K. J. Somaiya College of Science and Commerce,
Vidyavihar, Mumbai-400077

Autonomous - Affiliated to University of Mumbai

(Reaccredited by NAAC with Grade A)

Syllabus for M.Sc.

(Autonomous- Revised)

Semester I and II

Program: M.Sc.

Course: Botany

(Cytogenetics and Plant Biotechnology)

Credit Based Semester and Grading System

With effect from the academic year 2018–2019

Preamble

Autonomy has given us the opportunity to frame the syllabus with a blend of Classical and Applied Botany which will open an array of opportunities in Higher Studies, Entrepreneurship, Research and Consultancy. Students will be geared up to get jobs in various industries such as Cosmetic, Pharmaceutical and Horticulture Industry.

M.Sc. Semester I Botany Syllabus

Credit Based and Grading System

To be implemented from the Academic year 2018-2019

SEMESTER I

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
18PS1BO01	**Paper Title: Plant Diversity I**			
	I	Microbiology	4	1
	II	Algae		1
	III	Mycology and Plant pathology		1
	IV	Applied mycology		1
18PS1BO02	**Paper Title: Plant Diversity II**			
	I	Bryophyta	4	1
	II	Pteridophyta		1
	III	Gymnosperms		1
	IV	Plaeobotany		1
18PS1BO03	**Paper Title: Taxonomy and Ethnomedicobotany III**			
	I	Taxonomy	4	1
	II	Ethnobotany		1
	III	Medicinal Botany		1
	IV	Pharmacognosy		1
18PS1BO04	**Paper Title: Functional Botany**			
	I	Economic Botany	4	1
	II	Phytotomy and Morphogenesis		1
	III	Palynology		1
	IV	Embryology		1

Course Code	PRACTICAL HEADINGS	Credits	L / Week
18PS1BOP01	Plant Diversity I	2	4
18PS1BOP02	Plant Diversity II	2	4
18PS1BOP03	Taxonomy and Ethnomedicobotany	2	4
18PS1BOP04	Functional Botany	2	4

M.Sc. Semester I Botany Syllabus

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SEMESTER II

Course Code	UNIT	TOPIC HEADINGS	Credits	L / Week
18PS2BO01	**Paper Title: Plant Physiology and Biochemistry I**			
	I	Photosynthesis	4	1
	II	Enzyme Kinetics		1
	III	Seed and Stress Physiology		1
	IV	Plant Growth Regulators		1
18PS2BO02	**Paper Title: Ecology II**			
	I	Ecology	4	1
	II	Population Ecology		1
	III	Environmental Botany		1
	IV	Plant Geography and Forestry		1
18PS2BO03	**Paper Title: Molecular Biology III**			
	I	Molecular Biology	4	1
	II	Gene Expression Control		1
	III	Recombinant DNA Technology		1
	IV	Genetic Engineering		1
18PS2BO04	**Paper Title: Computational Biology IV**			
	I	Biostatistics	4	1
	II	Bioinformatics		1
	III	Research Methodology		1
	IV	IPR		1

Course Code	PRACTICAL HEADINGS	Credits	L /Week
18PS2BOP01	Plant Physiology and Biochemistry	2	4
18PS2BOP02	Ecology	2	4
18PS2BOP03	Molecular Biology	2	4
18PS2BOP04	Computational Biology	2	4

SEMESTER I, PAPER I		
Code	**Title: Plant Diversity-I**	**Credits**
18PS1BO01	**Learning Objective:** Students will be able to govern the concepts of virology**.** Elaborate knowledge about algae and fungi will be used to develop industrial applications.	**04**
Unit I:	**Microbiology**	**Lectures**
	Behaviour of Viruses in Plants – Early stages of infection, Biochemistry of virus replication, Cellular sites of virus replication and assembly, Release and translocation of viruses in tissue. General structure of Tobacco mosaic virus and Citrus tristeza virus Transmission of plant viruses through vectors – Insects, Nematodes and Fungi, Without vectors; Contact seed and pollen Methods of detection of plant viruses – (i) In seeds, seed stocks and diseased plants, (ii) Indicator plants, (iii) Antigen-based methods, (iv) Histopathological methods	(15)
Unit II:	**Algae**	
	Classification of Algae up to Order with respect to Pigment, Thallus structure, Reproduction and Alternation of generation according to the system proposed by G. M. Smith Techniques of Culturing Algae, Algae in symbiotic Association as pollution indicator, Phytoplankton and water blooms	(15)
Unit III:	**Mycology and Plant Pathology**	
	Classification based on Vegetative and Reproductive structures according to the system proposed by G. M. Smith up to order. Spore bearing organs, release and dispersal, Host-parasite relationship, Classification of Plant Diseases based on Symptoms, Study of the disease with reference to the symptoms. Causal organism and control measures: i. Damping off of tobacco, ii. Late Blight of Potato, iii. Loose Smut of Wheat, iv. Brown Spot of Rice, v. Citrus Canker, vi. Leaf Curl Disease.	(15)
Unit IV:	**Applied Mycology**	
	Mycorrhizae – Morphology and Anatomy of mycorrhizae, importance of mycorrhizae in agriculture Dermatophytic fungi (medical mycology) – Skin disease in human-Dermatomycosis caused by *Tinea*, *Trichoderma* and *Cercospora* Fungi in human welfare – Fungi in medicine and food processing-Brewing and Baking.	(15)

Practicals:

Microbiology

1. Isolation and identification of plant viruses (Demonstration)

Algae

2. Study of following type with reference to their systematic position, thallus and reproductive structures: *Scytonema, Lyngbya, Anabaena, Spirullina, Oscillatoria, Vaucheria*, *Volvox, Scenedesmus, Ulothrix, Enteromorpha, Pithophora, Closterium, Nitella, Padina, Dictyota, Bactrachospermum* and *Gracilaria*.
3. Extraction of algal pigments and their separation by paper chromatography.
4. Preparation of algal herbaria.
5. Study of Phytoplankton.
6. Culturing Algae in laboratory.
7. Determination of Algal Biomass.

