry and interdisciplinary Studies related to Environment, Conservation, Pollution and Plant animal relations
- l) Assistance to public and corporate sectors in issues related to Environment and plants.

Unit III

6) Tools of Angiosperm taxonomy

15

i) Library:

- a) Literature: Definition, Origin, History and Evolution of literature of Taxonomy in India.
- b) Classification of Taxonomic literature: Checklist, Catalogue, Floras, Monographs, Revisions, Encyclopedias, Indices, Dictionaries, Journals etc. (Detailed information and applications)

ii) Museum (Herbarium)

Definition, Steps involved in development of a Herbarium, Maintenance of Herbarium, General account of Herbaria in India, (B.S.I. and other private Herbaria), Herbarium of KEW, Utility and importance of Herbaria in Taxonomy.

- iii) Garden:
 - a) Origin, History and development of gardens in India.
 - b) Types of gardens
 - c) Importance of gardens in Taxonomic studies
- iv) Sacred groves:
 - a) Definition and role of sacred groves in Taxonomy
- v) Seed and Gene Banks:
 - a) Types of seed and gene banks
 - b) Maintenance
 - c) Applications, utility and significance of seed and gene banks

10

7) Naming of plants:

- i)Necessity of naming plants
- ii)Methodology in naming plants
- iii)Plant Nomenclature:
 - a)Definition
 - b)Steps involved in formation of International Code of Botanical Nomenclature (ICBN).
 - c)Detailed study of Principles, Articles, Recommendations, Rules etc.

Exercises on plant Nomenclature and Typification

15

8)Plant identification strategies

Taxonomic Evidences: Application of information from interrelated subjects-

- a)Exomorphic characters (including microscopic characters)
- b)Endomorphic characters:
 - i.Anatomical characters
 - ii.Cytological characters
 - iii.Palynological and Embryological characters
 - iv.Biochemical characters

Keys:

- a.Definition and Classification of keys
- b.Preparation of keys for Taxon, based on exomorphic characters

9) Modification of the phenotype

10

i) Genotype and Phenotype

ii) Plasticity of the phenotype

iii) The investigation of phenotypic variability

iv) Modifications with respect to operative factors (light, temperature, water, wind, soil and biotic)

PAPER VIII –ANGIOSPERMS

Unit I

1) Approaches to Angiosperm Taxonomy

- i) Establishment of systematic position and detailed study of the following families with reference to distribution, salient features, floral formula, floral diagram, morphological peculiarities and economic importance of the members available in Maharashtra :

Nymphaeaceae, Flacourtiaceae, Onagraceae, Begoniaceae, Myrsinaceae, Oleaceae, Gentianaceae, Lentibulariaceae, Nyctaginaceae, Piperaceae, Loranthaceae, Casuarinaceae, Orchidaceae, Araceae.

Unit II

- 2) Latest information regarding the present status, affinities, phylogeny, and interrelationships of the above families.

08.

2) ANATOMY

15

- i) Basic features of Node-petiole and Nodal anatomy.
ii) Leaf architecture patterns in dicotyledonous plants.
iii) General account of floral anatomy in hypogynous, epigynous and perigynous flowers and importance of floral anatomy in Taxonomy.
iv) Seed and fruit anatomy of monocotyledonous and dicotyledonous plants

Unit III

3) EMBRYOLOGY AND PALYNOLOGY

- a) Types of Ovules.
b) Development of different types of embryo sacs.
c) Role of embryology in plant breeding.
a) Pollen pistil interaction and its significance.
b) Evolution of Pollen aperture types in angiosperms.

4) MEDICINAL BOTANY

- i) History, origin, characteristics, uses, present status and varieties of the following plants. Ginger, Eucalyptus.
- ii) Fumitories and Masticatories.
- iii) Mild stimulants - Tea, Coffee, Cocoa.
- iv) Psychoactive drugs-Narcotics, Hypnotics and Hallucinogens.

