DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY

CIRCULAR NO.ACAD/SU/M.Sc.Bot./I & II Sem./Syllabus/94/ 2014

It is hereby notified for information of all concerned that, on the recommendations of the Board of Studies in Botany and Dean, Faculty of Science, the **Academic Council at its meeting held on 08-07-2014** has accepted the "***Revised Syllabus of M.Sc. Botany", Semester-I & II for affiliated colleges.***

This is effective from the **Academic Year 2014-2015** and onwards.

The **syllabus is available on the University Website.**

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Aurangabad-431 004.
REF.NO.ACAD/SU/M.SC. BOT./
2014/16466-515
A.C.S.A.I.No.461[17].

Date:- 12-08-2014.

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Director,
Board of College and University Development.

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DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,

AURANGABAD.

REVISED SYLLABUS

FOR

M. Sc. IN BOTANY

FOR AFFILIATED POST GRADUATE COLLEGES OF DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, AURANGABAD.

EFFECTIVE FROM JUNE 2014

M. SC. BOTANY REVISED SYLLABUS (SEMESTER PATTERN)

SEMESTER – I

Course No.	Title	Hours	Exam. duration	Marks
I	Biology and Diversity of Bacteria, Viruses, Phytoplasma and Fungi	60	3 Hrs	50
II	Taxonomy of Angiosperms	60	3 Hrs	50
III	Plant Physiology & Metabolism	60	3 Hrs	50
IV	Plant Genetics and Molecular Biology	60	3 Hrs	50

SEMESTER – II

Course No.	Title	Hours	Exam duration	Marks
V	Biology and Diversity of Algae, Bryophytes and Pteridophytes	60	3 Hrs	50
VI	Gymnosperms and Paleobotany	60	3 Hrs	50
VII	Plant Ecology and Biostatistics	60	3 Hrs	50
VIII	Plant Development and Reproduction	60	3 Hrs	50

PRACTICAL BASED ON (SEMESTER I&II)

Course. No.	Title	Hours	Exam duration	Marks
IX	Practical based on paper no (I&V)	90	6 Hrs	50
X	Practical based on paper no (II&VI)	90	6 Hrs	50
XI	Practical based on paper no(III&VII)	90	6 Hrs	50
XII	Practical based on paper no (IV&VIII)	90	6 Hrs	50

SEMESTER – III

Course No.	Title	Hours	Exam duration	Marks
XIII	Bioinformatics & Instrumentation	60	3 Hrs	50
XIV	Plant Resource Utilization & Conservation	60	3 Hrs	50
XV	Elective – I	60	3 Hrs	50
XVI	Elective – II	60	3 Hrs	50

SEMESTER – IV

Paper. No.	Title	Hours	Exam duration	Marks
XVII	Plant biotechnology	60	3 Hrs	50
XVIII	Applied Botany	60	3 Hrs	50
XIX	Elective – III	60	3 Hrs	50
XX	Elective – IV	60	3 Hrs	50

PRACTICAL BASED ON (SEMESTER III &IV)

Paper. No.	Title	Hours	Exam duration	Marks
XXI	Practical based on paper no (XIII&XVII)	90	6 Hrs	50
XXII	Practical based on paper no (XIV&XVIII)	90	6 Hrs	50
XXIII	Practical based on paper no (XV&XIX)	90	6 Hrs	50
XXIV	Practical based on paper no (XVI&XX)	90	6 Hrs	50

General Instructions

1. M.Sc. Botany s course is divided into four semesters.

2. Every theory paper will have workload of 60 periods each of 60 minutes duration distributed unit wise as indicated in this syllabus. **[4 periods/wk X 15 weeks=60 (60 lectures +15 tutorials)]** This workload is inclusive of test, tutorial & seminars to be conducted as mandatory PG activities. Every practical Paper will have workload of 90 periods each of 60 minutes duration. **(6 periods/week X 15 weeks=90)**

3. The weekly workload is

   [a] Each theory paper in every semester is **4 periods/week each of 60 minutes duration**

   [b] Each practical paper in every semester **is 6 periods/week each of 60 minutes duration**

4. It is must to complete a minimum of **ten practicals** in each practical paper of every semester

5. Every student should deliver minimum **ONE** seminar per semester per paper.

6. There should be **five** regular tests per paper and **five** tutorials per paper during each semester.

7. It is mandatory for students to have minimum **75% attendance** in each semester.

8. The students should successfully complete minimum **one month** in-plant training in any of the industry/NGO/University/Institutes /etc.

9. In every semester it is compulsory to undertake educational tour **(one short and one long)** tour including one industrial visit, and the report of the same should be submitted at the time of final practical examination of the consequent year.

COURSE-I

(Biology and Diversity in Viruses, Phytoplasma, Bacteria and Fungi)

Unit I. **Viruses** - Characteristics, Ultrastructure and chemical nature of viruses, transmission and multiplication of viruses, isolation and purification of viruses, general account of plant diseases, TMV and papaya leaf curl.

Unit II. **i. Phytoplasma-** General characteristics, ultrastructure and role in causing plant diseases.

ii. Bacterial Plant diseases: General account, Citrus canker, Angular leaf spot of cotton, Soft rot of fruits and vegetables

Unit III. **Bacteria** - General characteristics, ultrastructure, classification, Koch's' Postulates archaebacteria and eubacteria, nutrition, reproduction (fission and genetic recombination), Plasmids and their characteristics, role of bacteria in nitrogen fixation.