Fungi

8. Study of the following types with reference to their systematic position, thallus and reproductive structures: *Stemonitis, Pythium, Phytophthora, Xylaria, Peziza, Daedalea, Ustilago, Claviceps, Cercospora* and *Alternaria*.

Plant Pathology

9. Study of the disease with reference to the symptoms. Causal organisms and Control Measures: Damping off of Tobacco, Late Blight of Potato, Loose Smut of Wheat**,** Brown Spot of Rice, Citrus Canker, Leaf Curl Disease.

Applied Mycology

10. Study of mycorrhizae using photomicrographs.
11. Identification of mycorrhizae from suitable plant material.
12. Preparation of wine from suitable fruit

Reference Books:

1. Agrias G. 2005, Plant Pathology, 5th Ed. Elsevier Academic Press
2. Gibbs Adrian and Bryan Harrison, Plant Virology – The Principles, Edward Arnold Press
3. Khan J. A. and Dijkestra J. 2002, Plant Viruses as Molecular Pathogens
4. Hull R. 2009, Comparative Plant Virology, 2nd Ed, Elsevier Academic Press
5. Bhattia,A.2004.Treatise on Algae.S.Chand & Company ,New Delhi
6. Bilgarmi,K.S and Saha,L.C.1996.A text book of Algae.CBS Publishers, New Delhi
7. Bold ,H.C.&Wynne,M.J.1995.Introduction to Algae.Prentice Hall of India, New Delhi.
8. Kashyap,A.K.and Kumar,H.D. Recent advances in Phycology.Rastogy & company.
9. Kumar,H.D.1985.Algal cell biology.East West Press,New Delhi.
10. Kumar ,H. D.1999.Introductory Phycology .East West Pvt. Ltd.,New Delhi.

11. Pandey,B.P.2004. Algae.S.Chand & Company Ltd.New Delhi.
12. Prescott,G.W.1969.The Algae: A review .Nelson Publ.
13. Round,F.E.1984.The Ecology of Algae.Cambridge University, Press, London.
14. Sharma,O.P.2002. Text book of Algae.Tata McGraw Hill Publ. Comp. Ltd. New Delhi.
15. Sharma,P.D.2003.A Text book of Botany-Lower plants.Rastogi Publications, Meerut.
16. Smith,G.M.1976. Cryptogamic Botany Vol.1.Tata Mc Graw Hill Publ. Comp.. Ltd. New Delhi.
17. Vashishta,B.R..1999.Algae.S.Chand &Company, New Delhi
18. Ainsworth,G.C.,Sparrow,K.E., Sussman.The Fungi. Academic Press, NewYork
19. Alexopoulose,C.J.,Mims,C.W., Blackwell,M.1996.Introductory Mycology. John Wiley & Sons, New York.
20. Bessy,E.A.1979.Morphology and Taxonomy of Fungi.Vikas Publishing House, New Delhi.
21. Burnett,J.H.1968.Fundamentals of Mycology.Edward Arnold Ltd. London.
22. Chopra ,G.L.1998. A text book of Fungi .S.Nagin&Co . Meerut.
23. Dube,H.C.1996. An Introduction to Fungi.Vikas Publish.House, New Delhi.
24. Elizabeth Moore-Landeeker.1996.Fundamentals of Fungi.Prentice Hall, New Jersey.
25. Hale,M.E.1983.Biology of Lichens. Edward Arnold,London.
26. Hudson, H. J. Fungal Biology. Edward Arnold, London.
27. Moore, D..*et al* .1986.Developmental Biology of higher Fungi
28. Mehrothra,R.S. and Aneja,K.R.1990.An Introduction to Mycology. Wiley Eastern Ltd. New Delhi12.
29. Sharma,O.P.2007.Text book of Fungi . Tata McGraw Hill,Publishing Co. Ltd.New Delhi.
30. Sharma,P.D.2004.The Fungi for University students.Rastogi Publications, Meerut.
31. Srivastava,J.P.1998.Introduction to Fungi. Central Book Depot, Allahabad.
32. Sumbali,G.2005.The Fungi.Narosa Publishing House, New Delhi.
33. Agrios, G.N.1997.Plant pathology. Academic Press, New Delhi .
34. Bilgrami,K.S.&H.C.Dube.1990.A text book of modern plant pathology. Vikas Publishing House, New Delhi.
35. Butler,E.J.& Jones,1949.Plant pathology.Mc Millan ,London
36. Chatterjee,P.B..1997.Plant protection techniques .Bharati bhavan, Patna.
37. Chattopadhayay,S.B.1991.Principles and procedures of plant protection Oxford &IBH, New Delhi
38. Manners, J.G.1982.Principles of Plant pathology.Cambridge University Press, London.
39. Marshall,H.1999. Diseases of plants .Anmol Publications Pvt.Ltd. , New Delhi .
40. Mehrotra,R.S.2000. Plant pathology. Tata McGraw Hill,Publishing Co.Ltd. New Delhi.
41. Mundkur,B.B.1982. Text book of Plant diseases. Macmillan India Ltd., New Delhi

