

Title of the Paper	<b>CORE PAPER-I: Biodiversity - I ALGAE, FUNGI, LICHENS, BRYOPHYTES, BACTERIA, AND VIRUSES</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - I Semester	6	4	

## ALGAE, FUNGI, LICHENS, BRYOPHYTES, BACTERIA, AND VIRUSES

### UNIT - I: Algae

Classification of algae by Fritsch (1935-45) and Christensen (1964) system. General characteristic features of algae: Chlorophyceae, Xanthophyceae, Chrysophyceae, Bacillariophyceae, Cryptophyceae, Dinophyceae, Chloromonadineae, Euglenophyceae, Phaeophyceae, Rhodophyceae, and Cyanophyceae. Structure, reproduction and life histories of the following genera: *Oscillatoria*, *Scytonema*, *Ulva*, *Codium*, *Navicula*, *Padina*, *Gelidium*.

### UNIT - II: Fungi

Classification of Fungi Alexopoulos and Mims. Heterothallism in fungi, sexuality in fungi, Parasexuality, sex hormones in fungi. Cultivation of mushrooms – *Pleurotus*, Mycorrhizal Fungi, Economic importance of fungi.

Structure, reproduction and life histories of the following genera:

Plasmiodiophromycetes	: <i>Plasmodiophora</i>
Oomycetes	: <i>Phytophthora</i>
Zygomycetes	: <i>Rhizopus</i>
Ascomycetes	: <i>Taphrina</i>
Basidiomycetes	: <i>Polyporus</i>
Deuteromycetes	: <i>Fusarium, Alternaria, Cercospora</i>

### UNIT - III: Lichens

Lichens: Classification - Structure of thallus, nutrition, asexual reproduction, sexual reproduction, structure of apothecium, economic importance.

### UNIT - IV: Bryophytes

Classification of algae by Watson (1971). General characteristic features of Bryophytes: Hepaticopsida, Anthocerotopsida and Bryopsida. Range of gametophytes and sporophytes in bryophytes. Economic importance of bryophytes. Structure, reproduction and life histories of the following genera: *Targionia*, *Reboulia*, *Porella*, *Funaria*.

## UNIT - V: Bacteria and Viruses

Classification, structure and reproduction of Bacteria, Mycoplasma, Viruses - Harmful and beneficial microbes. Important plant diseases caused by bacteria, viruses and viroids.

### REFERENCE BOOKS

1. Alexopoulos, C. J. And Bold, H. C. Algae and Fungi. The Macmillan Co. London
2. Bold, H. C and Wynne, M. J. 1978. Introduction to the Algae: Structure and Function. Prantice Hall of India New Delhi
3. Chapman, V. J. 1962. The Algae. Macmillan and Co. Ltd. New York.
4. Dioxn, P. S. 1973. Biology of Rhodophyta. Hafner Press. New York.
5. Dodge, J. E. The Fine Structure of Algal Cells. AP London
6. Fogg., G. E. 1953. The Metabolism of Algae. Methuen & Co. London
7. Fott, B. 1959. Studies in Phylogy. Academia Prague
8. Fritsch, F. E. 1935. The Structure and Reproduction of Algae, Vol. I. University Press Cambridge
9. Fritsch, F. E. 1945. The Structure and Reproduction of Algae, Vol II. I. University Press Cambridge
10. Harley, J. L. 1969. The Biology of Mycorrhiza Leonard Hill. London
11. Kumar H. D and H. N. Singh. 1982. A text Book on Algae. Affiliated East- West Press Pvt. Ltd
12. Morris, I. 1968. An Introduction to the Algae, Hutchinson University Library, London
13. Phillips, J. M. and Hayman, D. S. 1970. Improved procedures for clearing roots and staining parasitic and vesicular arbuscular mycorrhizal fungi for rapids assessment and infection. Trans. Br. Mycol. Soc. 55:158-161.
14. Pickett\_ Heaps, J. D. 1975. Green Algae. Sinauer Associates, Sunderland, Mass
15. Prescott, G. W. 1969. The Algae: A Review. Thomson Nelson & Sons. London
16. Round, F. E. 1973. The Biology of Algae. Edward Arnold. London
17. Schenck, N. C. and Perez, Y. 1990. Manual for the identification of VA mycorrhizal fungi. Publications, Gainesville, Florida USA pp283
18. Smith, G. M. 1951. Manual of Phycology. Chronica Botanica Co., Waltham Mass
19. Smith, G. M. 1955. Cryptogamic Botany Vol. I Mc Graw - Hill Co. New York
20. Smith, S and Reed, D. J. 1997. Mycorrhizal Symbiosis Academic Press.
21. Stein, J. R. Hand Book of Phycological Methods. University Press. Cambridge
22. Kumar . H. D. and H. N. Singh. A text book of Algae. Affiliated Esat West Press. Pvt. Ltd. New Delhi (1971)
23. Gangulee and Khar. College Botany The New Central Book Agency Calcutta
24. Chapman . V. J and H. J. Chapman . The Algae. 2 nd Edition (1961)
25. Alexopoulos. Introduction to mycology. Wiley Eastern Pvt. Ltd. New York (1973)
26. Elizabeth Moore and Lander Fundamentals of Fungi. Prantice hall New Jursery

Title of the Paper	<b>CORE PAPER-II: Biodiversity - II PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - I Semester	6	4	

## PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY

### UNIT - I: Pteridophytes

General characteristics and classification (Reimer, 1954). Apospory - Apogamy, Origin and evolution of stele and soral evolution. Heterospory and seed habit, Telome theory, morphogenesis Economic importance.

### UNIT - II

Structure, reproduction and life histories of the following genera: *Isoetes*, *Angiopteris*, *Osmunda*, *Pteris*, *Polypodium*, *Salvinia*

### UNIT - III: Gymnosperms

General characters - Range of structure-Anatomy - Reproduction Phylogeny and Classification (K.R.Sporne, 1954). Phylogeny and Economic importance of Gymnosperms.

### UNIT - IV

Structure (Exomorphic and endomorphic) - reproduction and life histories of the following genera: *Araucaria*, *Podocarpus*, *Cupressus*, *Ephedra*.

### UNIT - V: Paleobotany

Study of fossils - Importance of Fossils: Formation and types of fossils, techniques of study of fossils, geological time scale. Applied aspects of paleobotany; use in coal and petroleum exploration. Study of organ genera: *Calamites*, *Sphenophyllum*, *Calamostachys*, Study of organ genera: *Lyginopteris*, *Medullosa*, *Pentoxylon*.

### REFERENCE BOOKS

1. Eames.A, 1963 – Morphology of lower vascular plant, McGraw Hill.
2. Forster and Gifford, 1959 – Comparative Morphology of a Vascular Plants.
3. Pandey B.R., 1977 – A text book of Botany, Pteridophytes and Gymnosperms, K. Nath & Meerut.

4. Parihar. N.S., 1967 – An introduction of Embriyophyta, Vol.III – Pteridophyta, Central book depot, Allahabad.
5. Smith.G.M., 1955- Cryptogamic Botany, Volume-III – McGraw Hill.
6. Sporne.K.L., 1976 – Morphology of Pteridophytes, 4<sup>th</sup> edition, B.I.Publication.
7. Vashista.P.C., 1971 – Botany for Degree students : Pteridophyta. S.Chand & Co.
8. Chainberlain.C.J. – Gymnosperms structure and evolution, Chicago.
9. Sporne. K.R., - Morphology of Gymnosperms, Hutchinson University Library.
10. Gupta.M.N., 1972, - The Gymnosperms (2<sup>nd</sup> Edition) Shiva Lal Agarwala & Co., Agra.
11. Vashista, 1976, Gymnosperms, S.Chand & Co.

Title of the Paper	<b>CORE PAPER - III: PRACTICAL - I : COVERING THEORY PAPERS I AND II</b> AND-II 101 and 102			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - I Semester	8	4	19MUMP101

### COVERING THEORY PAPERS I AND II

#### Algae

Study of algae in the field and laboratory of the genera included in theory. External morphology and internal anatomy of the vegetative and reproductive structures of genera given in the theory. Preparation of culture media and Culture of Green Algae and Blue Green Algae in the Laboratory (Demonstration). Haemocytometer, TDS meter.

#### Fungi

Study of morphological and reproductive structures of the genera mentioned in theory. Isolation and identification of fungi from soil, air, and Baiting method. Preparation of culture media.

#### Lichens

Study of morphological and reproductive structures of the genera *Usnea*.

#### Bryology

External morphology and internal anatomy of the vegetative and reproductive organs of genera given in the theory.

#### Bacteria and Viruses

Diseases caused by Bacteria and Viruses in plants.

**Bonafide record of practical work done should be submitted for the practical examination.**

Title of the Course / Paper	<b>ELECTIVE - I: PLANT PATHOLOGY</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - I Semester	4	3	

## PLANT PATHOLOGY

### UNIT- I

History and Principles of Plant Pathology, Scope and Significance of Plant pathology Plant Pathogens – Variation in Plant pathogens – Epidemiology and forecasting of Plant diseases – Host Parasite Interrelationship and Interaction.