Unit IV. **Fungi** - General characteristics of fungi. Reproduction in fungi (Vegetative, asexual, sexual) Trends in classification of fungi. General account and outline of classification of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina,

Unit V. i. **Economic importance of fungi** - In medicine, In Agriculture (Biopesticides and Biofertilizers), In industry, Fungi as source of food (SCP, Mushrooms).

ii. Fungi as plant pathogens, *Albugo, Pythium, Phytophthora, Plasmopara, Claviceps, Cercospora, Helminthosporium, Alternaria, Fusarium, Rhizoctonia, Puccinia, Ustilago.*

PRACTICALS BASED ON COURSE- I

(Bacteria, Viruses, Phytoplasma and Fungi).

1. Sterilization Methods.
2. Preparation of Media.
3. Preparation of stains.
4. Isolation of Bacteria and Fungi from soil and infected plant tissues and pure culture.
5. Antibiotic assay.
6. Koch's postulates.
7. Gram staining.
8. Study of bacterial plant diseases - Citrus canker, Angular leaf spot of cotton, soft rot of fruits.
9. Study of viral plant diseases - Papaya mosaic, Tomato leaf curl, Yellow vein mosaic of Bhindi.
10. Study of Phytoplasma diseases - Little leaf of Brinjal, Sesamum phyllody, Grassy shoot of sugarcane.
11. **Morphology and Taxonomy of following fungi -**

    Albugo, Phytophthora, Mucor, Rhizopus, Plasmopara, Sclerospora, Taphrina, Phyllochora, Claviceps Chaetomium, Puccinia, Ustilago, Sphacelotheca, Agaricus, Potyporus Volveriella, Cyaihus, Lycoperdon, Geaster, Alternaria, Aspergillus, Penicilliuin,.Helminthosporium, Cercospora, Curvularia, Fusarium, Rhizoctonia, Coltetotrichutn, Phoma.
12. Spore germination of *Alternaria, Helminthosporium, Curvularia.*
13. Growth of Fungi on liquid and solid media — *Fusarium and Helminthosporium.*
14. Collection and submission of fungal, viral, phytoplasma and bacterial diseases of plants.

Suggested Readings - Course-I

(Viruses, Phytoplasma, Bacteria and Fungi)

1. U. Sinha and Sheela Shrivastava (1985) An Introduction to Bacteria, Vikas Publishing House Pvt. Ltd., New Delhi.
2. Burgey's Manual of Systematic Bacteriology, Vol. 1-4(1986-1989) Williams & Wilkins, Baltimore.
3. J.P, Verma (1992) The Bacteria, Malhotra Publishing House, New Delhi,

4. A.J. Salle (1974) Fundamental Principles of Bacteriology, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
5. K.G.Hardy (1987) Plasmids - a Practical Approach, IRL Press, Oxford, Washington D.C.
6. Bruce A. Voyles (2002) The Biology of Viruses, McGraw Hill, Boston.
7. LuriaS.E., J.E. Darnel!, D. Baltimore & A. Campbell (1978) General Virology, John Wiley & *Sons*, New York.
8) E.W. Mester, C.E. Roberts, M.M. Pearsall and B. J.Mc Carth- General Microbiology, Holt, Renehart & Winston, New York.
9. Powar & Daginawala (2004) General Microbiology Vol. II, Himalaya Publishing House, Mumbai.
10. R.F. Boyd (1984) General Microbiology, Times Mirror/Mosby College Publishing St. Louis.
11. S.B. Biswas & .Amrita Biswas (1993) An Introduction to Viruses, Vikas Publishing House Pvt. Ltd., New Delhi.
12. V.K. Gupta & M,K. Behl (1994) Indian Plant Viruses & Mycoplasma, Kalyani Publishers, Ludhiana.
13. S.P. Raychoudhari & T. K. Nariani (1977) Virus & Mycoplasma Diseases of plants in India, Oxford & IBH Publishing Co., New Delhi.
14. K.B. Deshpande & P.B, Papadiwal (1979) A Laboratory course in Bacteriology, COSIP-ULP - Botany Publication, Marathwada University, Aurangabad.
15. P.B. Papdiwal (1980) Biotechniques, COSIP- ULP - Botany Publication, Marathwada University, Aurangabad.
16. Alexopoulous C.J., C.W.Mims & M. Blakwel (1996) - Introductory Mycology, John Wiley & Sons Inc.
17. Dube H.C. (1994) - An Introduction to Fungi , Vikas Publishing House, New Delhi.
18) Sharma P.O. (2000) - Microbiology and plant pathology, Rastogi Publication, New Delhi.
19. Mukadam D.S. (1997) ^ The Illustrated Kingdom of Fungi, Aksharganga Publication, Aurangabad.
20. Mukadam D. S. (2004) - Modern Topics in Fungi, Saraswati Printing Press, Aurangabad.
21. Rangaswaini G. & A. Mahadevan (2001) - Diseases of Crop Plants in India., Prentice Hall of India, New Delhi.

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COURSE- II

(Taxonomy of Angiosperms)

Unit- I: **Angiosperms:** Definition, its characteristic features and probable causes of their evolutionary success. Taxonomy: Definition, scope, principles, aims and objectives of taxonomy. Biosystematics: scope and significance; principles and procedures; relationship between experimental and classical taxonomy; experimental categories.

Unit- II: **i. Evolutionary concepts**: Key concepts in evolution - origin of intrapopulation variation, population and environment, general biological principle, transference of function, adaptive radiation, punctuated equilibrium.

ii. Plant Speciation: Morphological, biological species concepts; allopatric, abrupt, sympatric, hybrid and apomictic speciation. Reproductive isolating mechanisms: Concept and various types.