Unit IV

5)Methods in evaluation of crude drugs:

20

- a)Organoleptic
- b)Microscopic:
 - i) Leaf constants:
 - a) Palisade Ratio
 - b) Vein islet number
 - ii) Trichomes and Trichome density
 - iii) Stomata:
 - a) Structure and type
 - iv) Cell inclusions
 - v) Sclereids
 - vi) Wood elements: Structure and organization
- c)Physico-Chemical :
 - i) Ash content
 - ii) Extractive values
 - iii) Qualitative chemical analysis
 - iv) Quantitative chemical analysis
- d)Biological: (with reference to plants from each of the following groups.)
 - i) Hepatoprotective
 - ii) Anti-fertility
 - iii) Anti-inflammatory
 - iv) Anti-ulcer
 - v) Neuro-pharmacological
- e) Evaluation of powdered drugs.
- f) Detection of adulterants and quality testing of crude drugs.

PRACTICAL VII – Angiosperms I

1) **Study of exomorphic characters:** study of stem, root, leaf, inflorescence, flower, fruit and seed of any five plants.

2) **Study of endomorphic characters:**

3) **Study of anatomical characters of Taxonomic importance:**

a. **Epidermal characters:** Study of following epidermal characters with respect to families Gramineae and Cruciferae.

- a) Epidermal cells
 - i) Cell size and shape.
 - ii) Cell wall materials and thickness of wall
 - iii) Cell wall surface and extra-cellular deposits
 - iv) Cell inclusions
- b) Study of stomata :
 - i) Type of stomata
 - ii) Size and shape of guard cells and other cells in association

b. **Epidermal outgrowths:** Study of trichomes in crotons.

4) **Study of cell inclusions:**

- b) Reserve food material: Use of differences in starch grain types in detection of varieties in *Diffenbachia seguine*.
- c) Secretory products : Analysis of Nectar from any five plants.
- d) Other metabolic end products :
 - i) Latex cells in Apocynaceae, Euphorbiaceae
 - ii) Resin cystolith in Begoniaceae
 - iii) Raphides in Onagraceae

5) **Study of vascular bundles:**

- i) Cortical vascular bundles in Casuarinaceae
- ii) Medullary Vascular bundles in Nyctaginaceae

6) **Study of anomalous secondary growth:** Pattern of anomalous secondary growth in Nyctaginaceae and Amaranthaceae.

7) **Study of wood anatomy:**

- i) Wood elements in members of Nympheaceae and Araceae
- ii) Distribution of wood parenchyma
- iii) Type of wood fibres

8) **Study of sclereids:** Sclereids in *Nymphaea* leaf, Sapota fruit and Bean testa..

9) **Study of Cytological characters of Taxonomic value:**

Study of karyotypes of *Allium cepa* and *Aloe vera* with respect to:

- i) Chromosomal number
- ii) Length of individual chromosomes
- iii) Arm ratio
- iv) Type of karyotype (symmetric/ asymmetric)

10) **Study of Palynological characters of Taxonomic value:**

- i) Eurypalynous type in Acanthaceae
- ii) Stenopalynous type in Casuarinaceae

11) **Study of Biochemical characters of Taxonomic value:**

- i) Extraction and qualitative testing of Solanaceous alkaloids
- ii) Study of modifications in the Phenotype using any suitable material.
- iii) Preparation of artificial key using minimum five plants belonging to a family.
- iv) Exercises on Nomenclature based on literature.

PRACTICAL VIII

Detailed study of the angiosperm families mentioned for theory with reference to morphological peculiarities and economic importance of its members.

