M. Sc. BOTANY –Syllabus 2014-15 onwards

SYLLABI AS PER THE CHOICE BASED CREDIT SYSTEM (CBCS)
(CURRICULUM EFFECTIVE FROM AUGUST 2014 -15 ONWARDS)

Approved by SCAA

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SYLLABI AS PER THE CHOICE BASED CREDIT SYSTEM (CBCS)
(CURRICULUM EFFECTIVE FROM JULY 2014 -15 ONWARDS)

THE FOLLOWING IS THE COURSE STRUCTURE, SCHEME AND SYLLABI

Eligibility: Undergraduate (B. Sc.) Botany, Plant Biology & Plant Biotechnology

COURSE STRUCTURE

Syllabus 2014 -15 onwards				
Semester I - Core theory 4, Practical 2, Elective 1				
			Int.	Ext.
			25	**75**
	TITLE OF THE PAPER	**Credit**	**Marks**	
CORE 1	PLANT DIVERSITY-I – ALGAE, FUNGI AND LICHENS	3	100	
CORE 2	PLANT DIVERSITY- II – BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY	3	100	
Practical - 1	PLANT DIVERSITY I & II	4	100	
CORE 3	MICROBIOLOGY	3	100	
CORE 4	CELL AND MOLECULAR BIOLOGY	3	100	
Practical - 2	MICROBIOLOGY AND CELL & MOLECULAR BIOLOGY	4	100	
Elective -1	**EVOLUTIONARY BIOLOGY** PLANT DISEASES AND INSECT PEST CONTROL AQUATIC AND MARINE PLANTS	2	100	
	Total Credits	**22**	**700**	
Semester II- Core theory 4, Practical 2, Elective 1and Field study				
	TITLE OF THE PAPER	**Credit**	**Marks**	
CORE 5	GENETICS	3	100	
CORE 6	ANATOMY AND DEVELOPMENTAL BOTANY	3	100	
Practical - 3	GENETICS, ANATOMY AND DEVELOPMENTAL BOTANY	4	100	
CORE 7	INSTRUMENTATION AND RESEARCH METHODOLOGY	3	100	
CORE 8	PHYTOCHEMISTRY AND PLANT HISTOCHEMISTRY	3	100	
Practical - 4	INSTRUMENTATION, PHYTOCHEMISTRY AND HISTOCHEMISTRY	4	100	
Elective – 2	PLANTS IN TAMIL CULTURE HORTICULTURE AND PLANT BREEDING	2	100	

	PLANTS FOR BIOENERGY & SPACE RESEARCH		
	FIELD STUDY	1	50
	Total credits	**23**	**750**
Semester III- Core theory 4, Practical 3, Elective 1, and Field tour/Seminar			
	TITLE OF THE PAPER	**Credits**	**Marks**
CORE 9	PLANT PHYSIOLOGY AND BIOCHEMISTRY	3	100
Practical - 5	PLANT PHYSIOLOGY AND BIOCHEMISTRY	4	100
CORE 10	TAXONOMY AND MEDICINAL PLANTS	3	100
Practical -6	TAXONOMY AND MEDICINAL PLANTS	4	100
CORE 11	ECOLOGY AND CONSERVATION BIOLOGY	3	100
Practical - 7	ECOLOGY AND CONSERVATION BIOLOGY	4	100
CORE 12	BIOETHICS AND INTELECTUAL PROPERTY RIGHTS	3	100
Elective - 3	**GENOMICS AND BIOINFORMATICS** BIORESOURCES AND TRADITIONAL MEDICINES FOREST ECOLOGY AND WESTERN GHATS	2	100
	FIELD TOUR/SEMINAR	1	50
	Total credits	**27**	**850**
Semester IV- Core theory 2, Practical 1, Field tour/Seminar - Project			
	TITLE OF THE PAPER	**Credit**	**Marks**
CORE 13	PLANT CONSERVATION BIOTECHNOLOGY	4	100
CORE 14	PLANT GENETIC ENGINEERING	4	100
Practical - 8	PLANT BIOTECHNOLOGY	4	100
DISSERTATION	PROJECT AND VIVA - VOCE	6	200
	Total credits	**18**	**500**
	Distribution of Credits	**Total Credits**	**Total Marks**
	Core Theory – 12 x 3 = 36 CORE THEORY - 2 X 4 = 8	44	1400
	Practical papers – 8 x 4 = 32	32	800
	Electives - 3 x 2 = 6	6	300
	Field Study	1	50
	Field tour/Seminar	1	50
	Dissertation/Project and Viva-Voce	6	200
	Grand Total Credits	**90**	**2800**

SCHEME - EXAMINATION AND EVALUATION

1. For each theory paper 25 marks for internal & 75 marks for External.

2. There is no passing minimum for internal examination. Passing minimum for external is 50% and the total passing minimum including internal & external is 50 %. For internal marks, the split up is 15 marks for test, 5 marks for seminar and 5 marks for Assignment. The average of all three tests will be taken for test marks.

3. For project valuation 75 marks maximum for internal and 75 marks maximum for external and thereby the total maximum for project valuation is 150. For Viva Voce maximum is 50 which will be conducted by both the internal & external examiners.

Grant Total for Project (150) + Viva Voce is (50) = 200 marks.

4. The question paper pattern for theory exam is as follows:

SECTION A – 10 x 1 mark –10 marks

(Two questions from each unit)

SECTION B – 5 X 5marks – 25 marks

(One question from each unit with either or choice)

SECTION C – 5 X 8 marks – 40 marks

(One question from each unit with either or choice)

Total 75 marks

5. PRACTICAL EXAMINATIONS - QUESTION PAPER PATTERN

QUESTIONS	INTERNAL – 40 marks	EXTERNAL – 60 marks	TOTAL
1. MAJOR	15	20	
2. MINOR	10	15	
3. SPOTTERS	10 (5 spotters, each 2 marks)	20 (5 spotters, each 4 marks)	
4. RECORD	5	5	
TOTAL	**40**	**60**	**100**

CORE – 1. PLANT DIVERSITY- I: ALGAE, FUNGI & LICHENS

UNIT I

ALGAE - Algal Diversity and Habitats- Terrestrial, Freshwater and Marine. Phylogeny of algae. Thallus organization - cell structure. Reproduction: vegetative- asexual- sexual- life cycle patterns – five types. Classification (Sylva, 1982) of Algae – pigments, reserve food, flagella (criterions). Contributions of Indian Phycologists : T. V. Desikachary, V.K. Krishnamurthy, M.S. Balakrishanan, V.S.S. Sundaralingam.

UNIT II

Salient features of – Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta, Rhodophyta. Algal blooms, Algae as biofertilizer, food, feed and industrial (commercial) products.

UNIT III

FUNGI – General Characteristics of fungi; substrate relationship in fungi; cell ultra structure; unicellular and multicellular organization; cell wall composition; nutrition (saprobic, biotropic, symbiotic); reproduction (vegetative, sexual and asexual); life cycle patterns - heterothallism; heterokaryosis; parasexuality.

UNIT IV

Recent trends in classification (Alexopoulus) of fungi. General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina, Deuteromycotina; fungi in industry, medicine and as food; fungal diseases in plants and human; mycorrhizae; as biocontrol agents. Contributions of Indian Mycologists.

UNIT V

LICHENS : Classification (Hale, 1969). Occurrence and interrelationship of phycobionts and mycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens. Lichens as indicators of Pollution, Economic importance of Lichens.