Unit- III: **Criteria used for classification,** phases of plant classification and brief history on account of artificial, natural, phylogenetic systems of classifications with special reference to Bentham and Hooker, Engler and Prantl's system, Takhtajan's system and Angiosperm Phylogeny group, APG III (2009) classification of classification and its merits and demerits.

Unit-IV: **i. Botanical Nomenclature:** Concept of nomenclature, Binomial nomenclature and its advantages, formation of code, International Code for Nomenclature for Algae, Fungi and Plants (ICN), Principles, Scientific names, Principle of priority, valid and effective publication, concept of Typification and its types.

ii. Taxonomic literature: Flora, manuals, monographs, periodicals, dictionaries, indices, journals, pictorial encyclopedias and books. History of botanical exploration in India, Maharashtra with special emphasis on Marathwada.

Unit-V: **i. Taxonomic evidences:** Morphology, anatomy, embryology, palynology, cytology, phyto-chemistry and numerical taxonomy. Taxonomic tools: Serological and molecular techniques, GIS, GPS, Use of data bases. Herbarium Techniques, Major herbaria of World and India with special emphasis on BAMU.

ii. Phytogeography: Theories of differentiation and natural selection, types and areas of natural distribution, centre of origin, theory of tolerance, patterns of geographical distribution, disjunction, vicariance and its relevance to plant taxonomy, invasions and introductions. Endemism: Concept of endemism, categories, biodiversity hotspots in world with special reference to India, Endemism in Indian flora, megacentres of endemism in India; Keystone and flagship species, sacred groves and their importance.

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PRACTICALS BASED ON COURSE-II

(Taxonomy of Angiosperms)

1. Morphology: Terminologies related to Habit and life span, root, stem, leaves, inflorescence, flower, fruits.
2. Phytography: preparation of scientific botanical description of a plant specimen.
3. Study of at least 20 locally available families of flowering plants.
4. Identification of genus and species of locally available wild plants.
5. Preparation of botanical keys at generic level by locating key characters.
6. Knowledge of at least 10 medicinal plant species.
7. Demonstration of the utility for secondary metabolites in the taxonomy of some appropriate genera.
8. Field trips within and around the University Campus, compilation of field notes and preparation of herbarium sheets of plants.
9. Botanical excursion of about one week duration to any botanically rich location preferable outside the State.

Suggested Readings

1. Cole, A.J. 1969 Numerical Taxonomy. Academic Press. London. :.
2. Daris, P.H, and Heywood, V.H. 1-973. Principles of Angiosperms'Taxonomy. Robert E.Krieger Pub. Co. New York.
3. Grant, V. 1971 Plant Speciation, Columbia, University Press, New York.
4. Grant, W.F. 1984. Plant Bicosystematic , Academic Press. London.
5. Harrison, H.J. 1971 New concepts in Flowering Plant Taxonomy. Hieman Educational Book Ltd., London.
6. Heslop-Harrison, J. 1967 Plant Taxonomy. English Language Book Soc. & Edward Arnold Pub. Ltd. U.K.
7. Heywood, V.H. and Moore , D.M. 1984 current concepts in Plant Taxonomy, Academic Press. London.
8. Jones, A.D. and wilbins, A.D. 1971 Variations and Adaptions in Plant species. Hieman & co. Educational Ltd. London.
9. Jones S.B. Jr. & Luchsinger,A.E. 1986 Plant systematics, (2nd Edition) McGraw-Hill Book Co. New York.
10.Radford, A.E. 1986 Fundamentals of Plant systematics. Harper & Raw Publicaations , U.S.A. Il. Soibrig. O.T. & Solbrig D.J. 1979. Population Biology and Evolution.
Addisonwesley Publicating Co. Inc. U.S.A. 12. Stebbins, G.L. 1974 Flowering Plant- Evolution Above Species Level Edward
Arnold Ltd.,'London. 13.Stace,C.A. 1989. Plant Taxonomy and Biosystamatics (2nd Edition) Edward Arnold,, London.
14. Takhtajan A.L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, .New York.
15. Woodland D.W. 1991. Contemporary Plant Systematies, rentice Hall, New Jersey.

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COURSE-III

(Plant Physiology & Metabolism)

Plant physiology

Unit-I: **Energy flow:** Principles of thermodynamics, free energy entropy and enthalpy chemical potential. redox reactions, structure and functions of ATP.

Unit-II: **Enzymology:** General aspects, structure of enzymes allosteric mechanism, regulatory and active sites, isozymes, Kinetics of enzymatic catalysis, Michaelis-menten equation and its significance.

Unit-III: **Photosynthesis and Respiration:** General concepts and historical background, evolution of photosynthetic apparatus. Photosynthetic pigments and light harvesting complexes. Photoxidation of water, mechanisms of electron and proton transport, carbon assimilation - the Calvin cycle, Photorespiration and its significance, the c4 cycle, the CAM pathway, biosynthesis of starch and sucrose, Photosynthetic productivity. Glycolysis, TCA cycle, electron transport and ATP synthesis, Pentose phosphate pathway, glyoxylate cycle

Plants Metabolism.

Unit-IV: **Nitrogen and sulphur metabolism:** Overview, biological Nitrogen fixation, nodule formation and symbiotic N Fixation / mechanism of nitrate uptake and reduction, ammonium assimilation, Sulfate uptake transport and it's assimilation.

Unit-V: **Plant growth regulators:** Physiological effects and mechanism and action of auxins, gibberellins, cytokinins ethylene, abscissic acid, Physiological role of Plant Growth regulators.