42. Pathak. V. N. ,Khatri, N. K. and Pathak,M.1996.Fundamentals of Plant pathology. Agrobotanical publishers (India), Bikaner.
43. Rangaswamy, G. and Mahadevan, A.2002. Diseases of crop plants in India. Prentice Hall of India, New Delhi.
44. Sharma,P.D 2005.Plant pathology.Narosa Publishing House, New Delhi.
45. Singh,R.S.2000. Introduction to the principles of Plant pathology. Oxford IBH, New Delhi.
46. Swarup *et al.,*1999. Plant diseases. Anmol Publications Pvt.Ltd., New Delhi.

SEMESTER I, PAPER II		
Code	**Title: Plant Diversity- II**	**Credits**
18PS1BO02	**Learning Objective:** Learning plant diversity helps students to establish the evolutionary trends in plants. It seeks employment in biodiversity. This study also enables them to explore areas of research and conservation. Students will also be able to predict how the plants get fossilized and preserved. They also will be predicting the evolution pattern of extinct plants.	**04**
Unit I:	**Bryophyta**	**Lectures**
	Classification of Bryophyta up to order according to system proposed by G.M. Smith Ecology of Bryophytes, Alternation of Generation. Origin and Evolution of Thallus, Sex organs and Sporophyte	(15)
Unit II:	**Pteridophyta**	
	Classification of Pteridophyta up to Order according to the system proposed by G.M. Smith Apogamy and Apospory Pattern of Spore germination in Pteridophytes Alternation of generations Cultivation and Maintenance of Ornamental Ferns Threatened Pteridophytes of India	(15)
Unit III:	**Gymnosperms**	
	Classification of Gymnosperms up to Order according to the system proposed by D.D. Pant and C.J. Chamberlein with special emphasis on comparison, merits and demerits. Evolutionary trends and origin of Gymnosperms Indian Contribution on Gymnosperms.	(15)

Unit IV:	Paleobotany	
	Paleobotanical Systematics – Rules, Principles, Naming, Problem in Naming Fossil remains of Non-vascular Plants – Algae, Fungi, Bryophyta, Basic Concepts and Scope, Condition favouring preservation of Fossil Plants Fossil Fuels, Process of Coalification Palaeogeographic and Paleoecological Significance of Flora.	(15)

Practicals:

Bryophyta

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

Pteridophyta

2. Study of vegetative and reproductive structures in : *Psilotum, Pteridium, Isoetes, Ophioglosum, Pteris, Angiopteris, Lygodium* and *Azolla.*

Gymnosperms

3. A study of following types: *Auraucaria, Cupressus, Podocarpus*, *Juniperus, Taxus,*
4. Study of *Ginkgo biloba* using permanent slides and photomicrograph.

Paleobotany

5. Study of fossils: (i) *Sigillaria, Calamites, Rhynia, Sphenophyllum* and *Glossopteris*. (ii) *Cordaites* and *Williamsonia*

References Books:

1. Chopra, R.N. and Kumara,P.K.1988. Biology of Bryophytes.Wiley East New Delhi.
2. Parihar, N.S. 1980.An introduction to Embryophyta Vol.I.Bryophyta.Central Book Depot, Allahabad.
3. Prem Puri.1981. Bryophytes:Morphology ,Growth and differentiation. Atma Ram and Sons, New Delhi
4. Rashid,A. 1998.An introduction to bryophyte . Vikas Publishing House, New Delhi.
5. Smith,G.M. 1976. Cryptogamic Botany Vol.II. Tata Mc Graw Hill. Publishing Co. Ltd., New Delhi.
6. Bierhost,D.W.1971. Morphology of vascular plants .Mac millan,London.
7. Eames,E.J.1983 Morphology of vascular plants .Standard University press.
8. Parihar,N.S.1980. An introduction to Embryophyta Vol.II.Pteridophyta Central Book Depot, Allahabad.
9. Rashid,A.1999. Pteridophyta. Vikas Publishing House, New Delhi
10. Sambamurthy AVSS, A Textbook of Bryophyta, Pteridophyta, Gymnosperms and Paleobotany
11. Scott,D.H.1962. Studies in Fossil Botany .Hafner Publishing Co., New York.