### UNIT- II

Pathogenesis or Disease development, Environment and nutrition in relation to disease development – Defence mechanism – Integrated disease management – Biotechnology in relation to Plant Pathology.

### UNIT- III

Principles of Plant diseases, Important diseases of crop plants in India (Bacterial blight of Rice, Wilt of cotton, Late blight of Potato, Red rot of sugar cane,). Mycoplasma (little Leaf diseases) – A brief account on Nematodes and Phytoplasma – Non-Parasitic diseases. Plant disease control (physical, chemical and biological).

### UNIT- IV

Genetics of plant disease: Disease Resistance – Genetics of virulence and resistance, Gene-for-gene concept, Techniques in plant breeding for disease resistance. Genetics of Host – parasite interaction – mutation, heterokaryosis, parasexual recombination.

### UNIT- V

Molecular Plant Pathology: Detection of pathogens in host tissues – ELISA – Incorporation of resistant gene methods – Electroporation – *Agrobacterium* fusion.

### REFERENCE BOOKS

1. Agrios, G.N. Plant pathology, IV Edition, Academic prus 1998.
2. Bilgrami K.S. and Dube H.C., A Text Book of Modern Pathology Vikas publishing house pvt., Ltd., 1976.
3. Chatterjee P.B., Plant protection techniques Bharati Bhavan 1997
4. Das Gupta H.K. Principles of Plant pathology Allied Publishers 1988.
5. Mehrotra R.S. Plant Pathology Tata-Mc Graw Hill Publish, co., Ltd., 1980.

6. Rangaswami G and A. Mahadevan Diseases of Crop plants in India. IV Edition Practice Hall 1999.
7. Singh R.S. Plant Pathogens : The fungi Oxford & IBH Publisher Co.1982.
8. Singh R.S. Plant Diseases Oxford and IBH publishing co., 1983.
9. Walker J.C. Plant Pathology Tata Mc Graw Hill Publishers 1969.
10. Mishra, A., A. Bohra and A. Mishra. 2011. Plant Pathology-Disease and Management. AgroBios, Jodhpur.
11. Pathak, Khatri and Pathak. 1996. Fundamentals of Plant Pathology. AgroBios, Jodhpur.
12. Pandey, B.P. 1982. Plant Pathology – Pathogen and Plant disease. S.Chand & Company Pvt. Ltd, New Delhi.

Title of the Paper	<b>ELECTIVE - I: BIOPESTISIDE TECHNOLOGY</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - I Semester	4	3	

### BIOPESTISIDE TECHNOLOGY

#### UNIT- I

Introduction of biopesticides. Advantages for the use of biopesticides.

#### UNIT- II

Types of biopesticides: Bioinsecticides, biofungicides, biobactericides, bionematicides and bioherbicides.

#### UNIT- III

Important bioinsecticides: *Bacillus thuringiensis*, NPV, entomopathogenic fungi (*Beauveria*, *Metarhizium*, *Verticillium*, *Paecilomyces*, *Momuraea*). Biofungicides: *Trichoderma*, *Gliocladium*, *Coniothyrium*, non-pathogenic *Fusarium*, *Pseudomonas* spp., *Bacillus* spp. Biobactericides: *Agrobacterium radiobacter*, *Pseudomonas* spp., *Bacillus* spp. Bionematicides: *Paecilomyces*, *Trichoderma*. Bioherbicides: *Phytophthora*, *Colletotrichum*.

#### UNIT- IV

Target pests and crops of important biopesticides and their mechanisms of action.

#### UNIT- V

Mass multiplication and formulation technology of biopesticides. Prospects and problems in commercialization and efficiency of biopesticides. Commercial products of biopesticides.

## REFERENCE BOOKS

1. Ainsworth, G.C. 1971. A Dictionary of the Fungi. Commonwealth Mycological Institute, Kew, Surrey, England.
  2. Alexopoulos C.J , Mims C.W. and Blackwell M.I 1996. Introductory Mycology. 4<sup>th</sup> Edition. John Wiley and Sons Inc.
  3. Bessey (1950). Morphology and Taxonomy of fungi. The Blakistan Co.
  4. Burnett J.H. (1968). Fundamentals of Mycology. Edwards Arnold Publication, Cambridge, UK. 841p.
  5. Carlile, M.J., Watkinson, S.C., and Gooday, G.W. 2001. The Fungi. 2nd Edition. Academic Press, San Diego
  6. Charlile, M.J., Watkinson, S.C. and Gooday, G.W. 2005. The Fungi. Elsevier, New Delhi.
  7. Dube H.C. (2013). An Introduction To Fungi - Scientific Publishers
  8. Gilman, J.C. 1957. A manual of soil fungi. Iowa State College Press, Ames, Iowa.
  9. Hawksworth, D.L., Kirk, P.M., Sutton, B.C., and Pegler, D.N. 1995. Ainsworth & Bisby's Dictionary of the Fungi. 8th Edition. C.A.B. International.
  10. Kendrick, B. 2000. The Fifth Kingdom. 3<sup>rd</sup> edition. Focus Publishing, Newburyport, MA. 386 p.
  11. Mehrotra R.S and Aneja R.S (1998). An introduction to Mycology. New Age Intermediate Press.
  12. Mehrotra, B.S. 1976. The Fungi. Oxford and IBH Publishing Co., New Delhi.
  13. Moore-Landecker, E. 1996. Fundamentals of the fungi, Prentice Hall international, USA.
  14. Subramanian, C.V. 1983. Hyphomycetes: Taxonomy and Biology. Academic Press, London and New York.
  15. Talbot, P.H.B. 1971 Principles of Fungal Taxonomy. Macmillan Press, London.
  16. Webster, J. 1970. Introduction to Fungi. Cambridge University Press, UK.
  17. Webster, J. and Weber, R. 2007. Introduction to Fungi. 3rd Edition. Cambridge University Press, UK.
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Title of the Course / Paper	<b>ELECTIVE - II - HERBAL DRUG BIOTECHNOLOGY</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - II Semester	4	3	

## HERBAL DRUG BIOTECHNOLOGY

### UNIT - I

Pharmacognosy scope and importance - source - Crude Drugs – Scope & Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Cultivation, Collection & processing of Crude Drugs. Medicinal & Aromatic Plants-Cultivation and Utilization of Medicinal & Aromatic Plants in India.

### UNIT - II

Plant Tissue Culture as source of medicines, Role of Plant tissue culture in enhancing secondary metabolite production (*Withania somnifera*, *Rauwolfia serpentina*, *Catheranthus roseus*, *Andrographis paniculata*, *Dioscorea sp.*) - Elicitation - Biotransformation, Hairy root culture. Factors affecting secondary metabolites production. Biogenesis of Phytopharmaceuticals.

### UNIT - III

#### Analysis of Phytochemicals

Methods of Drug evaluation (Morphological, Microscopic, Physical & Chemical). Preliminary screening, Assay of Drugs - Biological evaluation / assays, Microbiological methods- Chemical Methods of Analysis, Detection of Adulterants: Chemical estimations, Spectrophotometry & Fluorescence analysis. Drug adulteration - Types of adulterants.

### UNIT - IV

#### Types of Phytochemicals - I

Carbohydrates & derived products; Glycosides - extraction methods (Digitalis, Aloe, Dioscorea.); Tannins (Hydrolysable & Condensed types); Volatile Oils - extraction methods (Clove, Mentha);

## UNIT - V

### Types of Phytochemicals - II

Alkaloids - extraction methods (Taxus, Papaver, Cinchona); Flavonoids- extraction methods, Resins- extraction methods.-: Applications of Phytochemicals Application of phytochemicals in phytopharmaceutics; Biocides, Biofungicides, Biopesticides.

### REFERENCE BOOKS

1. Pharmacognosy, C. K. Kokate, A. P. Purohit & S. B. Gokhale (1996), Nirali Prakashan, 4th Ed.
2. Natural Products in medicine: A Biosynthetic approach (1997), Wiley. Hornok, L. (ed.) (1992).
3. Cultivation & Processing of Medicinal Plants, Chichister, U. K: J. Wiley & Sons. Trease & Evans.
4. Pharmacognosy - William Charles Evans, 14th ed. (1989), Harcourt Brace & Company.

Title of the Paper	ELECTIVE - II - MICROBIAL TECHNOLOGY			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - I Semester	4	3	

## MICROBIAL TECHNOLOGY

### Unit - I: Industrial Microbiology

Industrial fermentation - Type of bioreactors - Inoculum development - Scaling up process from shake flask to industrial fermentation - Recovery and purification of intracellular and extracellular products.

### Unit - II

Microbial production of antibiotics - Pencillin, Streptomycin- Organic acid- lactic acid , Citric acid, Vitamin - B 12 - Amino acid.- Lysine - Enzyme - amylase & production of pharmaceutical compounds through microbes,

### UNIT - III: Environmental and Agricultural Microbiology

Microbes in terrestrial, aquatic, -microbes in the extreme environments and their adaptations; methods for the determination of microbial numbers, biomass and activities. Significance of

microbial activities in the environment Microbial degradation of pesticides, petroleum and hydrocarbons; Microbial inoculants in agricultural; microbes as biological control agents.