References:

1. Alexopoulus, C. J. and Mims, M. Blackwel. 1996. Introductory Mycology. John Wiley & Sons Inc.
2. Clifton, A. 1958. Introduction to the Bacteria. McGraw-Hill book co., New York.
3. Kumar, H. D. 1988. Introductory Phycology. Affiliated east-west Press Ltd., New Delhi.
4. Mehrotra, R. S. and R. S. Aneja. 1998. An Introduction to Mycology. New Age International Press.
5. Morris, I. 1986. An Introduction to the Algae. Cambridge University Press, UK.
6. Rangaswamy, G. and A. Mahadevan. 1999. Disease of Crop Plants in India (4th Edition). Prentice Hall of India Pvt. Ltd., New Delhi.
7. Round, F. E. 1986. The Biology of Algae. Cambridge University Press, Cambridge.
8. Webster, J. 1985. Introduction to Fungi. Cambridge University Press.
9. Sharma, O.P. Text book of Algae. Tata McGraw Hill, New Delhi.
10. Vashista, P. R. 2000. Fungi. Chand and Co., New Delhi.
11. Raven, P. H. and G. B. Johnson. 2002. BIOLOGY 6th ed. Mc GrawHill. Boston, Madison, New Delhi.
12. Jon C. Herron and Scott Freeman. 2014. Evolutionary analysis (5th Edition.).
13. Peter J. Russell, Stephen L. Wolfe, Paul E. Hertz and Cecie Starr. 2008. Biology: The Dynamic Science, (1st Edition).
14. Peter H. Raven, George B. Johnson Jonathan B. Losos, Kenneth A. Mason and Susan R. Singer. 2008. Biology. (8th Edition).

CORE – 2. PLANT DIVERSITY- II: BRYOPHYTES, PTERIDOPHYTES, GYMNOSPERMS AND PALEOBOTANY

UNIT I

Bryophytes: Morphology, structure, reproduction and life history; distribution; classification (Watson/ Rothmalar), phylogeny. General account of Hepaticopsida: Marchantiales, Jungermaniales; Anthocerotopsida: Anthoceratales; Bryopsida:

Sphagnales; Funariales and Polytrichales. Economic and Ecological importance of bryophytes.

UNIT II

Pteridophytes: Morphology, anatomy and Reporduction; classification (Reimer/ Sporne), Phylogeny. Eevolution of stele; heterospory and origin of seed habit. Characteristics features of Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

UNIT III

Gymnosperms: General characters: Gymnosperms, the vessel-less and fruit less seed plants, variations in reproductive structures, pollen germination and the complexity of their female gametophyte. Evolution of gymnosperms and angiosperms. Economic importance.

UNIT IV

Classification of Gymnosperms (Sporne) and their Distribution in India : (Pilger and Melchoir) General account of Pteridospermales: (Lyginopteridaceae, Medullosaceae, Caytoniaceae and Glossopteridaceae). Cycadeoidales and Cordaitales. Structure and reproduction in Cycadales, Ginkgoales, Coniferales, Ephedrales, and Gnetales.

UNIT V

Paleobotany: Geological time scale. General account of fossils and Types. Fossil – algae - , fungi - , bryophtes - . Study of the following fossil forms – Lyginopteris, Heterangium, Medullosa, Cycadeoidea, Pentaxylon and Cordaites. Major fossil sites in India: Thiruvakkarai, Sriperumbudhur, Neyveli lignite, Rajmahal Hills. Paleobotany in phylogeny, Contributions of Indian Paleobotanists - Birbal Sahni, D.D. Pant, M. Ramanujam osmani.

References

1. Arnold, C. A.1947. An Introduction to Paleobotany.
2. Bhatnagar, S. P. and A. Moitra. 1996. Gymnosperms. New Age International Pvt. Ltd., New Delhi.

3. Boid, H. C. 1982. Bryophyta. Plant willies Eastern.
4. Coulter and Chamberlin. 1917. Morphology of Gymnosperms.
5. Foster, A. S. and E. M. Gifford. Morphology and Evolution of Vascular Plants.
6. Jon C. Herron and Scott Freeman. 2014. Evolutionary analysis (5th Edition.).
7. Parihar, N. S. 1967. An introduction to Embryophyta- Pteridophyta. Central Book Department, Allahabad.
8. Parihar, N. S. 1991. Bryophyta. Central Book Department, Allahabad.
9. Parihar, N. S. 1996. Biology and Morphology of Pteridophytes. Central Book Department, Allahabad.
10. Peter H. Raven, George B. Johnson Jonathan B. Losos, Kenneth A. Mason and Susan R. Singer. 2008. Biology. (8th Edition).
11. Peter J. Russell, Stephen L. Wolfe, Paul E. Hertz and Cecie Starr. 2008. Biology: The Dynamic Science, (1st Edition).
12. Puri, P. 1980. Bryobytes. Atma Ram & Sons, Delhi.
13. Rashid, A. 1985. An Introduction to Pteridophyta. Vikas Publishing House Pvt. Ltd.
14. Raven, P. H. and G.B. Johnson. 2002. BIOLOGY 6th ed. McGrawHill. Boston, Madison, New Delhi.
15. Scott, D. H. 1962. Studies in Fossil Botany.
16. Singh, H. 1978. Embryology of Gymnosperms. Encyclopedia of Plant Anatomy X. Gebruder Bortraeger, Berlin.
17. Sporne, K. K. 1991. The Morphology of Pteridophytes. BI Publishing Pvt. Ltd., Bombay.
18. Sporne, K. R. 1968. Morphology of Pteridophytes. BI Publications, New Delhi.
19. Sporne, K. R.1965. The Morphology of Gymnosperms. BI Publications, New Delhi.
20. Srivastava. 2004. Gymnosperms. Pradeep Publications, Jalander.
21. Stewart, W.N. and G.W. Rathwell. 1993. Paleobotany and the evolution of plants. Cambridge University Press.

PRACTICAL – I: PLANT DIVERSITY I & II

Study the following algal flora with special reference to their morphology and anatomy of vegetative and reproductive structures: *Spirulina, Scytonema, Ulva, Chaetomorpha*

(Hill streams), Cephaleuros (Tea and Mango leaves) Codium, Halimeda, Chara, Padina, Sargasum, Gracliaria, Ceramium (epiphytic), Cyclotella (Diatoms - freshwater).

Study the morphology and reproductive features of following Fungi: *Albugo, Aspergillus, Peziza, Polyporus, Puccinia, Colletotrichum, Fusarium, Cercospora, Parmelia, Usnea (Lichens).*

Morphological and anatomical studies of the following Bryophytes using whole mount preparation, dissection and sections: Marchantia, *Reboulia, Porella, Anthoceros, Funaria, Polytrichum.*

Structural details of the vegetative and reproductive parts of the following types : Psilotum, Lycopodium, Selaginella, *Isoetes, Equisetum, Ophioglossum, Lygodium, Adiantum, Marselia, Salvinia.*

Comparative study of vegetative and reproductive parts of *Cycas, Cupressus, Araucaria, Podocarpus, and Gnetum.*

Structural details of the following fossil types: Lyginopteris, *Heterangium, Medullosa.* Rhynia, Lepidodentron, Sphenophyllum, Calamites.

CORE – 3. MICROBIOLOGY

UNIT I

Fundamentals of Microbiology**:** Definition and scope - history and recent developments. Spontaneous generation-biogenesis. Diversity of microorganisms. Classification of Bacteria according to Bergey's manual. Ultra structure of Archaea (Methanococcus); Eubacteria (E. coli); Unicellular Eukaryotes (Yeast).

Unit – II

Microbial Techniques: Principles of microbial nutrition, Types of culture media. Physical and chemical methods of sterilization. Cultivation of microorganisms: Pure culture Batch, fed-batch, continuous culture, synchronous growth. Culture enrichment methods, Culture collection and maintenance. Microbial growth - Methods of growth

estimation. Microbial Physiology**:** Cellular structures of prokaryotes and eukaryotes, Growth of bacteria – multiplication - nutritional requirements.

Unit III

Microbial Genetics: Introduction and history of microbial genetics. DNA and RNA as a genetic material. Bacterial reproduction - transformation, conjugation and transduction. Plasmid - characteristics and types. Microbial Interactions and Infection: Host–Pathogen interactions; Mechanism of pathogenesis. Pathogenicity islands and their role in bacterial virulence. Types of toxins and their structure and mode of action.

Unit IV

Regulation of gene expression: repression and induction; Operon model; Bacterial genome with special reference to *E. coli;* Phage λ and its life cycle; RNA phages; RNA viruses; Retroviruses; Basic concept of microbial genomics. Bacterial genetic system: recombination, plasmids, transposons. Virology: Structure and Classification of Bacterial, Plant, Animal viruses. Satellite viruses, Viroids, Virusoids. Microbial associations – symbiotic proto cooperation, Ammensalism, Commensalism, Syntropism, Parasitism and Predation with suitable examples.