12. Shukla,A.C.and Misra,S.P.1975.Essentias of Paleobotany . Vikas Publishing House, New Delhi.
13. Sharma,O.P 2006.Text book of Pteridophyta. . Macmillan India Ltd.,New Delhi.
14. Smith,G.M.1976. Cryptogamic Botany Vol.II. Tata McGraw Hill, Publishing Co.Ltd. NewDelhi.
15. Sporne,K.R. 1986. Morphology of Pteridophytes. Hutchinson University Library, London.
16. Stewart,W.N.1983. Paleobotany and evolution of plants. Cambridge University Press, London.
17. Sundara Rajan,S.1999. Introduction to Pteridophyta.New Age Publications, New Delhi.
18. Bhatnagar,S.P. and Alok Moitra 1997.Gymnosperms.New Age Publications ,New Delhi.
19. Biswas ,C.and Johri,B.M.1999.The Gymnosperms. Narosa Publishing House, New Delhi.
20. Chamberlain,C.J.1955.Gymnosperms-structure and evolution. Dover Publications,Inc.New York.
21. Chamberlain,C.J .2000 Gymnosperms CBS Publishers, New Delhi.
22. Coulter and Chamberlain,1964. Morphology of Gymnosperm Central Book Depot, Allahabad.
23. Ramanujan,C G.K.1976. Indian Gymnosperms in time and space. Today and Tomorrows printers and publishers, New Delhi.
24. Sharma,O.P.1997. Gymnosperms, Pragati Prakasan,Meerut.
25. Sporne,K.R.1986. Morphology of Gymnosperms, Hutchinson University Library, London.
26. Vashishta,P.C.1999. Gymnosperms, S.Chand & Company, New Delhi.

SEMESTER I, PAPER III		
Code	**Title: Taxonomy and Ethnomedicobotany**	**Credits**
18PS1BO03	**Learning Objective:** Students will be able to interpret the basic knowledge of taxonomic diversity and important families. It demonstrates the relationship between plants and population. Students will be able to elaborate on basic concepts in principle of pharmacognosy and related medicinal plants.	**04**
Unit I:	**Taxonomy**	**Lectures**

	System of Classification: Artificial, Natural, phylogenetic International Code of Botanical Nomenclature (ICBN), Concept of Character: Introduction, Type, Function, Value of taxonomic characters, Numerical taxonomy and Chemotaxonomy, Botanical Survey of India	(15)
Unit II:	**Ethnobotany**	
	Study of Ethnobotany of plants and Tribals of Maharashtra. Ethnobotanical study with the help of literature and digital herbaria as an aid to ethnobotanical study. Research advances in Ethnobotany.	(15)
Unit III:	**Medicinal Botany**	
	Monograph of Drugs with respect to Botanical Source, Geographical distribution, Macroscopic and Microscopic characters, Chemical constituents, Therapeutic uses and Adulterants of a) *Tylophora asthamtica,*(Leaf) b) *Plantago ovata* (Fruit and Seed), c) *Holarrhena antidysenterica* (Bark), d) *Ricinus communis* (Seed), e) *Acorus calamus* (Rhizome), g) *Coleus forskohlii* (Leaf), Plant as Medicine for the treatment of –Arthritis, Renal Disease (Kidney Stone), Constipation, Piles.	(15)
Unit IV:	**Pharmacognosy**	
	Introduction –Definition, History Secondary Metabolites – Saponins, Steroids, Volatile Oil, Flavonoids, Anthraquinones. Phytochemical Screening – Steps involved in extraction of Medicinal plants; Size reduction, General Methods of Extraction of Medicinal plants; Maceration, Infusion, Decoction, Percolation, Hot Continuous Extraction, Aqueous and Alcoholic Extraction by Fermentation, Counter Current Extraction, Ultrasound Extraction, Supercritical Fluid Extraction- Filtration, Concentration and Drying	(15)

Practical:
1. A study of the following plant families with respect to their morphological peculiarities and economic importance : Ranunculaceae, Lythraceae, Acanthaceae, Sapotaceae, Boraginaceae, Chenopodiaceae, Scitaminaceae (Cannaceae, Zingiberaceae, Musaceae)
2. Study of the following Medicinal Plants, Plant parts with respect to their morphological and anatomical features with Identification of phytoconstituents (Saponins, Steroids, Volatile Oil, Flavonoids, Anthraquinones) for the authentication of the drug source and their chemical constituents and uses: *Tylophora asthamatica*

(Leaf), *Plantago ovata* (Fruit and Seed), *Holarrhena antidysenterica* (Bark), *Ricinus communis* (Seed), *Acorus calamus* (Rhizome), *Coleus forskohlii* (Leaf).

3. Study of plant as Medicine and their Therapeutic value used in treatment of diseases as prescribed in theory.
4. Determination of extractive value of plant material.
5. Crude extract preparation and its screening for phytochemicals.
6. Preparation of digital herbarium.

Reference Books:

1. Judd WS, Campbell CS, Kellog EA & Stevens PF (1999), Plant Systematics. Sinauer Associates, Inc., Massachusetts, USA
2. Lawrence GHM (1964), Taxonomy of Vascular Plants, Mac Millon Co., New York
3. Rendle AB (1967), Classification of flowering plants, Cambridge University Press
4. Sharma OP (1990) Plant Taxonomy, Oxford Publishers, New Delhi
5. Singh G (1999), Plant systematics: Theory and Practice, Oxford IBH.
6. Hooker JD (1879), Flora of British India. Reeve & Co., London 14. Hutchinson J (1959), Families of flowering plants, Cambridge University Press
7. Lawrence GHM (1955), An Introduction to plant Taxonomy, Central Book Depot
8. Sivarajan VV (1991) An introduction to Principles of Taxonomy, London
9. Sivarajan VV (1999), Principles of plat Taxonomy, Oxford and IBH Publishing Co.
10. Stace C (1985), Plant Taxonomy and Biosystematics, London.
11. Takhtajan AL (1969) Flowering plants. Origin and Dispersal, Oliver and Boyed.
12. Sen S (1992), Economic Botany, New Central Book Agency, Kolkata
13. Arora PK and Nayar EK. Wild relatives of Crops plants in India, NBPGR Sci. Monograph No. 7 2. CSIR, The useful plants of India, Publication and Information Directorate, CSIR, New Delhi
14. Kochar LS (1981) Economic Botany in the Tropics, Macmillan
15. Nutrition and Dietetics - Shubhangini Joshi, 3rd Edition
16. Dietetics - B. Srilakshmi, 6th Edition
17. Textbook of Human Nutrition -Mahtab S. Bamji, N. Pralhad Rao and Vinodini Reddy
18. The Ayurvedic Formulary of India Part I &II, Govt. of India, New Delhi
19. Modern Methods of Plant Analysis - Paech and Tracey.
20. Phytochemical Methods: A Guide to Modern Techniques of plant Analysis – Harbone
21. Pharmacognosy- Kokate et al
22. Textbook of Pharmacognosy- Mohammed Ali
23. Pharmacognosy- Wallis
24. Pharmacognosy- Trease & Evans-1996
25. Pharmacognosy- Shaw and Quadri
26. Pharmacognosy Part –II –Rumit Shah and Heena Kathad

27. Basic principles of Ayurveda – Athavale.
28. Ethnobotany – P.G. Sharma.

	SEMESTER I, PAPER IV	
Code	**Title: Functional Botany**	**Credits**
18PS1BO04	**Learning Objective:** Students will be able to predict the impact of economic botany. They will be able to interpret the function based on internal morphology. They will be able to compare the functions and morphology of pollen and spores. Students will be able to elaborate the development of embryo to mature seed and original plant.	**04**
Unit I:	**Economic Botany**	**Lectures**
	Source, Cultivation, Processing and Uses of – Oil producing plants; Olive, Coconut, Sunflower, Aromatic plants; *Geranium, Citronella, Patchouli,* Spices and Condiments; Star anise, Cinnamon, Mustard and Vanilla, Tannins and Dye material – Tanning industry, Sources of tanning material, manufacture of ink, dyes and pigments, sources of natural dyes.	(15)
Unit II:	**Phytotomy and Morphogenesis**	
	Meristems – Definition, Classification and type of meristems, Theories of shoot apical meristem, Theories of root apical meristem Development of flower; Transition to flowering, formation of floral organs, phylogenetic origin of flowers, floral development in *Arabidopsis* and *Antirrhinum,* Applied aspects of plant anatomy.	(15)
Unit III:	**Palynology**	
	Pollen wall development- Exine growth phase, Intine growth phase Pollen proteins and allergens. Evolutionary Trends among pollen grains based on Palynotaxonomy, Applications of Palynology, Role of palynology in taxonomy.	(15)
Unit IV:	**Developmental Botany**	

	Male gametophyte: Pollen development and gene expression male sterility sperm dimorphism and hybrid seed production; pollen tube growth and guidance; pollen storage; pollen embryos, Pollen-pistil interaction and fertilization. Pollen-stigma interactions, double fertilization; *in vitro* fertilization. Polyembryony, Apomixis and Parthenocarpy, Seed development and fruit growth; Endosperm development during Early, Maturation and Desiccation stages; Embryogenesis, Ultrastructure and Nucellar cytology; Storage proteins of endosperm and embryo; Dynamics of fruit growth; Biochemistry and Molecular biology of fruit maturation, Role of embryology in taxonomy.	(15)

Practicals:

1. Study of Source, Properties and Uses of: Oil Producing Plants- Oilve, Coconut, Sunflower.
2. Study of different methods of extraction and detection of Essential oils of *Geranium, Patchouli, Citronella* by TLC/ HPTLC
3. Study of Spices and Condiments- Star anise, Cinnamon, Mustard and Vanilla.
4. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant such as *Coleus, kalanchoe, Tobacco*.
5. Examination off shoot apices in a monocotyledon in both T. S. and L. S. to show the origin and arrangement of leaf primordial by permanent slides.
6. Study of epidermal peels of leaves such as *Coccinia, Tradescantia, Thunbergia*, etc. to study the development and final structure of stomata and prepare stomatal index.
7. Study of whole roots in monocots and dicots. Examination of L. S. of root from permanent preparation to understand the organization of root apical meristem and its derivatives by permanent slides. Origin of lateral roots by permanent slides.
8. Study of leguminous roots with different types of nodules.
9. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (*Maize, Grasses, Crotolaria, Tradescantia, Brassica, Petunia, Solanum melongena*)
10. Test for pollen viability using stains and *in vitro* germination. Pollen germination suing hanging drop and sitting drop cultures, suspension culture and surface culture.
11. Role of transcription and translation inhibitor (Sodium butyrate) on pollen germination and pollen tube growth.