#### **UNIT - IV: Food Microbiology**

Brief history of microorganism in food stuffs; source, types and role of microorganisms in spoilage of fruits and vegetables - fresh and processed meats and poultry, miscellaneous foods such as eggs, bakery products, dairy products, beer, wines, and canned foods. Food safety regulations.

#### **UNIT - V: Innate and Adaptive Immune System**

Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. Generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions.

#### **REFERENCE BOOKS**

1. Principles of fermentation technology by Stanbury, P.F Whitaker A. and Hall 1995. Pergaman. Mc Neul and Harvey
2. Fermentation Biotechnology Industrial perspective by Chand.
3. A text book of industrial microbiology by Cruger.
4. Text book industrial microbiology by A.H. patel.
5. Text book of industrial microbiology by L.E. casida.
6. G. Tortora, B. Funke and C. Case. Microbiology: An Introduction. 5th ed. Menlo Park, CA: Bejamen/Cummings, 1995
7. J. Ingraham and C. Ingraham. Introduction to Microbiology. Belmont, CA:Wadsworth, 1995.
8. T.D. Brock, M.T. Madison, J. M. Martinko and J. Parker. Biology of Microorganisms. 7th ed. Englewood Cliffs, N.J: Prentice-Hall, 1994.

Title of the Paper	<b>CORE Paper - IV Biodiversity - III: Taxonomy and Economic Botany of Angiosperms</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - II Semester	5	4	

## TAXONOMY AND ECONOMIC BOTANY OF ANGIOSPERMS

### UNIT - I

Taxonomy and systematics, objectives of plant systematics, hierarchy. Systems of classification - Takhtajan, APG, Bar coding. Important criteria used per classification in each taxon. Botanical Gardens & Herbaria.

### UNIT - II

Modern trends in Taxonomy - numerical taxonomy - chemotaxonomy - Biosystematics. Botanical Survey of India- its organization and role. ICBN- Importance and principles of binomial nomenclature - Valid and effective publication, Citation, rejection and retention of names, Typification, Limitation to priority.

### UNIT- III

A detailed study of the following families and their interrelationships and phylogeny:

1. Magnoliaceae
2. Ranunculaceae
3. Menispermaceae
4. Portulacaceae
5. Rosaceae
6. Capparidaceae
7. Brassicaceae
8. Passifloraceae
9. Meliaceae
10. Rhamnaceae
11. Vitaceae
12. Sapindaceae
13. Aizoaceae
14. Combretaceae
15. Moringaceae
16. Nyctaginaceae
17. Tiliaceae.

#### UNIT – IV

18. Turneraceae
19. Oleacea
20. Boraginaceae
21. Bignoniaceae
22. Acanthaceae
23. Anacardiaceae
24. Apiaceae
25. Lamiaceae
26. Casuarinaceae
27. Commelinaceae
28. Amaryllidaceae
29. Arecaceae
30. Musaceae.

#### UNIT - V: Economic Botany

Origin, evolution, botany, cultivation and uses of (i) food, (Wheat, Potato, Sugarcane: forage and fodder crops (Sorgham, Gram), (ii) Fibre crops (Cotton, Jute). (iii) Medicinal and aromatic plants (*Atropa belladonna*, *Rauwolfia serpentine*, *Withania somnifera*, and *Phyllanthus amarus*) (iv) vegetable oil yielding plants (Soybean, Safflower, mustard). Important fiber - wood and timber yielding plants and non-wood forest products (NWFPs) such as *Bambosa rattens*, raw materials for paper making, gums, tannins, dyes, resins and fruits Plants used as avenue trees for shade, pollution control and aesthetics. Energy plantation - cultivation and uses of *Casuarina* & *Jatropha*.

#### REFERENCE BOOKS

1. Lawrence.G.H.M, 1985 – An Introduction to Plant Taxonomy, Central Book Depot, Allahabad.
2. Porter.C.L., 1982 – Taxonomy of Flowering Plants, Eurasia Publications House, New Delhi.
3. Rendle.A.B., 1980 – The Classification of Flowering Plants (Vol. I & II), Vikas Students Education.
4. Pandely.B.P., 1987 – Taxonomy of Angiosperms.
5. Pandey.B.P. (1987) – Economic Botany.
6. Verma. V (1984) – Economic Botany.
7. Hill.A.W. (1981) – Economic Botany, McGraw Hill Pub.
8. Willis.T.E(1994) – Text Book of Pharmacognosy. Tata McGraw Hill Publishers.
9. Gokhale.S.B (1992) – Pharmacognosy. S.Chand & Co.
10. Ansari.S.H. (1993) – Pharamacognosy S.Chand & Co.

Title of the Paper	<b>CORE Paper - V DEVELOPMENTAL BOTANY- ANATOMY, EMBRYOLOGY AND PALYNOLOGY OF ANGIOSPERMS</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - II Semester	5	4	

## **DEVELOPMENTAL BOTANY- ANATOMY, EMBRYOLOGY AND PALYNOLOGY OF ANGIOSPERMS**

### **UNIT - I: Anatomy**

Organization and theories regarding shoot, root and floral meristems, Vascular cambium - origin, development and types. Cambial activity - normal and anomalous. Cork cambium, Periderm, polyderm, rhytidome, lenticels. Anomalous thickening in Dicot and Monocot stem. Xylem, xylary elements - differentiation Maceration technique - tracheids, vessels, fibre and parenchyma Patterns of secondary wall thickening. Tyloses; reaction wood, heart wood and sap wood. Growth rings. Phloem - primary and secondary elements - ontogeny-differentiation. Structural variations and characteristics of phloem components.

### **UNIT - II**

Secretory cells and tissues; their structure, classification and significance. Types- external and internal secretory structures. Nodal anatomy - uni, tri & multilacunar, Kranz anatomy. Stomata - development and types. Programmed cell death, aging and senescence. Experimental anatomy - PGR and tissue differentiation. Applied plant anatomy in paper and fibre industry.

### **UNIT - III: Embryology**

Microsporogenesis., Morphology, cytology and physiology of tapetum Microgametogenesis – microspore, division of generative cell, pollen wall morphogenesis and structural variability. Pollen fertility and sterility, Pollen germination, Pollen storage. Ovule-types, Megasporogenesis - Megagametogenesis, Embryosac development and types, ultrastructure of egg, synergids and antipodals.

### **UNIT - IV**

Fertilization - Heterospermy, discharge and movement of sperms. Syngamy and triple fusion; post-fertilization changes. Heterofertilization. (double fertilization). Endosperm - types, endosperm haustoria, Embryogeny -Laws of Embryogeny - Classification – mono and dicot embryos - variations and differences in development, Apomixis. Polyembryony. Embryology in relation to Taxonomy.

## UNIT - V: Palynology

Palynology - aeropalynology - pollen allergy and palynological calendars. Pollen analysis of honey; pollen loads. Paleopalynology - role in coal and oil genesis. Recent advances in palynological studies.

### REFERENCE BOOKS

1. Bhojwani. S. S. and Bhatnagar. S. P. 1981 Embryology of Angiosperms. Vikas Pub. Co. Ltd
  2. Cronquist. A. .1968The evolution and Classification of Flowering Plants.
  3. Davies . P. H. and Heywood. V. H. 1967Principles of Angiosperm taxonomy. Oliver and Byod. Edinborough
  4. .Davies. G. L Systemic Embryology of Angiosperms,
  5. Dixon. A. 1985. Plant Cell Culture- A practical Approach IRL press. Oxford
  6. Ertman.G. 1954. An Introduction to Pollen Analysis. Cronica Botanica.
  7. Hutchinson. J. 1973. The Families of Flowering Plants. Oxford Uni. Press.
  8. Johri. B. M. 1984. Embryology of Angiosperms. Springer Verlaug.
  9. Lawrence. G. H. Introduction to Vascular Plants. Oxford. IBH. Delhi.Maheswari.P. Embryology of Angiosperms. Oxford. IBH. Delhi
  10. Nair. P. K. K. Essential of Palynology
  11. Narayanaswamy. S. 1994. Plant Cell and Tissue Culture. Tata McGraw Hill Ltd. New Delhi
  12. Reinert. J. Bajaj. T. P. S. Applied and Fundamental Aspeests of Plant cell, tissue and organ Culture. Springer - Verlaug.
  13. Sivarajan. S. 1989. Introduction to Principles of Taxonomy. Oxford. IBH New Delhi.
  14. Carlquist.S. 1961. Comparative Plant Anatomy. Holt Richart
  15. Cutter. E. G. Plant Anatomy- Experimental and Interpretation
  16. Easu. K. 1987. Anatomy of Seedling Plants. Wiley Pub.
  17. Fahn. A. 1989. Plant Anatomy. Mac Millon
  18. Gray. P. 1964. Hand Book of Plant Microtechnique.
  19. Jenson. W. A. 1962. Botanical Histochemistry. The Benjamin/ Cunnings
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Title of the Paper	<b>CORE Paper - VI ENVIRONMENTAL BOTANY, PHYTOGEOGRAPHY AND REMOTE SENSING</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - II Semester	4	4	

## **ENVIRONMENTAL BOTANY, PHYTOGEOGRAPHY AND REMOTE SENSING**

### **UNIT - I: Ecological Principles**

Physical environment /Abiotic environment, biotic environments; their interactions concept of habitat & niche. Diversity of plant life; growth form, life form.