- 1) Study of nodal anatomy and node-petiole anatomy patterns in *Eucalyptus*, *Nerium*, *Clerodendron*, *Brassica*, *Annona* and *Chenopodium*.
- 2) Study of leaf architecture in dicotyledonous plants through vein clearing /Photographs.
- 3) Study of the Pericarp structure in dehiscent (Orchidaceae) and in indehiscent (Nyctaginaceae and Gramineae) fruits.
- 4) Seed coat structure in *Linum usitatissimum*, *Ludwigia*, *Jussiaea*, *Phaseolus*, *Malus pumila*, *Lycopersicon esculentum*, *Lepidium sativum*, *Punica granatum* and in any orchid.
- 5) Study of different types of ovules and embryosacs (permanent slides / photographs).
- 6) Study of pollen aperture types in Angiosperms (from permanent slides)
- 7) Organoleptic, microscopic and physico-chemical evaluation of the following drugs.
 - a) Ginger rhizome
 - b) Vasaka leaf
 - c) Fennel fruit
 - d) Survey of formulations containing above drugs.
- 9) Detection of adulterants in the following samples on the basis of organoleptic, microscopic and physico-chemical evaluation:
 - i) Tobacco leaves (Adulterant -*Diospyros* leaf)
 - ii) Pepper fruits (Adulterant *Lantana* fruits/ papaya seeds)

ENVIRONMENTAL BOTANY

Paper VII – Ecology and Environmental Botany

Unit I

1. Ecosystems and their functioning with reference to productivity, food chains and webs, energy transfers, pyramids. (2)
2. Formation types in the world, with special reference to India – Terrestrial forest – evergreen, deciduous, scrub; grassland, desert, littoral forest, lake, river, ocean, with the help of at least one example each. Arid zones in India. Concept of carrying capacity. Productivity of the earth. IBP and its output. Contributions of Whittaker, Helmut Leih. (10)
3. Energy sources of the earth. Quantitative aspects of its transfers from the sun, through plants to the top of energy pyramid. Fossil fuels and their global stocks. Non-renewable and renewable stocks of energy sources. Bio-fuels – wood, dung, gobar gas, methanation, others. Energy saving and co-generation. Energy use and environmental health. (10)

Unit II

4. Nitrogen cycle – Role of nitrogen in plant metabolism and in biosphere. Normal nitrogen cycle and as tampered by man – agricultural nitrogen fixation, industrial emissions, transportation, etc. Impact in terms of eutrophication of environment, and health. (5)
5. Sulphur cycle – Forms of sulphur in biosphere and geosphere, sulphur in fossil fuels and its release with industrialization, sulphur cycling in soil bacterial metabolism. Impact on plants and on life. (5)
6. Carbon cycle – Forms and places of occurrence of carbon. Photosynthetic sequestration of carbon. Carbon in biomass in forest ecosystems. Cycling of carbon in biosphere and in oceans. Global warming problem and its possible implications.
7. Oxygen cycle – Origin of molecular oxygen on earth, its increase in atmosphere through geological eras. Inventory, role in plants, in biosphere and in oceans. Causes of disturbance of the cycle, effects. Role of plants in oxygen balance, oxygen emission by plants and forests. The problem of ozone layer around the earth. (6)

Unit III

8.Plant population dynamics – Significance of different shapes and sizes of seeds, soil seed banks, seed rain. Allelopathy. Strategies for survival under stresses like competition, Predation / parasitism, water stress, salinity, pollution. Adaptation to stresses and to xenobiotics. Adaptive evolution, Darwin as the greatest Ecologist. (20)

Unit IV

9.Plants in environment – Interaction with pollutants in air, water and soil. Absorption, accumulation and bio-magnification of gaseous pollutants like fluorine and heavy metals like Cu and Pb. Plant indicators, from the original Clementsian concept to pollution indicators. International Bio-indicator programme of the IUBS. Examples of bio-monitoring of forests, lakes, grasslands, urban areas, industrial areas etc. Pollution mapping using corticolous lichens, mosses and higher plants. (20)

10.Aerobiology, pollen calendars, disease forecasting, allergens and remedial measures. (06)