Reference Books

1. Bhojwani, S.S and Bhatnagar, S.P. 2000. The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd. New Delhi.
2. Johri, B.M. 1984. 1984. Embryology of Angiosperms. Springer Verlag. Berlin.
3. Maheswari, P. 1980. Recent Advances in the Embryology of Angiosperms.
4. Pandey, A.K. 1997. Introduction to Embryology of Angiosperms. CBS Publishers and Distributors, New Delhi.
5. Pandey, S.N. and Chadha, A. 2000. Embryology. Vikas Publishing House Pvt. Ltd. New Delhi.
6. Chandurkar,P.J. 1966. Plant anatomy. Oxford &IBH Publication Co. New Delhi.
7. Cutler,D.F.,1978 .Applied Plant Anatomy .Orient Longman, New Delhi.
8. Cutler,E.G. 1978. Plant Anatomy (Vol.I,II.) Edward Arnold, London.
9. Eames ,A.J.,& Mac Daniels,L.H. 1979.An introduction to Plant Anatomy. Mc Graw Hill New York.
10. Esau,K. 1974. Plant Anatomy. Wiley Eastern Ltd. , New Delhi
11. Esau,K. 2002. The anatomy of seed plants. John Wiley & Sons, New York.
12. Fahn,A. 1989. Plant Anatomy,Pergamon press,Oxford ,New York.
13. Foster,A.S. 1960. Practical Plant Anatomy. Van Nostrand & East West, New Delhi.
14. Metcalfe,C.R. and Chalk ,L.1950.Anatomy of the dicotyledons and Monocots(Vol.I,II),
15. Oxford University Press, London.
16. Shivanna KR and Johri BM (1985) The Angiosperm Pollen: Structure and Function. New Delhi, India: Wiley-Eastern.
17. Bhojwani, S.S and Bhatnagar, S.P. 2000. The Embryology of Angiosperms, Vikas Publishing House Pvt. Ltd. New Delhi.
18. Johri, B.M. 1984. 1984. Embryology of Angiosperms. Springer Verlag. Berlin.
19. Maheswari, P. 1980. Recent Advances in the Embryology of Angiosperms.

SEMESTER II, PAPER I		
Code	**Title: Plant Physiology and Biochemistry**	**Credits**
18PS2BO01	**Learning Objective:** Students will be able to predict the plants response to environmental conditions and variation. They also will be able to design the environmental conditions for *in vitro* cultivation of plants.	**04**
Unit I:	**Photosynthesis**	**Lectures**
	Regulation of C3, C4 and CAM pathways of Photosynthesis – Role of light in the activation of dark phase enzymes, Regulation of RUBISCO, PEPcase, CA, NADP-MDH, PPDK Pentose Phosphate Pathway and its significance, Photosynthesis in prokaryotes – Pigment system in bacteria and Cyanobacteria Light harvesting mechanisms, reductive TCA cycle.	(15)
Unit II:	**Enzyme Kinetics**	
	Properties of enzymes, Factors affecting enzyme activity, Mechanism of formation of enzyme-substrate complex Michaelis-Menten curve and Lineweaver-Burk Plot Enzyme inhibition; Types of inhibition with examples, Allosteric enzymes and their regulation, Biological role of enzymes.	(15)
Unit III:	**Seed and Stress Physiology**	
	Seed physiology – Dormancy; Introduction, Mechanism, Breaking of Seed dormancy, Physiology and Biochemistry of Seed Germination- long-lived m-RNA. Factors affecting germination, Metabolic aspects of germination Stress Physiology – Introduction, Types; Biotic and Abiotic stress, Environmental Stress; Water stress, Drought, Cold, Salt, Mechanism of plant's response to water and related stress; Chilling injury, High-temperature stress.	(15)
Unit IV:	**Plant Growth Regulators**	
	Biosynthesis, Storage, Breakdown, Bioassay and transport of Auxin; IAA, Gibberrelin; GA3 and GA12, Cytokinin; Zeatin Significance and applications of Polyamines, Ethylene, ABA.	(15)
Practicals		
Major Experiments: 1. Study of diurnal fluctuation in titratable acid number (TAN) 2. Extraction and estimation of GOT and GPT from suitable plant material. 3. Extraction of pectinase from suitable source and study its activity. 4. Determination of K_m and V_{max} of the enzyme Amylase.		

5. Determination of the effect of inhibitors (Cu and Hg) on the activity of enzyme amylase.
6. Effect of water and salinity stress on chlorophyll content.

Minor Experiments:

7. Study of the effect of physical and chemical factors on breaking seed dormancy.
8. Assessing seed viability by TTC method.
9. Solvent extraction of chlorophyll a, b, carotenoids and xanthophyll from plants grown under water and salinity stress and study of their absorption spectra.
10. Separation of organic acids by paper chromatography.
11. Study of the enzyme polyphenol oxidase from potato peel.