### **UNIT - II: Population Ecology**

Population characteristics; Population growth curves; Demography, structure, mortality, natality, age and distribution. Levels of species diversity and its measurements; edges and ecotones.

### **UNIT - III: Ecosystem Ecology**

Structure, function, food chain, food web, energy flow, nutrient cycling (C, N, P, S). Terrestrial ecosystem & aquatic ecosystem. Environmental pollution, effects & control measures.

### **UNIT - IV: Conservation Ecology**

Principles of conservation; Sources; and their management strategy with suitable examples (Biosphere reserves etc.) Disaster Management. Global Environmental change Biodiversity: Status, monitoring and documentation. Endangered plants of India. IUCN category of endangered species.

### **UNIT - V: Biogeography**

Major Biomes of the world; bio-geographical zones of India; theory of island biogeography; Continental drift; principles of Remote sensing and its applications. Methods of estimating population density of plants through remote observations.

### **REFERENCE BOOKS**

1. Mick Crawley. 1996. Plant Ecology, 2nd Edition Wiley-Blackwell.
2. Fahey, T.J. and Knapp, A.K. 2007. Principles and Standards for Measuring Primary Production. Oxford.
3. Grant, W.E. and Swannack, T.M. 2008. Ecological Modeling. Blackwell.
4. Wilkinson, D.M. 2007. Fundamental Processes in Ecology: An Earth system Approach. Oxford.

5. Ambasht, R. S. (1974). A text book of plant ecology. Students & Friends and Co., Varanasi, India.
6. APHA, (1985). Standard methods for the examination of water and waste water. APHA, Washington, DC.
7. Barry, Cox, C and Peter D. Moore (2005). Biogeography: an ecological and evolutionary approach. Blackwell Pub., Co., London.
8. Chapman (1999). Ecology - Principles and applications. Cambridge University Press, Foundation Books, New Delhi.
9. Jones, H. G. (1983). Plants and Microclimate: a qualitative approach to environment plant physiology. Cambridge University Press, London.
10. Koromondy, E. J. (1996). Concepts of ecology. Prentice – Hall of India Pvt. Ltd, New Delhi.
11. Kumar, H. D. (1997). General Ecology. Vikas Publishing House Pvt. Ltd., New Delhi.
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Title of the Paper	PAPER-VII PRACTICAL - II (COVERING THEORY PAPER <del>IV, V and VI</del> 205, 206 and 207)			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - II Semester	8	4	19MVMP202

Imparts Advance level training in above subjects.

#### **Taxonomy And Economic Botany of Angiosperms**

Description of a species, based on herbarium and live specimens of the families mentioned in the theory.

Solving nomenclature problems

Field visits for at least 2-3 days to collect specimens on the spot in Tamil Nadu. Submission of not less than 20 herbarium sheets representing the families studied

#### **Environmental Botany and Remote Sensing**

1. Determination of air temperature at different altitudes (Ground Level 50, 100 and 150m).
2. Determination of air temperature at 2 hourly interval starting from 6 am to 6p.m.
3. Determination of the minimum size of quadrat by species area curve (for grazing land, forest) field study for at least 3 days.

4. Determination of the quantitative characters of a plant community by random quadrat method (abundance, density, dominance, species diversity, frequency) in grazing land, forests.
5. Determination of the quantitative characters by belt transect method
6. Evaluation of life form classes of the local flora and preparation of biological spectrum of land.
7. Estimation of above ground and below ground biomass in a grazing land employing minimum size of quadrat.
8. Determination of soil moisture content by oven drying method.
9. Determination of water holding capacity.
10. Determination of pH of soil and water by universal indicator (or) pH meter.
11. Mapping of World vegetation
12. Mapping of Indian vegetation.
13. Instruments

Studying remote sensing through satellite pictures and visit to remote sensing laboratory ( at Anna University, Meteorological Centre at Numgambakkam)

### **Anatomy**

Laboratory work on the basis of topics listed under angiosperm anatomy theory. Micrometry in anatomical studies-ocular, stage and camera lucida-types. Techniques in making temporary and permanent microscopic preparations - free hand, peelings, clearing, maceration and wood section. Submission of not less than 5 permanent slides.

### **Embryology and Palynology**

Preparation of dissected whole mounts of embryo. Study of pollen (Acetolysis/and nonactolysis) Collection and Identification of local aerospora. Study from permanent preparation: - Development and structure of anther, Pollen, Ovule, megasporogenesis, embryosac, endosperm and embryo.

**Bonafide record of practical work done should be submitted for the practical examination.**

Title of the Course/ Paper	<b>ELECTIVE - III - WOOD TECHNOLOGY</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - II Semester	3	3	

## WOOD TECHNOLOGY

### Unit - I

wood formation – role of hormones, water , internal and external factors - Growth rings- Heart wood and sap wood, juvenile and reaction wood.- Vessels- length, shape, lateral wall pittings, perforations, intervessel pits,tyloses, Tracheids, size and wall characteristics- rays-classification and types

### Unit - II

Density and specific gravity of the wood – significance- Calculation of moisture content and and specific heat of wood- Principles of wood preservation- Preservatives- Process of preservation (pressure and non pressure methods)- Seasoning of wood.

### Unit - III

Mechanical properties of wood-tensile strength-compression strength- shearing strength- bending strength- stiffness-shock resisting capacity- hardness. Factors affecting mechanical properties of wood.

### Unit - IV

Chemical properties of wood- Cellulose- hemicellulose-, lignin, mineral matter- essential oil, tannins, resins, gums, eco-friendly dyes from bark and wood.

### Unit - V

Wood products- Timber, rail road ties, venees plywood- furniture, wood fuel- lead pencils- matches, tooth picks- paper pulp-filaments and yarn cellulose- gums, resins, turpentine- resins barks, tannins and dyes.

### REFERENCES

1. Bailey, I. W.1954 Contribution to plant Anatomy. Chronica Botanica Waltham Mass
2. Brown, H. P Text Book of Wood Technology Vol –I McGraw Hill Book Co. New York
3. Gamble, J. S. Manual of Indian Timbers London
4. Pearson, R. S. Commercial Timbers of India Govt of India Publications
5. Metcalfe, C. R. 1962. Anatomy of Dicotyledons Vol 2 Claredon Press London

Title of the Paper	<b>ELECTIVE - III: ETHANOBOTANY</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - I Semester	3	3	

## ETHANOBOTANY

### UNIT - I

Ethnobotany: concepts and definitions. Subdisciplines of ethnobotany. Interdisciplinary approaches. Knowledge of following sociological and anthropological terms: culture, values and norms, institutions, culture diffusion and ethnocentrism. History of Ethnobotany: A brief history of ethnobotanical studies in the world and in India.

### UNIT - II

Distribution of tribes in India. Basic knowledge of following tribes of Tamil Nadu: Irulas, Kanis, Paliyars and Malayalis.

### UNIT - III

Sources of ethnobotanical data: Primary - archeological sources and inventories, Secondary - travelogues, folklore and literary sources, herbaria, medicinal texts and official records. Methods in ethnobotanical research. Prior Informed Consent, PRA techniques, interviews and questionnaire methods, choice of resource persons.

### UNIT - IV

Ethnobotanical knowledge and communities: Folk Taxonomy Plants associated with culture and socio-religious activities. Non timber Forest Produce (NTFP) and livelihood Sustainable harvest & value addition

### UNIT - V

Bioprospecting and commercial use of traditional knowledge. Developing research partnerships: Codes of ethics and research guidelines, equitable research relationships, Traditional knowledge (TK) in relation to Intellectual Property Rights and Biopiracy. Equitable Benefit sharing models of the world. Problems in equitable benefit sharing.

### REFERENCE BOOKS

1. Apte, T. 2006. Intellectual Property Rights, Biodiversity and Traditional Knowledge. Kalpavriksh, Grain & IIED, Pune / New Delhi.