Unit-VI: **Stress physiology:** Plant responses to biotic and abiotic stress mechanisms of biotic and abiotic stress tolerance HR and SAR, water deficit and drought resistance, salinity stress, metal toxicity, freezing and heat stress, oxidative stress.

Practical Based on Course-III

(Plant Physiology and Metabolism)

1. Extraction of Chlorophyll pigments with the help of solvent.
2. Separation of chlorophyll pigments by paper and thin layer chromatography,
3. Estimation of reducing sugars using Fehling's method.
4. Isolation of starch from potato.
5. Isolation of pectin form fruit rinds.
6. Effect of temperature on permeability.
7. Difference between C3 and C4 plants- chlorophyll content and leaf anatomy.

8. Chemical tests for protein.
9. Estimation of protein by Lawry's method.
10. Isoelectric point of casein.
11. Immobilization of enzymes using sodium alginate.
12. Preparation of leaf protein concentrate (LPC) by heat coagulation method.
13. Extraction/Estimation of crude fat using Soxhlet extractor.
14. Iodine number of fat.

Suggested readings based on
(Plant Physiology & Metabolism)

1. Plant physiology: F.N. Salisbury and C.W. Ross, CBS Publishers and Distributors, New Delhi.
2. Principles of Biochemistry, A.L. Lehninger, CBS Publishers and Distributors, New Delhi.
3. Plant physiology: R.G.S. Bidwell, Mac Millan Publishers Co., New York.
4. Advnced plant physiology, M.B. Wilkins, English Language Book Society, London.
5. Principles of plant physiology, Bormer, J. and Galston, A.W.
6. Introductory plant physiology, Noggle G.R. and Fritz, G.S., Prentice Hall, USA.
7. Plant Water Relationships, Slyter, R.O. Academic Press, New York.
8. Plant physiology, D. Hess, Narosa Publishing House, New Delhi.
9. Elementary Biochemistry, Mertz, E.T. Vakils, Fetter and simsons Pvt Ltd. Mumbai.
10. Essentials of Biological Chemistry, Fairley, J.L. and Kilgon, G.L., Altilised Earr west Press Pvt. Ltd., New Delhi.
11. Plant physiology, Devlin, R.M. and Hostan, F.H., CBS Publishers and Distributors, New Delhi.
12. Plant Physiology, S. C. Datta, Willey Eastern Limited, Culcutta.
13. Plant Physiology, S. Mukharji, A. K. Ghosh, New Central Book Agencies, Kolkatta.
14. An Introduction to Biometry, A. M. Mungikar, Sarswati Printing Press, Aurangbad.
15. Biostatical Analysis, A.M.Mungikar, Sarswati Printing Press, Aurangabad.
16. Laboratory Manual in Biochemistry, Jayraman, J., New Age International Publishers, Mumbai.
17. Experiment in Plant Physiology, D. Bajracharya. Narosa Publishing House, New Delhi.

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COURSE-IV
(Plant Genetics and Molecular Biology)

Plant Genetics

Unit I. **Mutation:** i. Spontaneous and induced mutations.
ii. Physical and chemical mutagens.
iii. Molecular basis of gene mutations.
iv. Transposable elements and mutation induced by transposons.
v. Site directed mutagenesis.

Unit II. i. DNA damage and repair mechanism.
ii. Initiation of cancer at cellular level. Proto-oncogenes and oncogenes.

Unit III. **Cytogenetics of aneuploidy and structural heterozygotes:**
i. Effect of aneuploids on plant phenotypes.
ii. The use of monosomics and trisomics in chromosome mapping of diploid and polyploid species.
iii. The breeding behaviour and genetics of structural heterozygotes.
IV. The complex translocation heterozygoies.
v. Robertsonian translocation.
vi. B-A translocation.

Molecular Biology

Unit IV. **Cell signaling:** Signal transduction, signaling pathways, second messengers, cAMP, genetic disorders due to the G protein defect. Lipid derived second messengers. Receptor tyrosine kinase and signaling pathway. Molecular biology of signaling.

Unit V. **Protein sorting:** Targeting of proteins to organelles. Translocation of secretory proteins across the ER membrane. The post translational modifications in RER.

Unit VI. **Techniques in Molecular biology:** Ultracentrifugation, fractionation, Electrophoresis, PCR, GISH, FISH and Immunochemical techniques.

Practicals Based on Course IV

1. Utilization of banding technique for identification of chromosomes in karyotype.
2. Orcein and Feulgen staining of the polytene chromosomes of Chironomus.
3. Characteristics and behaviour of B chromosomes using appropriate material.
4. Study of chromosome pairing and disjunction in translocation heterozygote.
5. Meiosis of complex translocation heterozygotes.
6. Isolation of plant DNA and its quantitation by spectrophotometric method.
7. Isolation of DNA and preparation of Cot curve.
8. Restriction digestion of plant DNA, its separation by agarose gel electrophoresis and visualization by ethidium bromide staining.
9. Demonstration of Western blotting.
10. Estimation of seed proteins by Lowry's method.