Reference Books

1. Brett, C.T. and Waldron, K.K. 1996. Physiology and Biochemistry of Plant Cell Walls, Chapman and Hall London.
2. Campbell, M.K. 1999. Biochemistry. Saunders College Publishing, New York.
3. Conn, E.E. and Stumpf P.K. et al., 1999. Biochemistry. John Wiley and Sons. New Delhi.
4. David T. Dennis and David H. Trurpin (Eds.) 1993. Plant Physiology,
5. Lincoln Taiz and Eduardo Zeiger, 1991. Plant Physiology. The Benjamin/ Cummings publishing Company, Inc.
6. Noggle and Fritz, 1999. Introductory Plant physiology. Prentice hall, London.
7. Salisbury, F.B. and Ross. C. 2000, Plant physiology. John Wiley & Sons, New Delhi.
8. Strafford, G.A. 1979 Essentials of Plant Physiology. Heinemann Publishing Co. New York.
9. Wilkins, M.B. (Ed) 1984. Advanced Plant Physiology, Pitman Publishing Co. New York.
10. William G. Hopkins, 2002. Introduction to Plant Physiology. John Wiley & Sons. Inc. New York.
11. Hames, B.D. et al., 1999. Instant notes in Biochemistry. Viva books Pvt. Ltd. New Delhi.
12. Jain, J.L. 2000. Fundamentals of Biochemistry. S. Chand & Co. New Delhi.
13. Plummer, D.T. 1996. An Introduction to practical Biochemistry. McGraw Hill
14. Satyanarayana, U. 1999. Biochemistry. Books and Allied (P) Ltd. Calcutta.
15. Wilson and Goulding. 1992. Biologists Guide to Principles and Techniques of Practical Biochemistry.
16. Principles of Biochemistry, Lehninger C Rs. Publ. (1982)
17. Biochemistry, L. Stryer, W.H. Freeman, San Francisco.
18. Schaum's Outline Series of Theory and Problems of Biochemistry, Philip W. Kuchel and G.B. Ralston. Int. Ed., McGraw-Hill Book Co
19. Problem Approaches in Biochemistry. Wood and Hood.
20. Biochemistry by Voet and Voet.

SEMESTER II, PAPER II		
Code	**Title: Ecology and Environmental Botany**	**Credits**
18PS2BO02	**Learning Objective:** Students will be able to coordinate between various factors of environment. Students will be able to demonstrate the relationship between organisms and corresponding niche.	**04**
Unit I:	**Ecology**	**Lectures**
	Ecosystem- (i) Aquatic Ecosystem (ii) Terrestrial Ecosystem Major Plant Communities of World, Concept of Model and Ecosystem Modelling, Development and Evolution of Ecosystem Ecosystem Management.	(15)
Unit II:	**Population Ecology**	
	Niche concept, Types- Competition and Ecological Niche Population Ecology – Influences of abiotic factors on Populations Interactions between Populations – Interspecific Interactions Population Growth Curve, Hardy-Weinberg law, Concept of Metapopulation- Demes and dispersal, Interdemic extinctions, age, structured population.	(15)
Unit III:	**Environmental Botany**	
	Soil Pollution – Nature of Agrochemicals and implications to soil environment Quality, Noise Pollution – Sources, Reasons and effects Natural Disasters – Land Slide, Oil Spill, Present Concern – Conservation of Genetic Resources, Gene pools, land races, Global Warming and coastal ecosystems, Depletion of forest cover, Threats to Mangroves, Urbanization and Plant cover.	(15)
Unit IV:	**Plant Geography and Forestry**	
	Study of Climate, distribution and their adaptation to the environment- Desert, Tundra, Grassland and Savannah Continental drift, Endemism – Types of Endemics, Endemic flora Forest Surveying – Definition, Objectives, Classification Forest Legislation.	(15)
Practicals:		
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 excursion 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 experiments** 1. Determination of Nygard index of algae in a water body.		

2. Determintion of dust load on leaves of roadside plant.
3. Comparison of a plant species collected from two different areas.
4. Analysis of soils of two different areas for CO_3, NO_3.
5. Determination of primary production of an area by harvest method.
6. Determination of primary production of an area by chlorophyll method.
7. Determination of primary aquatic production by harvest method.
8. Study of effect of pollution on chlorophyll contents and morphology of stomata of the plants.

Minor experiments

1. Determination of epidermal architecture of leaves.
2. Determination of LAI of different types of trees.
3. Assessment of pollution in ambient air, on the basis of injured leaf area.
4. Study of plant adaptation in relation to climate with reference to Desert, Tundra and Grassland.

Field exercises

5. Assessment of erosion status of land along a 'stream' on a slope or on flat land.
6. Assessment of status of waste land, on the basis of its appearance and visible plant growth.
7. Assessment of degradation of a forest on the basis of its canopy cover and height, strata and species diversity.

Reference Books:

1. Agarwal, K.C. 2001 Environmental Biology, Nidi Publ. Ltd. Bikaner.
2. Aradhana PS 1998, Environmental Management, Rajat Publications, Delhi.
3. Arora Mohan, Ecology.
4. Ambasht RS and Ambasht NK, 1996. A text book of Plant Ecology. Students' friends and Co, Varanasi.
5. Chakarwarty CM, Plant Ecology and Environment Management.
6. Dash MC, 1996. Fundamentals of Ecology.TMH Publishing Company, New Delhi.
7. Kumar HD, 2000. Modern concepts of Ecology. Vikas Publishing House, New Delhi.
8. Kumar HD, 1997. General Ecology. Vikas Publishing House, New Delhi.
9. Mukharjee B, Ecology – A System Approach
10. Odum, F. E. 1971. Fundamentals of Ecology. W.B. Saunders and Company.
11. Purohit and Agrawal, Ecology and Environmental Biology
12. Subrahmanyam NS and Sambamurthy AVSS, Ecology, 2nd Edition
13. Sharma, P. D. Environmental Biology, Himalaya Publications.