2. BALEE W. L. 2003. Footprints of the Forests. Bishen Singh Mahendar Pal Singh, Dehra Dun, India.
3. COTTON, C. M. 1997. Ethnobotany – Principles and Applications. John Wiley and Sons Limited. New York, USA.
4. CSIR. 1940 - 1976. Wealth of India. A Dictionary of Raw Materials and Industrial Products - Raw Materials. Vol.1-11. CSIR Publication & Information Directorate. New Delhi.
5. CUNNINGHAM, A.B. 1993. Ethics, Ethnobiological Research, and Biodiversity. WWF. International Publication. Switzerland.
6. DAVID, N AND C. KRAMER. 2001. Ethnoarchaeology in Action. Cambridge University Press, New York.
7. Duthfield, G. 2004. Intellectual Property, Biogenetic Resources and Traditional Knowledge. Earthscan, London, UK..
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10. JAIN, S.K. 1991. Dictionary of Indian folk medicine and Ethnobotany. Deep Publishers. New Delhi.
11. JAIN, S.K. AND V. MUDGAL. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehra dun.
12. KATE, K. T., S. A. LAIRD. 2000. Commercial Use of Biodiversity. Earthscan, London, UK.
13. LAIRD, S.A. 2002. Biodiversity and Traditional knowledge Equitable partnerships in Practice. Earthscan Publications Ltd., London.
14. LEWIS, W.H., AND M.P.F.ELVIN LEWIS. 1976. Medical Botany. Plants Affecting Man's Health. A Wiley Interscience Publication. John Wiley and Sons. New York.
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19. RAMAKRISHNAN, P.S., R. BOOJH, K. G. SAXENA et al. 2005. One Sun Two World an Ecological Journey. Oxford & IBH. New Delhi, India.
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22. SIMPSON,B.B., AND M.C. OGORZALY. 1986. Economic Botany. Plants in Our World. McGraw Hill Company. New York.
23. SOFOWORA, A. 1982. Medicinal Plant and Traditional Medicine in Africa. John Wiley and Sons Limited. New York, USA.
24. SINGH, K.S. 1998. India's Communities. Oxford University Press, Delhi. Vols. I –VI.

25. SUBRAMANIAM, S.V., AND V.R. MADHAVAN, (Eds.). 1983. Heritage of the Tamil Siddha Medicine. International Institute of Tamil Studies. Madras.
26. SUDARSHAN, S.R., A.N.Y. REDDY, B. GOWDA. 1993. Oshadhi Koshha (Encyclopaedia of India Medicinal Plants). Vol.I. Kalpatharu Research Academy. Bangalore.
27. UNDP. 1994. Conserving Indigenous Knowledge. Integrating Two Systems of Innovation. Rural Advancement Foundation. Commissioned by UNDP.
- WONG, J.L.G., K. THORNER AND N. BAKER. 2001. Non-wood forest products. Resource assessment of non-wood forest products. Experience and biometric principles. Food and Agriculture Organization, (FAO), Rome.

Title of the Paper	EXTRA DISCIPLINARY- I: PLANT RESEARCH METHODOLOGY			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - II Semester	3	3	

## PLANT RESEARCH METHODOLOGY

### UNIT - I

Microscopy – Principle, Types of microscopes – Applications, Electron microscopes - Scanning and Transmission microscopes, Different Fixation and staining techniques for EM. Freeze – etch and Freeze fracture methods for E.M.,

### UNIT II

Microtomy - Rotary microtome - Fixatives, Dehydration, Paraffin sectioning. Stains – Micrometry, Centrifugation - Types. Chromatography - Paper Chromatography -Thin layer Chromatography - Column Chromatography-Gas Chromatography- Liquid Chromatography.

### UNIT III

Electrophoresis and their applications - Polyacrylamide gel electrophoresis - Agarose electrophoresis. Principle of Colorimeter and spectrophotometer- Applications

### UNIT- IV

Detection of molecules using ELISA, RIA, EIA, western blot, immunoprecipitation, fluocytometry and Immunoflorescence microscopy. Detection of molecules in living cells, in situ localization by techniques such as Fish & Gish.

## UNIT- V

Detection and measurement of different Radioisotopes normally used in biology. Safety guidelines. Writing the research report- The components of research report - Title - Authors and address, abstract - summary - synopsis - key words - introduction - review of literature - materials and methods-results-discussion-acknowledgements General introduction and General discussion.

### REFERENCE BOOKS

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2. Cromwell, L.F.J. Weibell, and E. A. Pfeiffer, Biomedical Instrumentation and Measurements (Second Edition), Prentice-Hall of India Pvt Ltd, New Delhi, 1980.
3. Day, R.A. How to write and publish a scientific paper, 3<sup>rd</sup> edition, Oryx Press, Phoenix, Arizona, 1988.
4. Gurumani, N. An Introduction to Biostatistics (Second edition). MJ Publishers, Chennai 2005.
5. Jayaraman, J. Laboratory manual of Biochemistry, Wiley Eastern Limited, New Delhi 110 002, 2000.
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9. Prescott, L.M.J.P. Harley, and D.A. Klein, Microbiology (Sixth edition) McGraw-Hill, New York, 2005.
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12. Webster, J.G. Bioinstrumentation, John Wiley & Sons (Asia) Pvt Ltd. Singapore

Title of the Course/ Paper	PAPER - VIII CORE - CELL BIOLOGY & GENETICS,			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	II Year - III Semester	5	4	

## CELL BIOLOGY AND GENETICS

### UNIT I

Membrane structure and function, Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes.

Structural organization and function of intracellular organelles cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, and chloroplast, Structure & function of cytoskeleton and its role in motility.

### UNIT II

*Cell division and cell cycle:*

Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

Chromosomes - morphology, fine structure - telomere-types: lamp brush, polytene, isochromosomes - heterochromatin and euchromatin, chromosome identification - banding techniques - chromosomal aberrations - gene structure - transposons.

### Unit- III

*Cell signaling:*

Hormones and their receptors, cell surface receptor, signaling through G- Protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component systems, light signaling in plants, bacterial chemotaxis and quorum sensing.

*Microbial Genetics:*

Methods of Genetic transfers - transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating.

## Unit – IV

Mendelian principles : Dominance, segregation, independent assortment. Concept of Gene : Allele, multiple alleles, pseudoallele, Extensions of Mendelian principles : Co-dominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting. Linkage and crossing over, sex linkage and sex influenced characters. Gene mapping methods: Linkage maps, tetrad analysis mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

## UNIT – V

Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance. Human genetics: Pedigree analysis, lod score for linkage testing, Karyotypes, genetic disorders. Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping. Mutation: Types, causes and detection, mutant types- lethal, biochemical loss of function, gain of function. Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications. Recombination: Homologous and non-homologous recombination including transposition.

## REFERENCE BOOKS

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2. Brachet and Mirsky (ed.): The Cell, Academic Press, Vols. 16.
3. Darlington, C.D. : Recent Advances in Cytology, Blarkstains Sons & Co.
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22. Klug, Concepts of Genetics, Pearson Education
23. Genes VII, Benjamin Lewin, OUP
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30. Strickberger, Genetics, Prentice Hall.
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34. Darbeshwar Roy, 2000. Plant Breeding: Analysis and Exploitation of variation, Narosa Publishing House, New Delhi.
35. Singh, P. 2001. Essentials of Plant Breeding, Kalyani Publishers, Hyderabad.

Title of the Course/ Paper	<b>PAPER- IX CORE- PLANT MOLECULAR BIOLOGY</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	II Year - III Semester	5	4	

## PLANT MOLECULAR BIOLOGY

### UNIT- I

Nucleic acids - Base pairing and variations in base composition. Types of DNA. Chargaff's rule - DNA size - fragility - melting curves - hydrophobic interactions denaturation - renaturation - circular and superhelical DNA - topoisomerase - special base Repeated sequence - Single stranded DNA - DNA methylation, structure of RNA. Inhibitors of nucleic acid biosynthesis- DNA synthesis and sequencing

### UNIT II

DNA replication - basic rule of replication – DNA replication in prokaryotes enzymology DNA topoisomerase - DNA polymerase - ligase, helicase Termination of DNA replication -

Replication of eukaryotic chromosomes- Eukaryotic DNA polymerase- DNA repair mechanism- DNA methylation- DNA gyrase.

### UNIT- III

Transcription - Enzymology - RNA polymerase - classes of RNA molecules - transcription in Prokaryotes and Eukaryotes - splicing mechanisms - Reverse transcriptions. Inhibitors of nucleic acid biosynthesis

### UNIT- IV

Protein synthesis and processing : (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA – identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins). Genetic code – characters – codons and anticodons – wobble hypothesis.

### UNIT V

Gene regulation - Operon concept - Lac repressor- -c-AMP, Catabolic repression-, *ara* - operon and *trp* operons - Gene expression in eukaryotes- gal gene expression in Yeast. Role of chromatin in gene expression and gene silencing.

### REFERENCE BOOKS

1. Alberts, B., Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1989. Molecular Biology of the cell, Garland Publishing Inc., New York.
2. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology, W.H. Freeman and Co., New York, USA.
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Title of the Course/ Paper	<b>PAPER - X</b>			
	<b>CORE: PLANT CELL AND TISSUE CULTURE</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	II Year - III Semester	4	4	

## PLANT CELL AND TISSUE CULTURE

### UNIT - I

Laboratory Organisation – Design of different laboratories and management. Methodologies – Aseptic techniques – methods of sterilization – basic procedure for Aseptic transfer – Incubation of culture – Composition of Culture Media – MS Medium – B5 Medium.