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Suggested Readings on Course- IV

1. Alberts, B. Bray, D. Lewis, J. Raff, M. Roberts, K. and Watson, J.D.1989. Molecular Biology (Ed.) Garland Publishing Inc. New York.
2. Atherly, A.G., Girton, J.R. and McDonald, J.F. 1999.The Science of Genetics. Saunders College USA.
3. Burnham, C.R. 1962. Discussions in Cytogenetics, Burgess Publishing Co., Minnesota.
4. Busch. H. and Rothblum, L. 1982 Volume X. The cell nucleus: DNA part A, Academic Press.
5. Hartl, D. L. and Jones E.W. 1998. Genetics : Principles and Analysis (4th Ed.) Jones and Barew Publishers, Massachusetts, USA.
6. Khush G.S. 1973 Cytogenetics of Aneuploids, Academic Press, New York, London.
7. Karp, G. 1999 Cell and molecular biology ; Concepts and Experiments, John Wiley and Sons Inc. USA.
8. Lewin, B. 2000. Genes VII. Oxford University Press, New York, USA. . Lewis, R. 1997. Human Genetics: Concepts and applications (2nd Ed).WCB, McGraw Hill, USA.
9. Malacinski, G. M. and Friefelder, D. 1998. Essentials of Molecular Biology (3rd Ed.), John and Bartlet Publishers Inc. London.. Russel, P. J. 1998. Genetics (5th Ed) The Benjamin / Cummings Publishing Company, Inc. USA.
10. Snustad, D. P. and Simmons.MJ.2000. Principles of Genetics (2nd Ed.), John Wiley and Sons Inc. USA.

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SEMESTER – II

Course No.	Title	Hours	Exam. duration	Marks
V	Biology and Diversity of Algae, Bryophytes and Pteridophytes	60	3 Hrs	50
VI	Gymnosperms and Paleobotany	60	3 Hrs	50
VII	Plant Ecology and Biostatistics	60	3 Hrs	50
VIII	Plant Development and Reproduction	60	3 Hrs	50

PRACTICAL BASED ON (SEMESTER I&II)

Course. No.	Title	Hours	Exam duration	Marks
IX	Practical based on paper no (I&V)	90	6 Hrs	50
X	Practical based on paper no (II&VI)	90	6 Hrs	50
XI	Practical based on paper no(III&VII)	90	6 Hrs	50
XII	Practical based on paper no (IV&VIII)	90	6 Hrs	50

COURSE-V

(Biology and Diversity of Algae, Bryophytes and Pteridophytes)

Algae

Unit I. **i.** Introduction and history of phycology with special reference to Indian work.
ii. Algae in diversified habitats (Terrestrial, fresh water, marine)
iii. Criteria used in classification of algae, pigments, reserve food and flagella; and important systems of classification of algae.

Unit II. **i.** A general account of thallus organization, reproduction and life history of algae.
Study of important groups of algae with reference to general account, cell structure and method of reproduction and life cycle pattern
a) Cyanophyta – *Nostoc, Oscillatoria, Scytonema*
b) Chlorophyta - Thallus structure, Cell structure, salient features of *Volvocales, Chlorococcales, Oedogonials, Chaetophorales, Zygnematales* (Desmids).
c) Phaeophyta - With special reference to alternation of generation.
d) Rhodophyta: With reference to triphasic life cycle

Unit III. **a) Xanthopyta-** With special reference to *Botrydium* and *Vaucheria.*
b) Bacillariopyta- Diatoms)
c) Prochlorophyta — General account
d) Algal blooms, Algal bio fertilizers, Algae as food, feed and uses in industry, pharmaceuticals and energy.

Bryophytes

Unit IV: Systems of classification, distribution, Economic importance.
Habitat, external and internal morphology, reproduction, evolutionary tendencies, phylogeny and interrelationships of gametophytes and sporophytes of the following orders: Sphaerocarpales, Takakiales, Marchantiales and Jungermanniales,.

Unit V. Habitat, external and internal morphology, reproduction, evolutionary tendencies, phylogeny and interrelationships of gametophytes and sporophyte of the following orders : Anthocerotales, Sphagnales, Andreales, and Bryales.

Pteridophytes:

Unit VI. 1. Classification, Origin and evolution,
2. Phylogenetic relationship with Bryophyta,
3. Psilopsida- Psilotales and Psilophytales,
4. Lycopsida- Lycopodiales, Selaginellales, Isoetales,
5. Equisetopsida - Equisetales,

Unit VII. A broad outline of classification upto orders and genera.
1. Sporophyte and gametophyte in Pteridophytes,
2. Stelar organization and evolution,
3. Origin of leaf and Telome concept,
4. Sporocarp,
5. Heterospory and seed habit,
6. Comparision of Pteridophyta with Bryophyta and Gymnosperms.

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PRACTICALS BASED ON COURSE- V

Algae

1. Collection and study of algae as mentioned in theory. Identification up to generic level.
2. **Morphological study of algal forms:**
   Microsystis, Oscillatoria, Lyngbya, Nostoc, Anabaena, Scytonema, Tolypothrix, Rivularia, Gloeotrichia, Cahthrix, Chlamydomonas, Pandorina, Eudorina, Volvox, Hydrodictyon, Scenedesmus, Pedistruium," Ulothrix, Ulva, Odeogonium, Cladophora, Pithophora, Draparnaldia, Draparnidiopsis, Coleochaete, Cosmarium, Closterium, Caulerpa, Acetabularia, Chara, Nitella, Botrydium, Vaucheria, Pinnularia, Navicula, Fragillaria, Ectocarpus, Diciyota, Fucus, Batrachospermum, Polysiphonia, Corallina.
3. **Separation of Algal Pigments**

Bryophytes

i. **Vegetative Organization**- *Marchantia, Riccia, Anihoceros, Porella, Sphagnum,Polytrichum.*
ii. **Anatomical Organization :** *Marchantia, Cyalhodhim, Anthoceros, Porella, Sphagnum.*
iii. **Archegonia and Antheridia and their Organization**- *Riccia, Marchantia, Porella, Anthoceros, Sphagnum.*
iv. **Sporophytes** —*Riccia, Marchantia, Pellia, Porella, Anthoceros, Funaria, Sphagnum,Polytrichum.*

Pteridophytes:

1. Morphological and anatomical studies of

1) *Psilotum* 2) *Lycopodium.* 3) *Selaginella*, 4) *Isoetis*, 5) *Equisetum*, 6) *Ophioglossum*,
7) *Osmunda*, 8) *Gleichenia*, 9) *Pteris*, 10) *Adianium*, 11) *Marselia*, 12) *Salvinia*,
13) *Azolla* and additional forms/species collected during study tour.