Unit: V

Molecular mechanisms responsible for and resulting from the interactions between plants and microbes-Role of Rhizosphere bacteria in enhancing plant growth. *Rhizobium* and related genera of bacteria and their role in nitrogen fixation. Usage of *A. tumefaciens* to move genes into plants. Molecular methodologies used for the study of plant-microbe interactions. Superoxides and “Pathogenesis Related Proteins”-Systemic acquired resistance, signal transduction, plant disease resistance genes (“R” genes), and strategies of using both systemic acquired resistance and R genes for crop protection.

REFERENCES

1. Alexander, A. M. 1974. Microbiology Ecology, Jhon Willy & Sons.

2. David R Hyde. 2010. Genetics and Molecular biology. Special Indian edition, Tata Mc Graw Hill P.Ltd., New Delhi.
3. Dubey, R. C. and D. K. Maheswari. 2012. A text of Microbiology (**Revised edition**). S. Chand and Company Ltd., New Delhi.
4. Geeta Sumbali and R. S. Mehrotra. 2009. Principles of Microbiology. First edition, Tata Mc Graw Hill P. Ltd., New Delhi.
5. Mahabal Ram. 2010. Fundamentals of Cytogenetics and Genetics. First edition, PHI Learning P. Ltd., New Delhi.
6. Moat, G. and John W. Foster, Michael P. Spector. 2002. Microbial physiology. Fourth edition, A John Wiley sons, Inc. publication. New Delhi.
7. Pelczar, T. R. and M. J. Chan and N. R. Kreig. 2006. Microbiology. Fifth edition, Tata Mc Graw-Hill INC. New York.
8. Prescott, L. M., J. P. Harley and D. A. Klein. 2005. Microbiology. Sixth edition, International edition, Mc Graw Hill.
9. Ramawat and Shaily Goyal. 2010. Molecular biology and Biotechnology. First edition S. Chand & Co. Ltd., New Delhi.
10. Robert F Boyd. 1984. General microbiology. Times mirror and Mosby college publishers.

CORE – 4. CELL AND MOLECULAR BIOLOGY

UNIT I

Cell structure, Detailed study - origin, structure and functions of cytoplasmic organelles - Mitochondria, Chloroplast, Golgi apparatus Ribosome, Dictyosome, Lysosome, Sphaerosome, Glyoxisome and Peroxisome. Cytoplasm- physicochemical properties and chemical composition. Cell wall – Primary, secondary and tertiary at microscopic, submicroscopic and molecular levels. Chemistry of cell wall polysaccharides, cellulose, lignin, chitin, suberin, cutin and wax.

UNIT II

Plasma membrane- structure, chemical nature, models and functions - Transport across cell membranes. Signal transduction**:** Overview, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, calcium-calmodulin cascade, diversity in protein kinases and phosphatases, specific signaling mechanisms, e.g. two-

component sensor-regulator system in bacteria and plants. Structure and functions of Nucleus, Nuclear envelope and Nucleolus.

UNIT III

Chromosomes- detailed morphology. Chromosome structure and packaging of DNA, organization of centromere and telomere. Cell cycle and its regulation role of cyclins and Cdks. Cell divisions: Mitosis, Meiosis - process of meiosis in detail, Chromosomal aberrations-, duplications, inversions (paracentric and pericentric) and translocation. Euchromatin and heterochomatin; banding patterns; specialized types of chromosomes; polytene, lampbrush, B- chromosomes and sex chromosomes; molecular basis of chromosome pairing. Physical mapping of genes on chromosomes. Computer chromosome analysis, chromosome micro dissection. Karyotype analysis.

UNIT IV

Nucleic acid- physical and chemical structure of DNA, Types of DNA, Watson and Crick model of DNA, Viral DNA, bacterial DNA, Mitochondrial and chloroplast DNA. DNA as genetic material, DNA synthesis and replication, semi-conservative, discontinuous replication, event in replication biochemical replication, termination of replication, Enzymes of DNA replication, gene mutations. Methylation of DNA and mismatch repair. C-value paradox, cot curve and its significance.

UNIT V

Structure and functions of different types of RNA. Transcription - Transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, elongation and termination, RNA processing (capping, polyadenylation, RNA editing, and splicing), RNA transport and Transcription inhibitors. Genetic code. Translation - Prokaryotic and eukaryotic translation machinery, aminoacylation of tRNA, initiation factors, formation of initiation complex, elongation and elongation factors, termination, translational proof-reading, Translational inhibitors. Post-translational modification of proteins.

REFERENCES

1. Lewin, B. 2000. Genes VII. Oxford University Press, New York.
2. Alberts, B. and D. Bray, J. Lewis, M. Raff, K. Roberts and J. D. Watson. 1999. Molecular Biology of Cell. Garland Publishing, Inc., New York.
3. Wolfe. S. L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co., California, USA.
4. Rost, T. *et al*. 1998. Plant Biology. Wadsworth Publishing Co., California, USA.
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6. Buchanan, B. B, and W. Gruissem, R. L. Jones. 2000. Biochemistry and Molecular Biology of Plants. American Society of plant physiologist, Maryland, USA.
7. De, D. N. 2000. Plant cell vacuoles: An Introduction. CSIRO Publication, Collingwood, Australia.
8. Klein Smith, L. J. and V. M. Kish. 1995. Principles of Cell and Molecular Biology (2nd edition). Harper Collins College Publishers, New York, USA.
9. Lodish, H. and A. Berk, S. L. Zipursky, P. Matsudaira, D. Baltimore, J. Darnell. 2000. Molecular Cell Biology (4th Edition). W.H. Freeman and Co., New York, USA.
10. Jon C. Herron and Scott Freeman. 2014. Evolutionary analysis (5th Edition.).
11. Peter J. Russell, Stephen L. Wolfe, Paul E. Hertz and Cecie Starr. 2008. Biology: The Dynamic Science, (1st Edition).
12. Peter H. Raven, George B. Johnson Jonathan B. Losos, Kenneth A. Mason and Susan R. Singer. 2008. Biology. (8th Edition).

References for practical

1. Glick, B. R. and J. E. Thompson. 1993. Methods in Plant Molecular Biology and Biotechnology. CRC Press, Boca Raton, Florida.
2. Glover, D. M. and B. D. Hames (Eds). 1995. DNA cloning 1: A Practical Approach; Core Techniques, 2nd edition PAS, IRL press at Oxford University Press, Oxford.

3. Gunning, B. E. S. and M. W. Steer. 1996. Plant Cell Biology: Structure and function. Jones and Bartlett Publishers, Boston, Massachusetts.
4. Hackett, P.B. and J. A. Fuchs, J. W. Messing. 1988. An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation. The Benjamin/ Cummings Publishing Co., Inc Menlo Park, California.
5. Hall, R. D. (Ed). 1999. Plant Cell Culture Protocols. Humana Press, Inc., New Jersey, USA.
6. Harris, N. and K. J. Oparka. 1994. Plant cell Biology: A Practical Approach. IRL Press, At Oxford University Press, Oxford, UK.
7. Shaw, C. H (Ed). 1988. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.

PRACTICAL –2 : MICROBIOLOGY & CELL AND MOL. BIOLOGY

1. Methods of sterilization.
2. Preparation of culture media and Culture of bacteria on solid and liquid medium for the growth of microorganisms
3. Determination of bacterial growth & Growth curve by turbidimetric method.
4. Simple and Differential staining
5. Isolation pure cultures from soil and water and maintenance of organisms by plating, streaking and serial dilution methods.
6. Effect of temperature, pH and carbon and nitrogen sources on growth.
7. Assay of antibiotics and demonstration of antibiotic resistance.
8. Analysis of water for portability and determination of MPN.
9. Biochemical characterization of selected microbes.
10. CO2 fixation by photosynthetic microbes.
11. Preparation of alcohol from fruit juice(s).
12. Isolation and observation of genomic and plasmid DNA from microorganisms.
13. Screening of amylase/cellulase producing organisms.
14. Identification and enumeration of white blood cells.
15. Antigen-Antibody precipitations reactions and determination of Antibody titre.
16. Transformation of E. coli.