### UNIT - II

General Techniques of – Micropropagation, Initiation of Culture, Multiplication, Rooting – Hardening. Callus Culture – establishment – Organisation – Embryogenesis. Somaclonal & Gametoclonal variation, - Uses in crop improvement. Synthetic Seeds – Practical applications.

### UNIT- III

Shoot TIP / Meristem Culture for Virus free plants. – Chemotherapy – Thermotherapy – Virus indexing – Initiation – multiplication – Rooting – Hardening – Anther culture – Production of Haploids – Utilization of Haploids in Agriculture. Protoplast Culture – Protoplast isolation, purification, viability test – culture – regeneration. Somatic Hybridization – Protoplast fusion techniques – Chemical fusion – Electrofusion selection of fusion products.

### UNIT - IV

Approaches and factors affecting the production of secondary metabolites, production of pharmaceutically important drugs – alkaloids – food additives and insecticides in *in vitro* system.

### UNIT - V

Cryopreservation & Germplasm storage, Bioreactor – Types of bioreactors – Stirred tank, air lift – its uses in various fields – Application of Tissue Culture – Techniques in Agriculture, Horticulture & Forestry.

## REFERENCE BOOKS

1. Trigiano, R.N., and D.J. Gray (eds.). 2000. Plant tissue culture concepts and laboratory exercises. CRC Press. (Textbook). 2nd Edition.
2. Kyte, M., and Kleyn, J. 1996. Plant from test tubes. Timber Press. Auge, R. et al., 1995. In vitro culture and its applications in horticulture. Science Publishers, Inc.
3. Crispeels, M.J. and D. E. Sadava. 2003. Plants, genes and agriculture. Jones and Bartlett Publishers.
4. Gamborg, O.L. and G. C. Phillips (eds). 1995. Plant cell, tissue and organ culture. Springer Lab Manual.
5. Potrykus, I, and G. Spangenberg (eds.). 1995. Gene transfer to plants. Springer Lab Manual.
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Title of the Course / Paper	PAPER - XI PRACTICAL - III (COVERING THEORY PAPERS <del>VII &amp; VIII</del> <del>310, 311 &amp; 312.</del>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	II Year - III Semester	8	4	19MVM P303

## **CELL BIOLOGY**

1. Study of dividing cells – squash
2. Calculate the mitotic index of onion root tip cells
3. Smear techniques
4. Study of induced aberrations in onion root tips employing chemicals and plant extracts.
5. Calculation of aberration percentage of chemical treated onion root tip cells
6. Induction of polyploidy using colchicines
7. Study of sub cellular organelles from electron micrographs

8. Nuclear stains
9. Pre fixatives
10. Demonstration of Salivary gland chromosomes

### **GENETICS**

11. Genetics problem based on the theory
12. Chromosome mapping
14. Calculation of variation pattern in fruits/leaves/ seeds - standard deviation standard error  
- Based on the data given.
15. Chi square test
16. Students "t" Test

### **PLANT MOLECULAR BIOLOGY AND BIOTECHNOLOGY**

17. Isolation of Genomic DNA
18. Isolation of RNA
19. Electrophoresis of nucleic acids (know protocols)
20. Preparation of competent E.Coil cells
21. Isolation of plasmid DNA
22. Restriction analysis of DNA
23. Southern blotting
24. RFLP techniques
31. PCR techniques

Cot curve, DNA melting curve, tertiary structure of protein, tRNA, recognition site for HIND III, EGO RI, Bam HI, Puc Plasmid, PCR flow chart, SDS, Southern blotting, X-ray diffraction protein DNA, Ethidium bromide, Lac Operon. Simple problems based on the theory syllabus.

### **PLANT CELL AND TISSUE CULTURE**

32. Tissue culture laboratory design
33. Sterilization
34. Inoculation of explant
35. Media preparation
36. Callus Culture
37. Organ Culture
38. Plant regeneration- Anther culture-
39. Synthetic Seed Preparation.

**Bonafide record of practical work done should be submitted for the practical examination**

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Title of the Course / Paper	ELECTIVE – IV – Biostatistics			
Category of the Course	Year/ Semester	Ins. Hr.	Credit	Subject Code
	II Year - III Semester	3	3	

## BIOSTATISTICS

### UNIT - I

Introduction to Biostatistics, sample collection and representation of Data - Primary and Secondary - Classification and tabulation of Data – Diagrams, graphs and presentation.

### UNIT - II

Analysis of quantitative characters and Measures of central tendency of mean, median, mode, standard deviation and standard error, ANOVA.

### UNIT - III

Probability; basic principles - types - Rules of probability - addition and multiplication rules.

Patterns of probability distribution; binomial - Poisson and normal - Tests of significance; Chi - square test for goodness of Fit; Null hypothesis, level of Significance - Degrees of Freedom.

### UNIT - IV

Student's - distribution; "t" test - Estimation of population parameters based on small sample statistics - Comparison of sample mean with population mean - comparison means of two small sample of equal and unequal sizes. - Correlation - types of correlation - methods of study of correlation - testing the significance of the coefficients of correlation - Regression and types.

### UNIT - V

Computer application in Biology - Computer memory and storage devices - Operating systems and application programmes - MS, DOS, MAC, MS excel and statistical functions - ANOVA. Basic introduction to Multivariate Analysis of Variance (MANOVA).

### REFERENCE BOOKS

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2. Milton, J.s. (1992) Statistical method in Biological and Health Sciences. McGraw Hill Inc., New York.
3. Scheffler, W.C. (1968) Statistics for biological sciences, Addison- Wesley Publication Co., London.

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10. Mahajan, B.K. (1984). Methods in Biostatistics for Medical students and Research works. Smt. Indu Mahajan, New Delhi.

Title of the Course/ Paper	<b>ELECTIVE SUBJECT- III - BIOINFORMATICS</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - II Semester	3	3	

## **BIOINFORMATICS**

### **UNIT - I**

Introduction to Bioinformatics – Definitions Proteomics, genomics, Need, Development and Potential of Bioinformatics, Basic on the internet- Biological Databases Sequence Data Banks – protein sequence data bank. SWISSPROT, Nucleic acid sequence data bank – GenBank, EMBL nucleotide sequence data bank, protein Data Bank (PDB), Genome data bank .

### **UNIT - II**

Predicting functional domains of gene, Predicting secondary structure of RNA Predicting molecular structure and functional domains of proteins,

### **UNIT - III**

Bioinformatics-Taxonomic classification- Operational taxonomic unit. Methods of phylogenetic analysis – Phenetic method and Cladistic method of analysis - Molecular phylogeny.

#### UNIT - IV

Microarray- Protein array, RNA arrays, DNA microarrays- Applications. Drug targeting.

#### UNIT - V

Techniques in Bioinformatics- FASTA, BLAST, Multiple Sequence Analysis- Open Reading Frame

#### REFERENCE BOOKS

1. AndrewsR. Leach. Molecular Modeling: Principles and Applications
2. Ignacimuthu, S. Plant Biotechnology, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi
3. Leonard , Banaszak. Foundation of Structural Biology
4. Rastogi, S. C1993, Mandiratta,Namita, Rastogi, Parag.. Bioinformatics-Concepts, Skill Applications
5. Shanmugavel. P. Principles of Bioinformatics Pointer Publication Jaipur

Title of the Course / Paper	<b>EXTRA DISCIPLINARY – II</b>			
	<b>PLANT BIOTECHNOLOGY</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	I Year - II Semester	3	3	

#### **PLANT BIOTECHNOLOGY**

#### UNIT - I

Recombinant DNA technology – Tools of recombinant DNA: restriction endonucleases and other enzymes; vectors; plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, BAC and YAC Vectors - choice of vectors - gene cloning principles and techniques- construction of genomics, c DNA libraries.

#### UNIT - II

PCR, PAGE, Southern and Northern blotting RFLP, RAPD, AFLP based DNA fingerprinting. Novel introduction and expression. - antisense and sense gene suppression-biosynthetic pathways to produce/accumulate alternative products.

### UNIT - III

Methods of crop improvements- gene transfer - indirect method- *Agrobacterium* mediated gene transfer gene transfer- Direct DNA gene transfer technology- liposome mediated gene transfer biolistic Gun (Shot gun method)- Electroporation- silicon carbide method –microinjection.

### UNIT - IV

Biotechnology and transgenics- Herbicide resistance- resistance against glyphosate, resistance against pests and insects- *Bacillus thuringiensis* – Bt genes endotoxins.

### UNIT - V

Transgenic plants as bioreactors, Transgenic plants as vaccine production systems, Regulation and release of Genetically modified organism in India- Recombinant DNA guidelines, Regulation of GM food – Status of development of GM food in India.