Suggested Readings

Algae

1. Chapman V.J. & DJ. Chapman (1983) The Algae, The MacMillan Press Ltd., London.
2. Desikachary T.V. (1959) Cyanophyta, 1CAR, New Delhi.
3. Fritsch F.E. (1961) The Structure and Reproduction of the Algae, Vol. I & H, Cambridge University Press, London.
4. KumarH.D. (1988) Introductory Phycology, Affiliated East-West Press Pvt. Ltd., New Delhi.
5. Prescott G. W. (1969) The Algae : A Review, Thomas Nelson .and Sons Ltd., Melbourne.
6. Round F.E. (1981) The Ecology of Algae, Cambridge University Press, London.
7. Smith G.M. (1950) The fresh water algae of the United states, McGrawIlill Hoc Co., NewYork.
8. Vijayraghavan & Sunita Kumari (1995) Chlorophyta, B. Singh Mahendra P. Singh, Dehra Dun.

Bryophytes

1. Smith (1955) Cryptogamic Botany I & II, McGraw-Hill, New York.
2. Prem Puri (1980) Bryophytes, Atmaram & Sons, Delhi.
3. Parihar (1991) Bryophytes, Central Book Dept., Allahabad.
4. Verdorn - (1932) Manual of Bryology, The Hegue.
5. Bower P.O.(1935) Primitive; land Plants, Macmillan and Co., London.
6. Campbell (1940) Evolution of land Plants, Stanford University Press.
7. Kashyap S.R.(1929, 1932), Liverworts of Western Himalays and the Pan); plain, Vol. I & II, The University of Panjab, Lahore.

Pteridophytes

1. Arnold , C.A. (1947) Introduction to Paleobotany, Me Graw-Hill Book Co. Inc., New York and London.
2. Eames, A.J. (1974) Morphology of Vascular Plants- lower groups, Tata Me Graw-Hill Publishing Co. New Delhi.
3. Foster, A.S. & F.M.Gifford (1967) Comparative morphology of vascular plants, Freeman Publishers, San Fransisco.
4. Parihar, N.S. (1976) The biology and morphology of the pteridophyta, Central Book Depot, Allahabad.
5. Rashid, A. (1976) An introduction to pteridophyta, Vikas Publishing House Ltd., New Delhi.
6. Smith, G.M. (1976) Cryptogamic Botany - Vol.11, Tata Me Graw-Hill Publishing Co. Ltd. New Delhi.
7. Spome, K.R. (1976) Morphology of pteridophyta, Hutchinson Univesity Library, London.

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COURSE: VI

(Gymnosperms and Paleobotany)

Gymnosperms

Unit I: 1. Introduction, Classification and distribution of Gymnosperms.

2. Systems of classifications of Gymnosperms

3. Economic importance of gymnosperms

4. Morphology, anatomy, reproduction, phylogeny of the following orders -

Cycadales (*Cycas, Zamia*) Ginkgoales (*Ginkgo*)

Coniferales (*Pinus, Thuja, Araucaria*) Taxales (*Taxus*)

Gnetales (*Gnetum*) Welwitschiales (*Welwitschia*)

Paleobotany

Unit III. 1. Introduction, Geologic time scale 2. Types of Fossils and fossilization

3. Contribution of Prof. Birbal Sahani 4. Plate tectonics.

5. Fossil localities in India

Type study of the following fossils-

i. Fossil Pteridophytes : *Rhynia*

ii. Fossil Gymnosperms : *Williamsonia, Cycadeoidea, Glossopteris*

iii. Fossil Angiosperms : *Pentoxylon, Sahnipushpam, Enigmocarpon*

Practicals: Based On Course- VI

1. Study of the vegetative and reproductive parts, including anatomy of the following genera : *Cycas, Zamia, Pinus, Cedrus, Taxodium, Cryptomeria, Cupressus, Thuja, Juniperus, Podocarpus, Cephalotaxus, Agathis, Araucaria, Taxus, Ginkgo, Gnetum.*
2. Impression and Compression, Petrification, Coal ball, Amber

Suggested Readings: Gymnosperms

1. Agashe, S.N. (1995) Paleobotany, Oxford & IBH, New Delhi
2. Biswas, C. and B.N, John (2004) The Gymnosperms, Narosa publishing Bourse, New Delhi
3. Coulter J.M, and C J. Chamberlain (1978) Morphology of Gymnosperms, Central Book Depot, Allahabad
4. Kakkar, R.K. and B.R. Kakkar (1995). The Gymnosperms (Fossils and Living), Central Publishing House, Allahabad.
5. Sharma O.P. (2002) Gymnosperms, Pragati Prakashan, Meerut.
6. Siddiqui K. A. (2002) Elements of Paleobotany, Kitab Mahal, Allahabad.
7. Arnold , C.A. (1947) Introduction to Paleobotany, Me Graw-Hill Book Co. Inc., New York and London.