17. Study of mitosis - onion root tip squash for chromosomal examination – Haematoxylin staining
18. Study of meiosis – Tradescantia/Rhoeo for chromosomal examination – Acetocarmine staining
19. Isolation of Chloroplasts and SDS – PAGE profile of proteins to demarcate the two subunits of RUBISCO.
20. Isolation of mitochondria and activity of its marker enzyme – Succinate dehydrogenase (SDH).
21. Isolation and separation and quantitation of nuclear DNA by spectrophotometric method. Preparation of 'cot' curve.
22. Isolation and separation and quantitation of nuclear RNA by spectrophotometric method. Agarose gel electrophoresis and Et Br staining.
23. Southern and Northern blot analysis using gene specific probes.

OPTIONAL ELECTIVE 1: ANY ONE OF THE FOLLOWING

Elective : EVOLUTIONARY BIOLOGY (MODIFIED)

Unit: I

Origin, evolution and diversification of life. First living molecules - Microevolution - prokaryotes- Protists- Plants- Fungi. Endosymbiois and co evolution. Geological time scale.

Unit : II . Natural selection; levels of selection. Darwin and the theory of evolution, quantitative traits. Types of selection ; sexual selection; genetic drift; gene flow; adaptation; convergence; species concepts; life history strategies; adaptive radiation; biogeography.

Unit: III

Origin of genetic variation; mendelian genetics; polygenetic traits, linkage and recombination; epistasis, gene-environment interaction; heritability; population genetics; molecular evolution - cladistics.

Unit: IV

Mutation and migration; units of selection; phylogenetic analysis and comparative methods; Speciation; extinction and biodiversity; evolution of diversification.

Unit: V

The Fossil Record and Life's History; The environment's role in development and evolution; Major transition in evolution; co-evolution; Macroevolution.

REFERENCES

1. Bishop, B. A. and C. Anderson. Students' conceptions of natural selection and its role in evolution.
2. Douglas J. Futuyma. 2005. Evolution. Sinauer Associates, Sunderland.

3. Hartl, D. L. 1988. A primer of population genetics (2nd Edition).
4. Jon C. Herron and Scott Freeman. 2014. Evolutionary analysis (5th Edition.).
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6. Minkoff, E. C. 1983. Evolutionary biology.
7. Peter H. Raven, George B. Johnson Jonathan B. Losos, Kenneth A. Mason and Susan R. Singer. 2008. Biology. (8th Edition).
8. Peter J. Russell, Stephen L. Wolfe, Paul E. Hertz and Cecie Starr. 2008. Biology: The Dynamic Science, (1st Edition).
9. Sean, B. C., J. K. Grenier and S. D. Weather bee. From DNA to Diversity (2nd Edition).
10. Sober, E. 1994. Conceptual issues in evolutionary biology.
11. Steven Gaulin and Donald McBurney. 2004. Evolutionary Psychology (2nd Edition).

Elective : PLANT DISEASES AND INSECT PEST CONTROL

Unit I:

Plant pathogens concepts of Plant diseases, Classification of plant disease based on casual organisms such as Fungi, Bacteria, Viruses, MLO's impact of plant diseases on crop production assessment, Diagnosis, Identification of casual organism by Koch postulates, Microscopic principles of plant disease control, Histochemical and Serological methods of studying plant pathogens. Molecular basis of diagnosis, Chemicals, Enzymes of pathogens in infective, Microbial toxins. Modern techniques in analysis of plant diseases.

Unit II:

Fungi and fungal disease, and Storage fungi, Infectious fungi, Mechanism of infection and Dissemination of fungal diseases, Symptomology and Identification of fungal diseases. Bacteria and bacterial disease, Classification, Mechanism of infection, Dissemination, Symptomology and Identification.

Unit-III

Viruses and viral disease: Mechanism of Infection and Dissemination symptoms and Methods of Identification, MLO's as diseases causing Prokaryotes, Classification of MLO'S. Diseases caused, Symptoms, Method of infection and Identification. Parasitic Green algae and parasitic higher plants-Symptoms and Identification

Unit-IV

Introduction of insects: Pests, General characters, Habitats, Damage, Economic Threshold Level, Natural enemies, Parasitoids and Predators. General description and morphology of the Insect: Head, Thorax and Abdomen. Anatomy and Physiology of the Insect: Digestive system, Nervous system, excretory system, Reproductive system and Circulatory system. Classification of pests: Based on damage, Feeding habitat and Taxonomy etc.

Unit-V

Classification of Insect pests based on Nature of damage, Mouth parts, Metamorphosis. General life cycle patterns of insect pests: Grasshopper, Aphid, Lepidopteron Borer, White grub, Red hairy caterpillar, Snails, Slug, Nematodes, Rat. . Application of insecticides – Targets, Droplet size, Application equipment, rational application. Biological control - Types of biocontrol agents. Techniques of biocontrol. Genetic control and area-wide management.

REFERENCES

1. Agrios, G. N. Plant Pathology. 5th Edition.
2. Atwal, A. S. Agriculture pest of India and South East Asia.
3. Green, M. B. Chemical for crop improvement and pest management.
4. Larry P. Pedigo. Entomology and pest management.
5. Maniloff, J.1992. Mycoplasma molecular biology and pathogenesis.
6. Mundkar, B. B. 1972. Fungi and plant diseases.
7. Paul and Khurana, S. M. 1998. Pathological problems of economic crop plant and their management.

8. Raychandhuri, S. P. and Anupam varma. 1989. Plant diseases caused by fastidious Prokaryotes.
9. Srivastava, K. P. A textbook of applied entomology.
10. Tarr, S. A. J. 1972. Principles of plant pathology.
11. Thurston, H. D. 1993. Tropical plant diseases.

Elective : **AQUATIC AND MARINE PLANTS**

Unit: I

Plant aquaculture: History, principles, scope and importance. Distribution, morphology, reproduction, life cycle, growth physiology and Culture techniques of sea weeds. Important cultivable species of aquatic plants and sea weeds, micro algae. Biodiversity of Seaweeds along the coast of India. Taxonomy of economically important seaweeds. Products from seaweeds.

Unit: II

Vascular plants: Biodiversity of freshwater higher vascular plants in India. Taxonomy of economically important freshwater higher vascular plants. Distribution, morphology, reproduction, life cycle, growth physiology and Culture techniques of freshwater higher vascular plants (Trapa, Typha), products of higher vascular plants. Taxonomy of economically important micro algae. Distribution, morphology, reproduction, life cycle, growth physiology and Culture techniques and Importance of Spirulina and chlorella. Application of microalgae in water treatment and Bioremediation.

Unit: III

Phytoplankton (freshwater and marine): - methods of assessment, spatial and temporal variations, succession, diversity; Nanoplankton; Algal blooms; Role in carbon sequestration. Classifications of plankton; Primary and secondary production - estimation, significance, affecting factors; Production - biomass (P/B ratio); Indices of productivity; Community interrelationships.

Unit: IV

Storage and structural components in algae: Seaweed polysaccharides- Chemical structure, properties and extraction of Agar. Nutrient requirement- Essential elements,

vitamins for growth of algae. Metabolic role of essential nutrients. Salt regulation in halophytes: Salt glands and salt secretion. Significance of vivipary. Leaf succulence, selective ion absorption. Salinity and metabolism: Influence of salinity on photosynthesis of halophytes. Induction of CAM. Membrane transport under salinity. Effect of salinity on growth and phytohormones.

Unit: V

Biodiversity of mangroves: Brief idea of Creek, Estuary, Lagoon and Delta. Definition - 'mangrove'. Distribution – biogeography of Indian mangroves, East and West coast mangroves, Mangrove shores and forests. Salient features of important mangrove families such as Rhizophoraceae, Sonneratiaceae Avicenniaceae, Myrsinaceae, Acanthaceae etc. Methods of natural and artificial regeneration in mangroves.