### REFERENCE BOOKS

1. Trigiano, R.N., and D.J. Gray (eds.). 2000. Plant tissue culture concepts and laboratory exercises. CRC Press. (Textbook).
2. Kyte, M., and Kleyn, J. 1996. Plant from test tubes. Timber Press. Auge, R. et al., 1995.
3. *In vitro* culture and its applications in horticulture. Science Publishers, Inc. Crispeels, M.J. and D. E. Sadava. 2003.
4. Plants, genes and agriculture. Jones and Bartlett Publishers. Gamborg, O.L. and G. C. Phillips (eds). 1995.
5. Plant cell, tissue and organ culture. Springer Lab Manual. Potrykus, I, and G. Spangenberg (eds.). 1995.
6. Gene transfer to plants. Springer Lab Manual. Jones, H. 1996. Plant gene transfer and expression protocols. Methods in molecular biology . 49. Humana Press. Kreuzer, H, and A. Massey. 1996.
7. Recombinant DNA and biotechnology. A guide for teachers. ASM Press.

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Title of the Course/ Paper	<b>PAPER- XII CORE - PLANT PHYSIOLOGY</b>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	II Year - IV Semester	5	4	

### PLANT PHYSIOLOGY

#### UNIT - I

Water relation in plants – properties of water, water potential, mechanism of water absorption – active – passive transport, apoplast & symplast concept. Solute transport and photosynthate

translocation – uptake, transport and translocation of ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; stomatal mechanism- anti transparent – ascent of sap

## **UNIT - II**

Photosynthesis – Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO<sub>2</sub> fixation – C<sub>3</sub>, C<sub>4</sub> and CAM pathways.

## **UNIT - III**

Respiration and photorespiration - Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

## **UNIT - IV**

Mineral nutrients – Role of Macro and Micro nutrients, Nitrogen cycle and fixation, Nitrogen metabolism – Nitrogen and ammonium assimilation; amino acid biosynthesis. Secondary metabolites – Biosynthesis of terpenes, phenols and alkaloids and their roles.

## **UNIT - V**

Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action of auxins, gibberellins, cytokinins and abscisic acid. Sensory photobiology – structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; photoperiodism, biological clocks and biological rhythm – circadian.

## **UNIT - VI**

Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses. Movement – nastic and tropic movements. Seed dormancy – causes and methods to break seed dormancy – physiology of seed germination – abscission – and senescence.

## **REFERENCE BOOKS**

1. Bidwell. R. G. S. 1979. Plant Physiology. Macmillon Delhi.
2. Datta. S. C. 1989. Plant Physiology. Central Book Depot, Allahabad.
3. Gauch. H. G. 1972 Inorganic Plant Nutrition. Hutchinson & Dowd. New York.
4. Govindji. 1982. Photosynthesis. AP. New York
5. Hall. D. V. K. K. Rao. Photosynthesis. Arnold London

6. Jacob, W. P. 1979. Plant Hormones and Plant Development. Cambridge University Press. Cambridge
7. Khan, A. A. 1982. The Physiology and Biochemistry of Seed development, Dormancy and Germination. Elsevier. Amsterdam
8. Salisbury, F. B., C. W. Ross. 1991 Plant Physiology. Wadsworth Pub. Co. Belmont
9. Ting, I. P. 1982. Plant Physiology. Addison Wesley Pb. Philippines
10. Michaelis, I. And J. C. Torrey. 1956. Plant in Action W. H. Freeman
11. Lea, P. J. and R. C. Leegood. 1993. Plant Biochemistry and Molecular Biology, John Wiley & Sons. New York.
12. Gregory, R. P. F. 1989. Biochemistry of Photosynthesis Wiley Chichester
13. Sage, R. and R. K. Monson (eds). 1999. The Biology of C4 Plants AP New York.
14. Dixon, R. O. D. and C. T. Wheller 1986. Nitrogen Fixation in Plants Blackie. Glasgow.
15. Postgate, J. 1987. Nitrogen Fixation 2nd Edition Cassel, London
16. Stacey, G., R. H. Burris and Evans, H. J. 1992. Biological Nitrogen Fixation. Chapman and Hall, New York
17. Mann, J. 1987, Secondary Metabolism Clarendon Press, Oxford
18. Harborne, J. B. Introduction to Ecological Biochemistry. Academic Press. Oxford.
19. Bonner, J. and J. E. Varner. 1979. Plant Physiology. Macmillan Delhi
20. Conn, E. E. and P. K. Stump. 1976. Outlines of Biochemistry Wiley Eastern
21. Robert Horton, H. L. A. Moran, R. S. Ochs, J. D. Rawn and K. G. Scrimgeour. 1996. 22. Principles of Biochemistry. Prentice hall International. NJ.
22. Fersht, A. 1985. Enzyme Structure and Metabolism. W. H. Freeman New York
  
23. Lewin, B. 1994. Genes. V. Oxford University Press. New York
24. Ferrier, R. J. and Collind, R. M. 1995. Monosaccharides Wiley, New York.
25. Moore, T. S. (ed). 1993. Lipid Metabolism in Plants. CRC Press. Boca Raton
26. Murphy, D. J (ed) 1994. Designer Oil Crops. VCH Press. Germany
27. Dey, P. M. J. B. Harborne (eds) 1997 Methods in Plant Biochemistry, Academic Press London
28. Dey, P. M. J. B. Harborne (eds) 1997. Plant Biochemistry, Academic Press London
29. Hopkins, W.G. 1995. Introduction to Plant Physiology, John Wiley & Sons, Inc., New York, USA.
30. Nobel, P.S. 1999. Physiochemical and Environmental Plant Physiology, Academic Press, San Diego, USA.
31. Taiz and Zeiger, 1998. Plant Physiology (2 nd ed.)
32. Voet and Voet, 1992. Biochemistry, John Wiley & Sons, Inc., New York, USA.

Title of the Course/ Paper	PAPER-XIII			
	CORE - PLANT BIOCHEMISTRY AND BIOPHYSICS			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	II Year - IV Semester	5	4	

## PLANT BIOCHEMISTRY AND BIOPHYSICS

### UNIT - I

Atomic structure; chemical bonds - Ionic bond, covalent bond, coordination bond, hydrogen bond; Radioactivity; Hydrogen ion concentration (pH), buffers. Biomolecules: Carbohydrates - properties of mono, oligo and polysaccharides. Structure and functions of trioses, tetroses, pentoses, hexoses, maltose, sucrose, starch and pectin-glycosidic linkage, glycoproteins, isomerism and mutarotation.

### UNIT - II

Biomolecules: Amino acids and proteins, ionic forms of amino acids, General reactions of amino acid metabolism. zwitterion, isoelectric pH, optical isomers of amino acids, physical properties of amino acids. Formation of peptide bond - peptides - structure of polypeptides primary, secondary, tertiary and quaternary protein structure - super secondary structures. Ramachandran plot - denaturation of proteins. Protein purification and Protein sequencing.

### UNIT - III

Biomolecules: Lipids- Classification, structure and properties - Fatty acids- saturated and unsaturated fatty acids - Structure of fatty acids and glycerol -phospholipids, glycolipids, steroids. - Biosynthesis and Oxidation of fatty acid - Glyoxalate pathway - Gluconeogenesis.

### UNIT - IV

Bioenergetics - Laws of thermodynamics - enthalpy, entropy and free energy. Exergonic and endergonic reactions. Redox potential. Structure and hydrolysis of high energy compound - ATP, Application of first and second law of thermodynamics in biological systems.

### UNIT - V

Enzymes- Properties- apoenzyme, Cofactors, metallic activators coenzymes. Nomenclature, Classification and Mode of enzyme action - Enzyme kinetics - Concept of active sites Michaelis-Menton constant - mechanism of enzyme action- enzyme inhibitors- allosteric control of enzymes. enzyme regulation. General principles of extraction and purification of enzymes.

Multienzyme complex – Enzyme immobilization. Application of enzymes in industry and medicine.

### REFERENCE BOOKS

1. Principles of Biochemistry by A.L.Lehninger, D.L.Nelson & M.M.Cox. (1993) Worth Publishers, New York.
2. Biochemistry by L.Stryer (1994) Freeman & Co, New York.
3. Biochemistry by G. Zubay (1988) Macmillan Publishing Co, New York.
4. The vital force: A study of Bioenergetics by F.M.Harold (1986) Freeman & Co, New York.

Title of the Course / Paper	PAPER-XIV PRACTICAL - IV: (Covering theory paper <del>XII</del> and <del>XIII</del> ) <i>415 and 416</i>			
Category of the Course	Year / Semester	Ins. Hr.	Credit	Subject Code
	II Year - IV Semester	8	4	<i>19MVMP404</i>

### PLANT BIOCHEMISTRY

1. Basic Biochemistry - Preparation of different types of solutions
2. Principles of Photometry - Colorimeter and Spectrophotometer- principles and Applications.
3. To find complimentary colour for different coloured solutions by using colorimeter.
4. Preparation of standard graph for potassium dichromate ( $K_2Cr_2O_7$ ) by using colorimeter (OR) Verification of Beer- Lambert Law by using colorimeter.
5. Principles of pH meter and application
6. Determination of pH of lemon juice and detergent powder by using pH meter.
7. Determination of neutralization point of acid- base mixture by titration method using pH meter.
8. Estimation of glucose by anthrone reagent method colorimetrically.
9. Estimation of aminoacids by ninhydrin method colorimetrically.
10. Estimation of proteins (Lowry's method and Bradford method ).
11. Extraction and separation of known and unknown amino-acids by using Paper Chromatographic method.
12. Assay of the enzyme Catalase
13. Assay of the enzyme Peroxidase
14. Assay of the enzyme Dehydrogenase

(DEMONSTRATION EXPERIMENTS PLANT BIOCHEMISTRY AND BIOPHYSICS)

1. Dialysis
2. Warburg manometer
3. Preparation of Buffers

Simple problems based on theory syllabus.