COURSE VII

(Plant Ecology and Biostatistics)

Unit I

i. **Scope and importance plant ecology.**

ii **Structure and Functions of ecosystem:** Abiotic components (climatic factors, Topographic/factors, Edaphic factors); Biotic components (Interactions among organisms, Autotrophs and Heterotrophs), Ecological Pyramids (Pyramid of numbers, Biomass and energy). Productivity (Primary and secondary productivity, food chains, Grazing and detritus food chains), food webs

Unit II

i. Energy flow in ecosystem: (single channel and Y shaped energy flow models. Biogeochemical cycles: N, P, C and S and litter decomposition.

Unit III

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

ii. Methods of studying communities: Floristic, physiogamic and Phytosociological methods.

iii. Clementsian Units of vegetation: Plant formation, Associations, consociations and society.

Unit IV

i. Biogeography: Major biomes of the world (Terrestrial, Tundra, arboreal coniferous forests, temperate and tropical grasslands and deciduous forests, Mediterranean and Desert vegetation, Tropical rain forests; Aquatic - Fresh water Estuarine water and marine water, Wetlands).

Unit V.

i. Environmental pollution in relation to air, water and soil.

ii. Climate change: Greenhouse gases, their sources, trends and role: Ozone layer and ozone hole (global warming, sea level rise, El-nino and Al Nino effect, UV radiation).

iii. Concepts of ecological management and sustainable development.

iv. Environment Impact Assessment (EIA), Environmental legislations, Man and Biosphere (MAB), State Biodiversity Board, State Wildlife Board, Central Pollution Control Board-CPCB, Maharashtra Pollution Control Board.

Unit VI. Biostatistics: Biostatistics: Collection and tabulation of data, Frequency distribution, normal curve, location, dispersion, normal distribution, tests of significance, t test, F test, Z-test, chi square test, correlation and regression. Experimental designs, Analysis of data: RBD, LSD, Factorial and split plot RBD.

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PRACTICALS BASED ON COURSE-VII

Plant Ecology

1. To determine minimum size and number of quadrates required for reliable estimate of biomass in grassland.
2. To determine diversity indices (Shannon – Wiever Index, Sorenson's Index concentration of dominance) for protected and unprotected grass land stands.
3. To determine soil moisture content, porosity and bulk density of soils collected from varying depths at different locations.
4. To determine the water holding capacity of soils collected from different locations.
5. To estimate the Dissolved Oxygen, Net Primary Productivity (NPP), Gross Primary Productivity (GPP), content in water samples by Winkler's method.
6. To estimate Free CO2, Mg++, Ca++, and Total Hardness of different reservoirs,
7. Estimation of chlorophyll content in SO_2 fumigated and non-fumigated leaves.
8. Compute Mean, Mode, Median, Mean Deviation, Standard deviation, Coefficient of variation using suitable ecological data.
9. Compare the date using 't' z and f test two means related to ecological data.
10. To find out association between important grassland species using chi-square test.
11. Interpretation of satellite imageries and aerial photographs and analysis of vegetation.
12. Demonstration of Geographical Information system (GIS) and Global Positioning System (GPS)

Suggested Readings

1. Mungikar, A.M. (1997) An introduction to biometry, Saraswati Printing Press, Aurangabad.
2. Benny Joseph (2005) Environmental studies, Tata McGraw Hill Publishing Co., Ltd., New Delhi.
3. Manju Yadav (2003) Ecology, Discovery Publishing House, New Delhi..
4. Ramkrishna, P.S. (2001) Ecology and sustainable Development` National book trust, New Delhi.
5. Trivedi, P.R. (1999) " Encyclopedia of Ecology and Environment" Vol. I - 10, Indian National Green party, New Delhi.
6. Mungikar, A.M. (2003) Biostatistial Analysis. Saraswati Printing Press. Aurangabad.
7. Sharma, P.D (2001) Ecology and Environment, Rastogi Publications. Meerut.
8. Trivedi. R.K., Goel P.K., Trisal C.L. (1998) Practical 'Methods in Ecology and Environmental Science:Enviro-media Publisher. Karad
9. Muller, Dombosis, D. and H. Ellenberg (1974), Aims and methods of vegetation ecology,
10. Odum E.P. (1971) Fundamentals of Ecology, Saunders, Philadelphia.
11. Rajagopalan, R. (2005) Environmental studies, Oxford University Press, New Delhi.
12 Misra, R. (1968) Ecology work book, Oxford and IBH Publishing Co., Calcutta, New Delhi.
13. Ambasht, R.S. (1990). A text book of Plant Ecology, students Friends & Co., Varanasi.

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COURSE-VIII

(Plant Development and Reproduction)

Unit I. **i.** Cell autonomy, Polarity, Potency, Specification and differentiation,

ii. Meristems: Types of Meristems, Organization of shoot and root apical meristem, various theories, Cytological and Molecular analysis of SAM, control of tissue differentiation especially Xylem and Phloem. Lateral rgan Initiation

iii. Tissue systems: Differentiation and functions of different tissue systems such as epidermis, parenchyma, chlorenchyma, sclerenchyma.

iv. Secretary Tissues: Nectaries, Extra floral Nectaries, laticifers, Resin ducts.

Unit II. **i. Secondary cambium:** Concept, classification, origin and activities. Cork cambium and Abnormal cambium.

ii. Vascular tissues: Origin, structure and functions Xylem and Phloem elements and their taxonomic significance, Wood development in relation to Environment.

Unit III. **Leaf:** Plastochrome, Mechanism and regulation of Phyllotaxy, Growth and differentiation, differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll, Functional diversity of trichomes and stomata.

Unit IV. **Root:** Initiation and development; lateral roots, root hair, root microbe interaction.