References

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2. Fasset, N. G. 1997. A Manual of Aquatic Plants. Allied Scientific Publishers, Bikaner.
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5. Lund, H. C. and J. W. G. Lund. 1995. Freshwater Algae. Biopress Ltd., Bristol.
6. McConnaughey, B. H. 1974. Introduction to Marine Biology.
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9. Sournia, A. 1978. Phytoplankton Manual. UNESCO Publication, Paris.
10. Tomas, C. R. 1997. Identifying Marine Phytoplankton. Academic Press, San Dieg.

CORE – 5. GENETICS

UNIT I

Mendelian Genetics: Laws of inheritance, modified Mendelian, ratios complementary and supplementary genes. Lethal genes, multiple alleles - ABO blood group system in

humans, Self incompatibility in Nicotiana. Polygenic inheritance - kernel colour in wheat, ear head length in maize, skin colour in humans.

UNIT II

Sex linked inheritance – color blindness, haemophilia. Behaviour of chromosomes during meiosis, non disjunction, linkage and crossing over – theories, and chiasma formation. Haploids, aneuploids and euploids, autoploids, chromosome and chromatin segregation; allopolyploids, types of genome constitution and analysis. Mapping - Bacteriophage genome, phage phenotypes, genetic recombination in phage. Genetics of chloroplasts and mitochondria, cytoplasmic male sterility.

UNIT III

Gene structure and Expression: Fine structure of gene, cis – trans test. Introns and their significance. RNA splicing. Regulation of gene expression in prokaryotes – lac operon, trp operon. Mechanism of gene regulation in eukaryotes. Terminator gene technology and its commercial importance.

UNIT IV

Molecular mechanism of recombination. Role of RecA and RecBCD enzymes. Site specific recombination. Chromosome mapping, linkage groups, genetic markers, construction of molecular maps, correlation of genetic and physical maps. Somatic cell genetics – an alternative approach to gene mapping. Stern's experiment and Mc Clintock Creighton experiment – transposable elements in prokaryotes and eukaryotes.

UNIT V

Mutations – Types of mutations, methods of detection of mutations, CIB method and attached X method, ploidy types and significance. Molecular mechanism of spontaneous and induced mutations, site directed mutagenesis. Homeotic mutants in *Arabidopsis* and *Antirrhinum*. Mutagenic effects of food additives and drugs. Ames test. DNA damage and repair. Initiation of cancer at cellular level, proto-oncogenes and oncogenes.

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2. Atherly, A. G, and J. R. Girton, J. F. McDonald. 1999. The Science of Genetics. Saunders College Publishing, Fort Worth, USA.
3. Burnham, C. R. 1962. Discussions in Cytogenetics. Burgess Publishing Co., Minnesota.
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8. Khush, G. S. 1973. Cytogenetics of Aneuploids. Academic Press, New York, London.
9. Lewin, B. 2000. Gene VII. Oxford University Press, New York, USA.
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11. Malacinski, G. M. and D. Freifelder. 1998. Essentials of Molecular Biology (3rd edition). Jones & Bartlett Publishers, Inc., London.
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13. Peter J. Russell, Stephen L. Wolfe, Paul E. Hertz and Cecie Starr. 2008. Biology: The Dynamic Science, (1st Edition).
14. Raven P. H. and G. B. Johnson. 2002. BIOLOGY (6th edition). McGrawHill. Boston, Madison, New Delhi.
15. Russel, P. J. 1998. Genetics (5thedition). The Benjamin/ Cummings Publishing Company Inc., USA.
16. Snustad, D. P. and M. J. Simmons. 2000. Principles of Genetics (2nd edition). John Wiley & Sons, Inc., U.S.A.

CORE – 6. ANATOMY AND DEVELOPMENTAL BOTANY

UNIT I

Tissue systems – simple and complex. Vascular cambium- origin, structure and development. Anomalous secondary growth: Boerhavia, Draceana. Secretory ducts and laticifers; wood development in relation to environmental factors. Leaf anatomy-structure of dicot and monocot leaves. Unique feature of plant development; differences between animal and plant development.

UNIT II

Seed germination and seedling growth: Mobilization of food reserves; tropisms; hormonal control of seedling growth. Shoot development: Organization of the shoot apical meristem (SAM); cytological and molecular analysis of SAM; control of cell division and cell to cell communication; control of tissue differentiation, especially xylem and phloem. Leaf growth and differentiation: Determination of phyllotaxy; control of leaf form; differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll. Root development: Organization of root apical meristem (RAM); cell fates and lineages; vascular tissue differentiation; lateral roots; root hairs.

UNIT III

Reproduction: Vegetative and sexual reproduction; flower development; genetics of floral organ differentiation. Male gametophyte: Structure of anthers; microsporogenesis, role of tapetum; pollen development and gene expression; male sterility; sperm dimorphism and hybrid seed production; pollen germination, pollen tube growth and guidance; pollen storage; pollen allergy; pollen embryos. Female gametophyte: Ovule development; megasporogenesis; organization of the embryo sac, structure of the embryo sac cells.

UNIT IV

Pollination, pollen-pistil interaction and fertilization: Floral characteristics, pollination mechanisms. Structure of the pistil; pollen stigma interactions, sporophytic and gametophytic self-incompatibility (cytological, biochemical and molecular aspects); double fertilization. Seed development and fruit growth: Embryogenesis – dicot and monocot, polyembryony, apomixes. Endosperm development and types; storage

proteins of endosperm and embryo; Dynamics of fruit growth; biochemistry and molecular biology of fruit maturation.

UNIT V

Senescence and programmed cell death (PCD): Basic concepts, types of cell death, PCD in the life cycle of plants, metabolic changes associated with senescence and its regulation; influence of hormones and environmental factors on senescence.

REFERENCES

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21. Shivanna, K. R. and N. S Rangaswamy. 1992. Pollen Biology: A Laboratory Manual. Springer-Verlag, Berlin.
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PRACTICAL -3: GENETICS, ANATOMY AND DEVELOPMENTAL BOTANY

1. Staining and localization of Nucleus – light and fluorescent microscopic methods.
2. Isolation of nuclei and identification of histones by SDS- PAGE.
3. Chromosome mapping from test cross data
4. Calculation of interference.

5. Multiple alleles and blood group inheritance - problems
6. Sex linked inheritance – problems
7. Population genetics -calculation of gene frequencies
8. Construction of molecular maps
9. Ames test
10. Role of dark and red light/far-red light on the expansion of cotyledons and epicotylar hook opening in pea.
11. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla.*
12. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and doubl-stained permanent slides of a suitable plant such as *Coleus, Kalanchoe, tobacco*.
13. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordial.
14. Study of alternate and distichous, alternate and superposed, opposite and superposed; opposite and decussate leaf arrangement.
15. Examination of rosette plants *(Mollugo, Raphanus, Hyoscyamus*)
16. Monocotyledon – leaf , stem, and root - sections
17. Dicotyledonous leaf, stem, root - sectioning
18. Anther sectioning and developmental stages
19. Acetolysis and Pollen grain staining.
20. SEM images of anatomical & morphological portions.

Core – 7. INSTRUMENTATION AND RESEARCH METHODOLOGY

UNIT I

Principles and operations - pH meter, Electrical conductivity and salinity meters. Preparation of solutions - Preparation of Molar, Normal, ppm and percentage and buffers. Spectrophotometer: Beer's Lambert law and its application, UV- visible, AAS, GC – MS, IR, NMR, Raman spectroscopy. Chromatography principle and applications – Paper, Thin layer and Column and HPLC .

UNITII

Electrophoresis: Agarose, Starch acrylamide gel Electrophoresis, principles and applications. Blotting Techniques: Southern, Western and Northern blot gel documentation systems. Microscopy: Principles and applications of Light, Compound phase contrast microscopes, Fluorescent microscopy, Electron microscopy: TEM, SEM, Confocal microscopy. Micrometry: Ocular and stage meter and Image analysis.