Paper VIII- Environmental Botany

Recent Trends and Applied Environmental Botany

Unit I

1. Phyto-sociology – Contributions from Braun-Blanquet to Dansereau. (4)
2. Mathematical ecology and ecological modeling Greig, Smith, G.P. Patil (2)
3. Plant demography – J.L. Harper, J.P. Grime and others. (2)
4. Dendro-ecology and its applications. (2)
5. Bio-diversity studies in India and in the world. Importance of conservation of bio-diversity and international effort in the direction. (5)
6. Tropical rain forests in the world, their structure and functions. – Contribution of Paul W. Richards. (4)
7. Ethno-botany, sacred groves, and traditional methods of conservation, Contribution of S.K. Jain, V.D. Vartak. (2)

Unit II

8. Agro-ecosystems, shifting cultivation, Agro-forestry, Plantation forestry, Silvicultural systems, their ecological significance. Contribution of P.S. Ramakrishnan. (5)
9. Management of natural resources – Forests, grasslands, wetlands, mangroves and coastal areas, aquatic systems. Contributions of M.S. Swaminathan, J.S. Singh, S.C. Pandeya, R.S. Ambasht, D.P. Zutshi and others. (5)
10. Treatment of waste water using plants. Choice of plant species and their plantation strategies. Manipulation of waterway for maximum interface. Problem anticipation in the functioning of the system. Improvement of root zone efficiency by inoculation of mycorrhizae. Restoration of lakes. Indian examples. (3)
11. Restoration of land – Categories of wastelands, physical, chemical and biological properties, causative factors forming wastelands. Methods of restoration. Revegetation, methods, choice of species, methods of plantation, aftercare. Choice of end-use of restored land. Options for use of fertilizers, manures, compost, vermin-compost, piggery waste, hatchery waste, sewage / waste water. Examples of heavy metal mine tailings, stone quarries, fly-ash ponds, urban wastelands. Aftercare. Case studies. Contribution of A.D. Bradshaw. Indian examples. (8)

Unit III

12. Restoration of mangrove ecosystem – Selection and treatment of coastal area with reference to tidal situation and physical properties. Choice of species. Collection of seed and seedling material, storage and plantation. Problems of seed dormancy, tidal forces, predation, nutrient supply etc. and methods to overcome the same. Case studies of Vikhroli, Dahanu, Chorao island. (8)

13. Urban ecosystem. Plants and their role in improvement of urban environment. Criteria for selection of plant species for plantation in different types of land uses in urban areas. Urban forests. Study of urban health through surveys of urban trees. A holistic approach to study – Industrial areas, Populations and their habitats, Water and other supplies and waste disposal, Transportation, Infra-structure, Education, Health, Sports and Entertainment, Amenities and Cultural issues – and relationship of all of these with plants. Case studies of Mumbai, Pune, Thane. Concept of Industrial Ecology. (7)
14. Botanists' contribution to Environmental Impact Assessment (EIA) and Environmental Management Programme (EMP). (4)
15. Designing of green belts for industries, highways, residential areas, institutions, playgrounds etc. Choice of species, density of plantation, plantation strategies. Advantages and limitations. Case studies from India (4)

Unit IV

16. Methods of conservation of water. Rainwater harvesting. Development of a watershed. Choice of site with reference to climate and topography. Choice of plant species. Landscaping, nursery setting, stake-holders' rights, peoples' participation. Continuous aftercare. Local interests and organizations. Role of NGOs, Local self government. Case study from Maharashtra. (4)
17. Salt land agriculture and its development, techniques and problems, Legislative aspects. Case study from Maharashtra. (5)
18. Palaeo-ecology and its applications. (4)
19. Role of bio-technologies tools in environmental restoration. Mass production of plants of required strains. Development of suitable nurseries on site for restoration. Possibility of acquiring tolerant strains of plants through gene manipulation. (6)
20. Role of international and national organizations in conservation and some relevant terms IUCN, UNDP, WWF, World Bank, European Union, MoEF, DST, DBT, CSIR, DSIR, UGC, CPCB, PCBs, Municipal Corporations Agenda 21, NGOs, Capacity building, GEMS, GEO, WRR, GRID, ENRIN, GIS, IBGP, IPR, TRIPS, etc. Legislation aiming at conservation. (6)