**PLANT PHYSIOLOGY**

1. Extraction and separation of photosynthetic pigments of C<sub>3</sub> and C<sub>4</sub> plants by paper chromatographic method.
2. Extraction and separation of photosynthetic pigments of C<sub>3</sub> and C<sub>4</sub> plants by thin layer chromatographic (TLC) method.
3. Extraction and separation of photosynthetic pigments of C<sub>3</sub> and C<sub>4</sub> plants by Column chromatographic method.
4. Extraction and separation of photosynthetic pigments by Chemical method.
5. Estimation of Chlorophyll a, Chlorophyll b and Total chlorophyll by Arnon's method.
6. Estimation of Carotenoids by using colorimeter.
7. Determination of absorption spectra of Chlorophyll a and Chlorophyll b by using colorimeter.
8. Determination of water potential by Plasmolytic method
9. Deficit (DPD) by weighing method.
10. Determination of effect of Chemicals on membrane permeability (Colorimetrically)
11. Determination of effect of Temperature on membrane permeability (Colorimetrically)
12. Effect of varying intensities of light on the rate of photosynthesis of an aquatic plant by using Wilmott's Bubble Counter
13. Effect -of varying wave lengths of light (Or Quality of light) on the rate of photosynthesis of an aquatic plant by using Wilmot's Bubble Counter.
14. Effect of varying concentrations of CO<sub>2</sub> on the rate of photosynthesis of an aquatic plant by using Wilmot's Bubble Counter.
15. Determination of rate of respiration of different respiratory substrates by using Titration method.

(DEMONSTRATION EXPERIMENTS PLANT PHYSIOLOGY)

1. Dye reduction test (Hill's Reaction)
2. Polyacrylamide Gel Electrophoresis (PAGE and SDS PAGE)
3. Estimation of total nitrogen by Kjeldhal method.
4. Bio- assay of 2,4-D.  
Bioassay of kinetin.

**Bonafide record of practical work done should be submitted for the practical examination**

Title of the Course/ Paper	<b>ELECTIVE - IV: ALGAL BIOTECHNOLOGY</b>			
Category of the Course	Year/ Semester	Ins. Hr.	Credit	Subject Code
	II Year - IV Semester	4	3	

## ALGAL BIOTECHNOLOGY

### UNIT - I

Objectives of algal biotechnology, Resource potential of algae. Commercial utility of algae, Algal production systems; indoor cultivation methods and Large-scale cultivation of algae. Harvesting algae.

### UNIT - II

Industrial application of algal fuel, algal lipids- transesterification to ester fuel- substitutes for petroleum derived fuel, production of fine chemicals, biofertilizers and hormones, application of seaweed liquid fertilizers. Algae as food for fish, poultry and animals.

### UNIT - III

Therapeutic uses. Remedial compounds, antioxidant, antithrombolytic, anticoagulants, wound healing, skin diseases, antiulcerogenic, antifungal, antibiotics and antitumour, antiviral compounds. Production of pigments and utilization. Role of algae in agriculture and aquaculture. symbiotic algae.

### UNIT - IV

Immobilization of algae: natural compounds of immobilization, methods of immobilization, Recombinant DNA technology in algae. Isolation, fusion and regeneration of protoplasts in macroalgae.

### UNIT - V

Role of algae in environmental health; Phycoremediation, Sewage disposal and waste treatment of industrial effluent, algae as indicators in assessing water quality and pollution. Role of algae in nanobiotechnology,

## REFERENCE BOOKS

1. Baddiley, S. Carey, N.H. Higgins, I.J. and Potter, W.G. 1994. *Microalgae: Biotechnology and Microbiology*. Cambridge University Press. Cambridge.
2. Becker, E.W. 1994. *Micro algae Biotechnology and Microbiology*. Cambridge University press.
3. Borowitzka, M.A. and borowitzka, L.J. *Microalgal Biotechnology*. Ignacimuthu, S. 1996. *Basic Biotechnology*. Tata Mc Graw Hill Publishing Ltd. New Delhi.
4. Trehan, K. 1990. *Biotechnology*. Narosa Pub. House. London.
5. Trivedi, P.C. 2001. *Algal Biotechnology*. Point publisher, Jaipur, India.
6. Alexopoulos, C. J. And Bold, H. C. *Algae and Fungi*. The Macmillan Co. London
7. Bold, H. C and Wynne, M. J. 1978. *Introduction to the Algae: Structure and Function*. Prantice Hall of India New Delhi.
8. Chapman, V. J. 1962. *The Algae*. Macmillan and Co. Ltd. New York.
9. Dixon, P. S. 1973. *Biology of Rhodophyta*. Hafner Press. New York.
10. Dodge, J. E. *The Fine Structure of Algal Cells*. AP London
11. Fogg, G. E. 1953. *The Metabolism of Algae*. Methuen & Co. London
12. Fott, B. 1959. *Studies in Phylogeny*. Academia Prague
13. Fritsch, F. E. 1935. *The Structure and Reproduction of Algae, Vol. I*. University Press Cambridge
14. Fritsch, F. E. 1945. *The Structure and Reproduction of Algae, Vol II*. University Press Cambridge
15. Kumar H. D and H. N. Singh. 1982. *A text Book on Algae*. Affiliated East- West Press Pvt. Ltd
16. Morris, I. 1968. *An Introduction to the Algae*, Hutchinson University Library, London
17. Pickett\_ Heaps, J. D. 1975. *Green Algae*. Sinauer Associates, Sunderland, Mass
18. Prescott, G. W. 1969. *The Algae: A Review*. Thomson Nelson & Sons. London
19. Round, F. E. 1973. *The Biology of Algae*. Edward Arnold. London Smith, G. M. 1955. *Crytogamic Botany Vol. I* Mc Graw - Hill Co. New York
20. Smith, G. M. 1955. *Crytogamic Botany Vol. II* Mc Graw - Hill Co. New York
21. Smith, S and Reed, D. J. 1997. *Mycorrhizal mSymbiosis* Academic Press.
22. Stein, J. R. *Hand Book of Phycological Methods*. University Press. Cambridge

Title of the Course / Paper	<b>ELECTIVE SUBJECT - IV: NANOBIO TECHNOLOGY</b>			
Category of the Course	Year/ Semester	Ins. Hr.	Credit	Subject Code
	II Year - IV Semester	4	3	

## NANOBIO TECHNOLOGY

### UNIT - I

#### *Introduction*

History of Nanotechnology, Difference between Nanoscience and Nanotechnology, Green nanotechnology, Bottom up and top down approaches.

### UNIT - II

#### *Biological Nano-Objects*

Structural and Functional Regulation of DNA: Geometry, Topology and Methylation : Geometry of the DNA Double Helix - The Z Conformation of DNA.- Supercoiled DNA - Methylation of DNA, Protein-Lipid Assembly and Biomimetic Nanostructure.

### UNIT - III

#### *Biological Membranes*

Biological Membranes - Lipid Membranes: Structure and Properties - Models and Methods for Characterising Membranes - Protein-Lipid Assembly - Applications of Biomimetic Membranes

### UNIT - IV

#### *Methods of Nanobiotechnology*

Optical tools – Nanoforce and imaging – Surface methods – Mass spectrometry – Electrical Characterization and Dynamics of Transport – Microfluidics : Concepts and Applications to the Life Sciences.

### UNIT - V

#### *Applications of Nanobiotechnology*

Real Time PCR – Biosensors : From the Glucose electrode to the Biochip – DNA Microarrays – Protein Microarrays – Cell Biochips – Lab on a chip – Polyelectrolyte multilayers – Biointegrating materials – Pharmaceutical applications of nanoparticles carriers.

### REFERENCE BOOKS

1. Industrial Pharmaceutical Biotechnology, Heinrich Klefenz, Wiley-Vch Publication, Germany, 2002.
2. Pharmaceutical Biotechnology, Daan Crommelin, Robert D Sindelar, 2002, Tailor and Francis Publications, Newyork, 2002.
3. Hand book of Pharmaceutical Biotechnology, Jay P Rho, Stan G Louie, 2003, Pharmaceutical products press, Newyork, 2003
4. Theory and practice of industrial pharmacy, Lachman L Lieberman, HA, Kanig, J, 1986, 3rd edition, Varghese publishing & Co, New Delhi, 2000.
5. Remington's Pharamaceutial sciences, Joseph Price Remington , 18th edtion, Mack publishing & Co., Easton, 1980.
6. Nanoparticles as Drug carriers, Vladimir P Torchilin, Imperial College Press, USA, 2006
7. Nanomedicine, Parag Diwan and Ashish Bharadwaj, pentagon press, India, 2006.