UNIT III

PCR – Thermocycler types : Principles and application. DNA finger printing Techniques, Radio active and Non- Radioactive probes and their usage. Autoradiography. Gene Delivery systems: Electroporation, Microprojectiles: particle bombardment, shotgun.

UNIT IV

Biostatistics. Principle and practice of statistical methods in biological research – Sources and presentation of data. Measures of Central Tendency – Mean, Median and Mode. Measures of Dispersion – Range, mean deviation, standard deviation, coefficient of variation and standard error. Simple correlation and linear regression analysis. Probability – Basic concepts. Theoretical distributions – Binomial, Poisson and Normal. Test of statistical significance – Chi-square test and t-test. F-distribution and analysis of variance (ANOVA) – one way and two way. Presentation of data using Excel.

UNIT V

Research Methodology – types of research, scientific research – hypothesis, experimentation, theory. Preparation research articles - Review article, research papers, Online publications. Thesis writing, Editorial norms and symbols. Presentation of research papers in seminar, symposia and conferences. Research ethics.

REFERENCES:

1. Wilson and Walker. Practical Biochemistry.
2. Ehrlich. PCR Technology.
3. Maniatis and Sambrook. Introduction to Gene cloning.
4. Roberts. Plant Biotechnology (Manual).

5. Philippa D. Dabre. Introduction to practical molecular Biology.
6. Sandhu, G. S. 1990. Research techniques in biological sciences (Ed). Anmol publications, New Delhi.
7. Khan and Khan. 1994. Biostatistics. Vikas Publising House Pvt. Ltd. New Delhi.
8. Panse and Sukhatme. 1992. Statistical Methods for Agricultural workers. ICAR, New Delhi.
9. Steel and Torrie. 1986. Principles and Procedures of Statistics with special reference to Biological Sciences.

CORE – 8. PHYTOCHEMISTRY AND PLANT HISOTOCHEMISTRY

Unit-I

Definition - Phytochemistry; **S**econdary metabolites: Classification, Occurrence and distribution in plants and their chemical constituents. Alkaloids, Steroids, Terpenoids, Flavonoids and Coumarins.

Unit-II .

Techniques in the isolation of bio-molecules of medicinal importance, solvent extraction, chemical separations, steam distillation, soxhlet extraction. Purification, concentration and determination and Quantification of compounds using Chromatography: TLC column chromatography, HPLC. Characterization of phytochemicals using spectroscopic methods.

Unit-III:

Applications of Phytochemistry in medicine and pharmaceuticals, food flavour and cosmetic industries. Biosynthetic pathways of important phytochemicals: Shikimic acid pathway Mevalonic Acid Pathway. Biosynthetic pathway for commercially important phytochemicals: Forskolin, Taxol and Vinca alkaloids.

Unit: IV

Microtomes: Rotary, Sledge, and Cryostat. Processing procedure for micropreparation; Fixing - Common chemical fixatives, their preparation and specific uses; Dehydration - Dehydrating agents, Clearing – Xylol/TBA series Paraffin infiltration- wax embedding. Preparation of blocks. wax blocks and paper boats. Sectioning of paraffin blocks using

rotary microtome. Adhesives and their preparations. Mounting and spreading of paraffin ribbons on micro slides. Processing and preparation of ultra thin sections for TEM.

Unit:V

Preparation of common laboratory stains and reagents – Basic: Safranin, Crystal violet, Basic fuchsin, Cotton blue. Acidic: Fast green, Orange G, Erythrosine, Eosin, and Toluidene blue O. Staining procedure: Single, double and triple staining. Staining combination: safranin and fast green /cotton blue crystal violet and orange-G and safranin. Histochemical analysis of plant tissues. Analysis of plant metabolites through histochemical staining. Localization of minerals, proteins, nucleic acids, insoluble carbohydrates, & lipids. Enzyme histochemistry – General account. Vital staining: Principle, procedure, and applications.

REFERENCES:

1. Agarwal, P. K. and R. S. Thakur, C. M Bansal. 1989. Carbon-13 NMR of Flavonoids. Elsevier Science Publishers, Amsterdam.
2. Aler Gingauz. 2001. Medicinal Chemistry; Oxford University Press. Wiley publications.
3. Braithwaite, A. and F. J. Smith. 1996. *Chromatographic Methods* (5th Edition) Blackie Academic & Professional London.
4. Gahan, P. B. 1984. Plant Histochemistry. Academic Press.
5. Graham L. Patrick .1996. Introduction to Medicinal Chemistry.
6. Harborne, J. B. 1984. Phytochemical Methods (2nd Edition). Chapman and Hall, London.
7. Jensen, W. A. 1962. Botanical Histochemistry. WH Freeman & Company.
8. Johansen, D. A. 1940. Plant Microtechnique. McGraw Hill.
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10. Krishnamoorthy, K. V. 1999. Methods in Cell Wall Cytochemistry. C.R.C. Press.
11. Mann J. Davidson, R. S and J. B. Hobbs, D. V. Banthorpe, J. B. Harborne. 1994. *Natural Products*. Longman Scientific and Technical Essex.

12. Miksche, J. P. 1976. Botanical Microtechnique and Cytochemistry. Dowa State University Press.
13. Pearse, A. G. E. 1980. Histochemistry, Theoretical and Applied (4th Edition), Vol. 1. Churchhill Livingstone.
14. Reed, R. and J. Holmes, J. Weyers, A. Jones. 1998. Practical Skills in Biomolecular Sciences. Longman, Essex.
15. Reid, P. D. and R. F. Pont-Lezica (Eds.). 1992. *Tissue Printing*. Academic Press, New York.
16. Sanderson, J. B. 1994. Biological Microtechnique. Bios Scientific Publishers.
17. Schwedt, G. 1997. The Essential Guide to Analytical Chemistry. John Wiley & Sons, New York.
18. Wilson, K. and J. Walker (Eds). 1994. Principles and Techniques of Practical Biochemistry (4thEdition) Cambridge University Press, Cambridge.

PRACTICAL – 4: INSTRUMENTATION, PHYTOCHEMISTRY AND PLANT HISTOCHEMISTRY

1. Fractionation of proteins using gel filtration chromatography by Sephadex G100 or Sephadex G200.
2. SDS-PAGE for soluble proteins extracted from the given plant materials and comparison of their profile by staining with Coomassie Brilliant Blue or silver nitrate.
3. Separation of isozymes of esterases, peroxidases by native polyacrylamide gel electrophoresis.
4. Verification of Beer and Lamberts law using spectrophotometry.
5. Separation of amino acids using Thin layer chromatography.
6. Separation of plant pigments using column chromatography.
7. Soxlet/steam distillation of major secondary compounds.
8. Isolation of some natural products: Piperine, caffeine, flavone, coumarin, triterpenoids
9. Spectroscopic estimation of some natural products
10. Preparation of stains
11. Microtomy – Preparation of thin sections and permanent slides.

12. Staining starch, cell wall, lipids, proteins and nucleic acids using bright field dyes
13. Preparation of double stained free hand sections and identification of the tissues with reasons (Normal or anomalous secondary thickening).
14. Free hand sections showing localization of soluble components-Proteins, Sugars and Lipids.
15. Preparation of serial sections, from the given block and identification of the tissues with histological reasoning.
16. Preparation of squashes and smears. Maceration of the tissues for separating cell types.
17. Students are expected to get a through understanding on reagents and buffers for the tissue processing and they should submit 15 permanent slides (5 serial, 5 hand sections for histology and 5 hand sections for sledge and Histochemistry) for valuation.

OPTIONAL ELECTIVE 2 : ANY ONE OF THE FOLLWOING

Elective: PLANTS IN TAMIL CULTURE

UNIT – I Land, People and Literature: Antiquity of Tamil land – occurrence of Paleolithic, Mesolithic, Neolithic and megalithic sites of human settlement. Landscape and vegetation and rainfall patterns.

UNIT – II A brief introduction to Sangam literature. Plants in “Kurinji pattu”. Tinai as landscape and ecosystem concept. Importance of plants in five landscapes: Mullai, Marutham, Kurinji, Neythal and Palai.