Practical VII- Ecology and Environmental Botany

- Assessment of carbon cycle in an ecosystem
- Preparation of an inventory of water in an ecosystem
- Determination of LD-50 values for pollutants (Cu, Pesticide, Phenol) using duckweed culture.
- Identification of polluted water from a group of water samples, on the basis of their phyto-plankton populations and Nygard index.
- Determination of energy content of primary production in an ecosystem, by bomb calorimetry.
- Preparation of profile diagram of vegetation across an ecotone, and bank of a water body (lake, river or creek). (Field exercise)

Practical VIII: Recent Trends and Applied Environmental Botany

- Determination of moisture content and water holding capacity of soils of different locations (e.g. garden, farm, roadside, mangrove area).
- Assessment of growth of roots in soils with different nutritional status.
- Determination of Tolerance Index of a plant species, towards polluted water, containing toxic material.
- Preparation of a Life Form spectrum of a plant community. (Field exercise.)
- Comparison of underground biomass of a plant species growing in different types of soil (nutrient rich, polluted and nutrient poor soils).
- Interpretation of satellite imagery, using recent images of familiar areas.
- Preparation of maps of Biosphere Reservations of India.
- Preparation of location maps of National Parks and Sanctuaries in Maharashtra.
- Identification of some important plants along with their locations, for their importance viz. Conservation status (rare, endangered, threatened, protected, ethnic significance etc).

MYCOLOGY AND PLANT PATHOLOGY

PAPER VII: General Mycology

Unit I

- 1 History of Mycology and Plant Pathology in India and contribution of Mycologists and Plant Pathologists:

T. S. Sadashivan, M. J. Thirumalachar, R. N. Tandon, M. N. Kamath, B. B. Mundkur, C. V. Subramaniam, E. J. Butler, K. S. Bilgrami, K. S. Thind, D. D. Awasthi, K. G. Mukerji, K. C. Mehta, John Webster, Barbara Mosse, E. A. Bessey, C. J. Alexopoulos, DeBary, C. T. Ingohd, Von Arx, S. D. Garrett, Paul Neergard, E. T. Reese. (10)

2. Soil Microbiology: Various techniques to determine the fungal and bacterial population in the soil, distribution of soil microflora with relation to the soil factors viz. texture, moisture, temperature, aeration, organic matter, various interaction amongst the soil microorganisms. (15)

Unit II

3. Fungal Taxonomy: A comparative account of various systems of classification of fungi (systems proposed by Bessey, Smith, Martin, Ainsworth and Alexopoulos) (20)

Unit III

4. Fungal Physiology: Membrane transport, transport system at tonoplast, nutrition in fungi with reference to carbon, nitrogen, minerals, vitamins and growth regulators. Secondary metabolites: shikonic acid pathway, aromatic metabolites Quinones and derivatives. (20)

Unit IV

5. Fungal Cytology and Genetics: Fungal cell wall, Nucleus: its behavior during cell division and sexual cycle in general, parasexual cycle, *Neurospora* and *Saccharomyces cerevisiae* as tools in genetic studies. (10)
- 5 Ecology of Fungi: Effect of environmental factors on growth and metabolism of fungi, pH, light and temperature, fresh water fungi, marine fungi, coprophilous fungi, predaceous fungi, Aeromycology – common forms of allergy. (15)