SEMESTER II, PAPER III		
Code	**Title: Molecular Biology**	**Credits**
18PS2BO03	**Learning Objective:** Students will be able to interpret the fundamentals of structure, properties and functions regulated by nucleic acid. They also will be able to develop various applications of biology in basic and applied field of research.	**04**
Unit I:	**Molecular Biology**	**Lectures**
	Transcription and translation in prokaryotes and Eukaryotes, Post- transcriptional modifications, Protein sorting in cell, Post-translational modifications – Proteolytic cleavage, glycosylation, chaperons, Intein splicing.	(15)
Unit II:	**Gene Expression Control**	
	Concept of Operon – Lac operon, Trp operon Control of gene expression in Eukaryotes – Transcriptional control, RNA processing control, m-RNA translocation control, m-RNA and protein degradation, Regulation of gene expression in λ phage - λ phage genome, Lytic and Lysogenic pattern of life cycle, Molecular regulation of switch between lytic and lysogenic life cycle	(15)
Unit III:	**Recombinant DNA Technology**	
	Vectors – Bacteria; Phagemids, Phasmids Plant; Plant viruses, M13 phage, Agrobacterium, Animal; YAC, BAC, High –Tech plasmids, Maximizing protein synthesis, facilitating protein purification, Protein export, Methods of gene transfer in plants – Natural and Artificial methods; Agrobacterium, Viruses, electroporation, Particle gun method, Liposomes, Protoplast fusion	(15)
Unit IV:	**Genetic Engineering**	
	Improving Genetic Traits – BT cotton, Herbicide resistance, Seed storage proteins, Golden rice, Flavr-Savr tomato, Ethical issues. Genetics of Nitrogen Fixation – Types of N_2 fixation, Organization and molecular analysis of *nif*- and *nod*- genes, Regulation of N_2 fixation.	(15)
Practicals:		

1. Polyacrylamide Gel Electrophoresis of proteins under Native condition. 2. Polyacrylamide Gel Electrophoresis of proteins with SDS. 3. Polyacrylamide Gel Electrophoresis of proteins with SDS under reduced condition. 4. Study the effect of proteolytic substances on proteins using Native PAGE. 5. Study of Lac-operon and Trp-operon using photomicrographs. 6. To perform λ-bacteriophage assay by plaque method. 7. Transformation of *E-coli* using PUC18/19. 8. Isolation of plasmid and characterization. 9. Study of genetically modified crops using photomicrographs (BT cotton, Golden Rice) 10. Study of *Nif*-genes, *Nod*-genes using photomicrographs. 11. Isolation of Rhizobia using CREYMA.
Reference Books
1. Russel P. (2008) Genetics 2. Lewin B (2008). Genes IX, Jones and Barlett Publishers. 3. Old, R.W. and Primrose, S.B 1983. Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford, London 4. Watson: Molecular biology.

SEMESTER II. PAPER IV		
Code	**Title: Computational Biology**	**Credits**
18PS2BO04	**Learning Objective:** It offers interdisciplinary program between biological and physical as well as mathematical science. Students will be able to design the overall process of research.	**04**
Unit I:	**Biostatistics**	**Lectures**
	Hypothesis testing – Null and Alternate hypothesis, Type I and II errors, P – value; one v/s two tail P value ANOVA – One way and Two way, Randomized Block design, Latin Square design, Introduction of software- SAS and MiniTap.	(15)
Unit II:	**Bioinformatics**	
	Kinds of Primers, Designing of primers Gene finding, Motif finding Gene Expression, profiling and applications, Microarray technology.	(15)
Unit III:	**Research Methodology**	

	Research – Meaning, Objectives, Motivation, Significance Research Process – Steps Research Problem – Selection, Necessity, Techniques in defining research problem Research Design – Meaning, Need, Features, Important concepts Interpretation of data – Concept, Requirement, Technique and Precautions Report writing – Significance, Steps, Layout, Mechanics, Precautions- Concept of plagiarism, Types. Research funding agencies in India.	(15)
Unit IV:	**IPR**	
	Biotechnology and the law – Objective, Evolution, Basic structure of gene techniques, Applications, Commercial potential of biotech inventions, Rational for IPR protection Protection of traditional knowledge – Objective, Concept, Holders, Issue concerning, Bio-prospecting and Bio-piracy Patenting,	(15)

Practical:

1. Problems based on P-value
2. Problems based on one way and two way ANOVA
3. Problems based on Randomized Block Design and Latin Square Design
4. To design a primer for the given DNA strand
5. To identify given motif using suitable software
6. To identify types of microarray
7. To identify objectives for given scenario / case
8. To identify motivations for given scenario / case
9. To postulate steps for solving given research problem
10. Interpret the given data into possible conclusion
11. Construct the layout for given scientific report
12. To file a patent.

Reference Books

1. George Burns and Paul Bottino. 6th Edition. The Science of Genetics.
2. Prasad S.- Elements of Biostatistics.
3. Richard Kowles. Solving Problems in Genetics
4. J. N. Thompsom Jr., Jenna Hellack, Gerald Braver and David Durica. Primer of Genetic Analysis. 2nd Edition, A Problems Approach.
5. Khan, I. A. and A. Khanum. 1994 Fundamentals of Biostatistics
6. B. N. Mishra and K. K. Mishra. Naya Prakash. 1983. Introductory practical

Biostatistics.
7. Research Methodology – C.R. Kothari
8. B.D. Singh Biotechnology
9. Rastogi, Bioinformatics
10. David Mount, Bioinformatics