UNIT – III Plants in Tholakkapiaym. Plants used in early Tamil culture as food and economy. Plants in love and war.

UNIT - IV Sacred plants associated with gods, temple, religion and rituals. Plants and poetic convention. Recent plant introductions and their adoption in Tamil culture.

UNIT – V Plants relevant to Astrological importance – Constellation (Rasi) and star plants. The continuing influence of plants present-day Tamil culture.

References:

1. HART, G.L. III. 1975. The Poems of Ancient Tamil. Their Milieu and Their Sanskritic Counterparts. University of California Press. Berkeley.
2. RAMANUJAM, A.K. 1975. The Interior Landscape: Love Poems from a Classical Tamil Anthology. Fitzhenry and Whiteside Limited. Ontario.
3. SAMY, P.L. 1967. ***Sanga Illakkiathil Sedikodi Vilakkam***. Saiva Siddhanta Publishing Society. Thirunelveli.
4. SAMY, P.L. 1972. Plants in Kurinji Pattu. Journal of Tamil studies.
5. SASIVALLI, V.C. 1989.***Pandai Tamilar Tolilkal***. International Institute of Tamil Studies. Madras.
6. SOBIDHRAJ, K.K.S. 1993. Thala Marangal. Sobitham. Tambaram East. Madras.
7. SRINIVASAN, C. Sanga Ilakia Thavarangal, Tamil University Publication. Thanjavur.
8. THANINAYAGAM, X.S. 1966.Landscape and Poetry. A study of Nature in Classical Tamil Poetry. Asia Publishing House. Madras.
9. VARADARAJAN, M. 1957. The treatment of Nature in Sangam literature. S.I.S.S.W Publishing Society, Madras-1.
10. www. Thavarathagavalmaiyam.com www.plantinfocentre.com

Elective: HORTICULTURE & PLANT BREEDING

Unit I:

PLANT BREEDING - Introduction – Objectives in Plant breeding. Floral Biology in relation to selfing and crossing techniques. Reproduction in Plants – Mode of reproduction in relation to breeding. Sexual reproduction – objectives and methods of emasculation and pollination – raising F1 hybrids. Asexual reproduction: Vegetative apomixes – Non recurrent apomixis, diplospory, apospory, parthenogenesis, Role of apomixes in plant breeding.

Unit II:

Hybridization - Objectives, choice of parents, problems and causes of failure of hybridization – Incompatibility and sterility – Methods of overcoming – genetic consequences of hybridization. Methods of handling segregating hybrids for isolation of superior strains – Bulk method and pedigree method of selection. Role of interspecific and intergeneric hybridization in plant improvement. Selection: Principles – genetic basis and methods. Mass selection, pure line selection, clonal selection.

UNIT III

Back-cross breeding - Theory and procedure for transferring various types of characters. Inbreeding consequences. Heterosis theories – genetic and physiologic basis – Applications in plant breeding – steps in the production of single cross, double cross, three way cross and synthetic cross – use of male sterility in hybrid production – cytoplasmic – Genetic and cytoplasmic – Genetic sterility.

UNIT IV:

HORTICULTURE - Concept and Scope – Familiarization of famous gardens in the world and in India. Tools and Implements. Plant growing structures – Green house, Glass house and Mist chamber.

UNIT V:

Plant propagation – Cuttage, Layerage, Graftage and Budding. Cultural practices – Thinning, Training, Trimming and Pruning. Fertilizers – Biofertilizer, Green manure, NPK, Compost – Vermicompost. Out door horticulture – Gardens – Vegetable garden, Medicinal plant garden Roof garden, Fruit garden, Lawns and Landscapes. Bonsai.

REFERENCES

1. Adroamce, G. W and F. R. Brison. 2000. Propagation of Horticultural Plants. Biotech Books, New Delhi.
2. Allard, R. W. 1999. Principles of Plant Breeding. John Wiley & Sons. Inc. New York.
3. Ame Hagberg and Eric Akerberg. 1962. Mutations and Polyploidy in Plant breeding. Heimeman Educational Books Ltd. London.
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9. Graf, A. B. 1981. Tropica (2nd Edition). Roehrs co., USA.
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14. Manibhushan Rao, K. 1991. Text book of Horticulture. Macmillan India Pvt. Ltd. New Delhi.
15. Panse and Sukhatme. 1992. Statistical Methods for Agricultural workers. ICAR, New Delhi.
16. Rao, A. B. 1991. Text Book of Horticulture. Mac Millan India ltd., New Delhi.
17. Sadhu, M. K. 1996. Plant Propagation Methods. New Age International (P) Ltd. New Delhi.
18. Sing, D. D. Plant Breeding: Principles and Methods. Kalyani Publishers, New Delhi.
19. Singh, B. D. 1999. Plant Breeding. Kalyani publishers, New Delhi.
20. Steel and Torrie. 1986. Principles and Procedures of Statistics with special reference to Biological Sciences.

Elective: PLANTS FOR BIO ENERGY AND SPACE RESEARCH

UNIT I

Energy sources - General account. Bio energy-energy plantations, social forestry and Silvi culture energy farms. Bio energy sources: Petrolieum plants (petro plants)-hydrocarbons for higher plants like *Hevea* and *Euphorbia.* Algal hydrocarbons. Alcohols: Alcohols as a liquid fuel-Hydrolisis of lignocellulosic materials, Ethanol

production-. Sources and processing of oils and fats for liquid fuels, Sugarcane molasses and other sources for fermentation and recovery of ethanol.

UNIT II

Biomass conversion: Non biological process- Direct combustion (hog fuel), pyrolysis, Gasification and Liquification. Bilogical process: Enzymatic digestion, aerobic and anaerobic digestion

UNIT III

Gaseous fuels: Biogas and hydrogen: Biogas technology profit from biogas plants. Biogas production: aerobic digestion solubilization, acidogenesis, methanogenesis. Biogas production from different feed stocks like *Salvinia* and *Eichornia.* Hydrogen as a fuel: Photobiological process of hydrogen production. Hydrogenese and hydrogen production. Halo bacteria.

Unit-IV

Principles and concepts of Remote Sensing. Electromagnetic spectrum; spectral characteristics of surface features (rocks, soils, vegetations, water). Space imaging - Landsat, SPOT, IRS, NOAA, Seasat, ERS, RADARSAT, INSAT. Satellites and their sensors, geometry and radiometry. Digital Image Processing: Principles, Image Rectification and restoration, Image enhancement and Mosaicing. Image classification. Supervised, Unsupervised, Ground truth data and training set manipulation, Classification accuracy assessment.

Unit-V

Geographical Information System (GIS): Basic principles and terminologies, Raster and vector data, Map projection, Topology creation, Overlay analysis, Data structure and Digital cartography; Software used in GIS Surveying: Leveling, Triangulation, Geodetic survey; Global Positioning System (GPS) Basic principles, Applications to environmental studies.

References:

1. Agarwal, N. K. 2004. Essentials of GPS. Spatial Networks Pvt. Ltd.

2. Chakraverthy, A. 1989. Biotechnology and alternative technologies for utilization of biomass or agricultural wastes. Oxford & IBA pub. Co., New Delhi.
3. Coronel, C. and S. Morris, P. Rob. 2009. *Database Systems:* Design, Implementation and Management (9th Edition). Course Technology.
4. Elachi, C. 1978*.* Introduction to Physics and Techniques of Remote sensing*.* John Wiley Pub.
5. Floyd, F. and W. H. Jr. Sabins. 1987. Remote Sensing, Principles and Interpretation (2nd Edition). Freeman & Company.
6. International Encyclopedia of Ecology and environment Vol.1-30. Indian Institute of Ecology & Environment Publications.
7. Kerry Turner, R. Sustainable Environment Management.
8. Lilles, T. M. and R. F. Kiefer. 1994. Remote Sensing and Image interpretation. John Wiley & Sons.
9. Maguire, D. and M. Batty. 2005. *GIS,* Spatial Analysis, and Modeling. Esri Press.
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11. Michael, L. and McKinney, Robert M Schoch. Environmental science-systems and solutions.
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14. Venkata Ramana, P. and S. N. Srinivas. 1996. Biomass energy systems. Tata energy Research Institute, New Delhi.
15. Vepal, S. and Malik, Padma Sridahar. Industrial biotechnology.