Embryology

Unit V. **Flower formation:** Structure and Development of flower

Unit VI. Male gametophyte: Structure and dehiscence of anthers, micro-sporogenesis, types and role of tapetum, male sterility, Male Germ Unit (MGU), pollen germination, pollen tube growth and development, pollen storage, pollen allergy, pollen embryos.

Unit VII. **Female gametophyte;** Development of placenta, Ovule development, magasporogenesis, organization of the embryo sac and integuments, Structure of the embryo sac, polarity and patterning.

Unit VIII. **i. Floral characteristics:** Pollination mechanism and vectors, breeding systems, structure of pistil, sporophytic and gametophaytic self-incompatibility (cytological, biochemical and molecular aspects) double fertilization, *In vitro* fertilization.

ii Seed development and fruit growth: Endosperm development, Embryogenesis, Ultra-structure and nuclear cytology; Development of dicot and monocot embryos, poly-embryony, apomixes, embryo culture, Types, Initiation, and development of fruit, Parthenocarpy.

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PRACTICALS BASED ON COURSE-VIII

1. Diversity in cells and tissues in monocot and dicot plants with respect to position, distribution, structure and function.
2. Dermatology - Trichomes and stomata.
3. Mechanical tissues (Collenchyma, Sclerenchyma, Stone cells and Xylem) , Secretary tissues (Mucilage Canals, Resin canals, Nectories, and oil glands), laticifers (Latex cells and Vessels).
4. Vascular tissues and its constituents by sections and maceration.
5. Nodal anatomy,
6. Wood anatomy, TS, TLS and FLLS
7. Leaf anatomy- *Nerium* and *Terminalia.*
8. Study of microsporogenesis and gamtogenesis in sections of anthers.
9. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Crotolaria, Tradescantia, Brassica, Petunia, Solanum* etc.)
10. Test for pollen viability using stains and vitro pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
11. Estimation of percentage and average pollen tube length *in vivo*
12. Role of transcription and translation inhibitors on pollen germination and pollen growth
13. Pollen storage, pollen pistil interaction, *in vitro* pollination.
14. Study of ovules and embryo sacs.
15. Field study of types of flowers and pollination mechanism. .
16. Emasculation, hand pollination.
17. Study of nuclear and cellular endosperms.

Suggested Reading

1. Procton, M. and Yeo, P. (1973), 'The pollination of flowers', William Collins Sons, London.
2. Raghavan, V. (1997), 'Molecular embryology of flowering plants', Cambridge University Press, Cambridge.
2. Raghavan, V. (1999) 'Developmental Biology of flowering plants', Springier Verlag, New York.
3. Shivanna, K.R. and V.K. Sarobney, (Ed) 'Pollen Biotechnology for crop production and improvement' Cambridge University Press. Cambridge.
4. Shivanna, K.R_ and Rangaswamy, N.S. (1992), 'Pollen Biology: A laboratory manual', Springer Verlag, Berlin.
6. Shivanna, K.R. and John, B.M. (1985), The angiospenn pollen structure and

function'. Wiiley Eastern Ltd., New York.

7. Burjes, J. (1985). "An Introduction to Plant cell development Cambridge University Press, Cambridge.

8. Fahn, A. (1977), "Plant Anatomy" (3rd edition, 1982), Pergamon Press, Oxford.

9. Esau, K. 1965. "Plant Anatomy" (Second edition; 7th reprint 1991), Wiley Eastern, New Delhi.

10. Foskt D.E. 1994 'Plant growth and development' - A molecular approach Academic press, Santiago.

11 Howell, S.H. 1998. Molecular genetics of plant development, Cambridge University Press. Cambridge.

12 Cutter, E.G. 1978 Plant Anatomy - Experiments and interpretations' Part I and II, Edward Arnold

13. Hyndon, R.F. 1990, Plant development - the cellular basis Univ. Hyman, London.

14. Murphy, T.M. and Thompson, WF. 1988 'Molecular plant development Prentice Hall. New Jersey.

15. Raghavan, V. 1999. 'Developmental biology of flowering plants' Springer Verlag, New York.

16. Reven, P.H., Evert, R.F. and Eicbhom, S.E. 1992 'Biology of Plants' (5th Edition), New York.

17. Sleeves, T.A. and Sussex, LM. 1989, 'Patterns in plant development (T~ edition) Cambridge Press. Cambridge.

18. Waisel, Y., Eshel, A. and Kalkaki, U. (eds) 1996. Plant Roots; The Hidden Hall (2nd edition) Dekker, New York.

19. Forster, A.S. 1960. 'Practical plant anatomy D.van Nostrand company. Inc.

20. Roberts, L.W. 1976. Cyto-differentiation in plants (Cambridge University Press. Cambridge.

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7. Burjes, J. (1985). "An Introduction to Plant cell development Cambridge University Press, Cambridge.
8. Fahn, A. (1977), "Plant Anatomy[3rd] (3rd edition, 1982), Pergamon Press, Oxford.
9. Esau, K, 1965. "Plant Anatomy" (Second edition; 7th reprint 1991), Wiley Eastern, New Delhi.
10. Foskt D.E. 1994 'Plant growth and development' - A molecular approach Academic press, Santiago.
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12 Cutter, E.G. 1978 Plant Anatomy - Experiments and interpretations' Part I and II, Edward Arnold
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14. Murphy, T.M. and Thompson, WF. 1988 'Molecular plant development Prentice Hall, New Jersey.
15. Raghavan, V. 1999, 'Developmental biology of flowering plants' Springer Verlag, New York.
16. Reven, P.H., Evert, R.F. and Eicbhom, S.E. 1992 'Biology of Plants' (5th Edition), New York.
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