PAPER VIII: Applied Mycology and Plant Pathology

Unit I

1. Crop Pathology: Study of the following diseases:

Wart of Potato, Club root of Cabbage, Downy mildew of Grapes, Bunt of Rice, Coffee Rust, Brown spot of Rice, Tikka disease of Groundnut, Citrus Canker, Leaf spot of Mango, Papaya Mosaic, Tomato leaf curl, Mechanism of infection, defense mechanism, phytoalexins and disease resistance, control of air borne and soil borne pathogens. History and importance of quarantine, principals and applications of quarantine regulations, phytosanitary certificate, plant quarantine in India. (25)

Unit II

2. Seed Pathology: Seed borne inoculums, kinds, density, its assessment in relation to the plant infection, epiphytotics due to seed borne inoculum, disease forecasting based on seed infection, tolerance limit, principals and methods of seed health testing. (10)
3. Forest pathology: Wood rotting fungi, their significance, study of following types: *Phomes*, *Ganoderma* and *Polyporus*. (10)

Unit III

4. Cultural studies in fungi: Different types of media, specific media for different groups of fungi, maintenance of live cultures, mycological herbaria of the world viz. CMI, ATCC, Baarn, IARI Delhi, Chandigarh. Current trends in Mycological Research. (15)
5. Food borne fungi: Common contaminants of fresh, processed and stored food, protection of food against contamination, chemical preservatives, Mycotoxins: toxin producing fungi and determination of mycotoxins, useful fungi. (10)

Unit IV

6. Industrial Mycology: Role of fungi in industries, in general, Organic acids: Gluconic acid, Citric acid, Itaconic acid. Uses of immobilization technique in fermentation by fungi. Fungi in effluent treatment. Biotransformation of steroids and terpenoids. (20)

PRACTICAL VII: Fungal Taxonomy and Cultural Studies.

1. Preparation of semi synthetic and synthetic media and their sterilization

- a) PDA
- b) Czapek-Dox
- c) Sabouraud maltagar
- d) Baiting technique (poppy seeds)

2. Taxonomic study of the following types:

Myxomycotina : *Arcyria, Hemitrichia, Plasmodiophora.*

Mastigomycotina : *Synchytrium, Achyla, Allomyces, Albugo.*

Ascomycotina : *Saccharomyces, Taphrina, Chaetomium, Meliola, Phyllachora, Neurospora, Daldinia, Elsinoe.*

Basidiomycotina : *Dacryopinax, Uromyces, Entyloma, Clavariella, Hexagonia, Daedalia, Pleurotus, Coprinus, Lycoperdon, Cyathus, Sphacelotheca.*

Deuteromycotina : *Alternaria, Bipolaris, Pestalotia, Curvularia, Cladosporium, Cercospora, Phyllosticta.*

3. Study of the effect of environmental factors on fungal cultures

- a) Temperature
- b) pH
- c) N₂ Source (Nitrate Nitrogen and Ammoniacal Nitrogen)

4. Immobilization of fungal biomass and its activity.

5. Isolation:

a) Isolation and enumeration of soil borne mycoflora using PDA plate method from acidic soil, alkaline soil and from rhizosphere of medicinal and leguminous plants.

b) Preparation of single spore culture of the given fungus.

PRACTICAL VIII: Applied Mycology and Plant Pathology

1. Study of Vesicular Arbuscular Mycorrhizal Population – Wet – sieving and Decanting method.
2. Estimation of the activity of the following enzymes
 - a) Protease
 - b) CMCase- kinetics: pH, temperature, protein and substrate concentration
3. Study of the diseases with reference to the symptoms, causal organisms and disease cycle: any FOUR DISEASES prevailing in the locality and not studied in the earlier years.
4. Study of the location of the seed mycoflora.
5. Study of the seed borne mycoflora by – I) Standard Blotter method
II) PDA plate method
6. Study of effect of biocide on the fungal growth/mildewing.
7. Study of the damage caused to the timber by wood rotting fungi by maceration technique (maceration of bark or wood)
8. Identification of common contaminants of fresh, processed and stored food.