CORE – 9. PLANT PHYSIOLOGY AND BIOCHEMISTRY

UNIT I

Energy flow: Principle of thermodynamics, free energy and chemical potential, redox reaction, structure and functions of ATP. **Fundamentals of enzymology:** Enzyme – substrate Properties, function and classification. Allosteric mechanism, regulatory and

active sites, isozymes, kinetics of enzymatic catalysis, Michaelis- Menten equation and its significance.

UNIT II

Translocation of water and solutes: Plant-water relations, mechanism of water transport through xylem, root- microbe interactions in facilitating nutrient uptake, comparison of xylem and phloem transport, phloem loading and unloading, passive and active solute transport, membrane transport proteins., sucrose-sensing mechanism.

UNIT III

Photochemistry and photosynthesis: General concepts and historical background, evolution of photosynthetic apparatus, photosynthetic pigments light harvesting complexes, photo oxidation of water, mechanisms of electron and proton transport, carbon assimilation – the Calvin cycle, photorespiration and its significance, the C4 cycle, the **CAM** pathway, biosynthesis of starch and sucrose, physiological and ecological considerations.

UNIT IV

Respiration and lipid metabolism: Overview of plant respiration, glycolysis, the TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternative oxidase system. Structure and function of lipids, fatty acid biosynthesis, synthesis of membrane lipids, structural lipids and storage lipids, and their catabolism. **Nitrogen fixation, nitrogen and sulphur metabolism:** Overview, biological nitrogen fixation, nodule formation and nod factors, mechanism of nitrate uptake and reduction, ammonium assimilation, sulfate uptake, transport and assimilation.

UNIT V

Plant growth regulators: physiological effects and mechanism of action of auxins, gibberellins, cytokinins, ethylene, abscisic acid, brassinosteroids, polyamines, jasmonic acid and salicylic acid, hormone receptors. Signal transduction and gene expression. **The flowering process:** Photoperiodism and its significance, endogenous clock and its regulation, floral induction and development – genetic and molecular analysis, role

of vernalization. **Stress physiology:** Plant responses to biotic and abiotic stress, mechanisms of biotic and abiotic stress tolerance, HR and SAR, water deficit and drought resistance, salinity stress, metal toxicity, freezing and heat stress, oxidative stress. **Sensory photobiology:** History of discovery of phytochromes and cryptochromes, and their photochemical and biochemical properties, photophysiology of light-induced responses, cellular localization, molecular mechanism of action of photomorphogenic receptors, signaling and gene expression.

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13. Thomas, B. and D. Vince-Prue. 1997. Photoperiodism in Plants (second edition). Academic Press, San Diego, USA.

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PRACTICAL – 5: PLANT PHYSIOLOGY AND BIOCHEMISTRY

1. Effect of time and enzyme concentration on the rate of reaction of enzyme (e.g. acid phosphatase, nitrate reductase).
2. Effect of substrate concentration on activity of any enzyme and determination of its Km value.
3. Demonstration of the substrate inducibility of the enzyme nitrate reductase.
4. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids and demonstration of fluorescence by chlorophyll.
5. Extraction Determination of chlorophyll a /chlorophyll b ratio in C3 and C4 plants
6. Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.
7. To demonstrate photophosphorylation in intact chloroplasts, resolve the phosphoproteins by SDS-PAGE .
8. Extraction of seed proteins depending upon the solubility.
9. Determination of succinate dehydrogenase activity, its kinetics, and sensitivity to inhibitors.
10. Demonstration of PGR effects – photomorphogenesis, stem elongation, apical dominance, callus induction.
11. Preparation of standard curve of protein (BSA) and estimation of the protein content in extracts of plant material by Lowry's or Bradford's method.
12. Effect of plant growth regulators on seed germination and seedling growth
13. Determination of the presence of IAA from plant tissues and quantification by Salkowski test.

14. Demonstration of respiration in flower buds by enzyme peroxidase activity.
15. Determination of seed viability by tetrazolium chloride test (TTC).

References for Practical:

1. Bajracharya, D. 1999. Experiments in Plant Physiology: A Laboratory Manual. Narosa Publishing House, New Delhi.
2. Cooper, T. G. 1977. Tools in Biochemistry. John Wiley, New York, USA.
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4. Dennison, C. 1999. A Guide to Protein Isolation. Kluwer Academic Publishers, Dordrecht, Netherland.
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9. Moore, T. C. 1974. Research Experiences in Plant Physiology: A Laboratory Manual. Springer-Verlag, Berlin.
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14. Wilson, K. and K. H. Goulding (Eds). 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.

CORE – 10. TAXONOMY AND MEDICINAL PLANTS

TAXONOMY OF ANGIOSPERMS

UNIT 1

Taxonomic hierarchy- major and minor categories, genus and species concept. Principles used in assessing relationship, delimitation of taxa and attribution of rank. Salient features of the International code of Botanical nomenclature - typification, priority, publication, author citation, homonym, synonym, tautonym, autonym, basionym and conserved names. Retention, choice and rejection of names, effective and valid publication. Taxonomic literature – floras, Monographs. National and international Herbaria, Role of BSI, herbarium preparation.

UNIT II

Evidences from Morphology, anatomy, palynology, embryology, cytology; phytochemistry (secondary metabolites) in relation to taxonomy. Molecular systematics. Phenetic versus phylogenetic systems; Cladistics in taxonomy; relative merits and demerits of major systems of classification - proposed by Bentham and Hooker, Engler and Prantl. A detailed study on APG - III Classification.

UNIT III

Phytogeographical regions of India. Endemism, hotspots and hottest hotspots; plant exploration; invasions and introductions; local plant diversity and its socio- economic importance, Ethnobotany (brief account); relevance of taxonomy to conservation, sustainable utilization of bio- resources and ecosystem research.

UNIT IV

Study of the following families **-** Magnoliaceae, Nymphaeceae, Menispermaceae, Rhamnaceae, Combretaceae, Melastomataceae, Rubiaceae, Ebenaceae, Convolovulaceae, Bignoniaceae, Acanthaceae, Lamiaceae, Polygonaceae, Asteraceae, Apocynaceae, Aristolochiaceae, Euphorbiaceae, Moraceae, Orchidaceae, Arecaceae, Cyperaceae, Poaceae.

UNIT V

Brief study on Medicinal and Aromatic plants - *Papaver somniferum, Atropa belladonna, Catharanthus roseus, Adhatoda ceylanica* (syn A. vasica), A*llium sativum, Rauvolffia serpentine, Withania somnifera, Phyllanthus amarus, (P. fraternus), Andrographis paniculata, Aloe barbadense, Mentha arvensis, Rosa sp., Pogostemon cablin, Origanum vulgare, Santalum album, Jasminum grandiflorum, Curcuma sp. Chrysopogon zizanioides, Cymbopogon sp., Pandanus odoratissimus*.

PRACTICAL – 6: TAXONOMY AND MEDICINAL PLANTS

1. Description of a specimen from representative, locally available families.
2. Description of a species based on various specimens to study intraspecific variation: a collective exercise.
3. Description of various species of genus; location of key characters and preparation of keys at generic level.
4. Location of key characters and use of keys at family level.
5. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
6. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.
7. Solving nomenclatural problems.
8. Field trips within and around the forest areas; compilation of field notes and preparation of herbarium sheets of such plants (20 different sheets), wild or cultivated, as are abundant.

REFERENCES:

1. Ahmedullah, M. and M. P. Nayar. 1987. Endemic Plants of the Indian Region. Vol. I. Botanical Survey of India, Howrah.
2. Cronquist, A. 1968. The Evolution and Classification of Flowering Plants. Houghton Mifflin, Boston.
3. Davis, P. H. and V. H. Heywood. 1973. Principles of Angiosperms Taxonomy. Robert E. Kreiger Pub. Co., New York.

4. Gamble, J. S. and C. E. C. Fischer. 1967. Flora of the Presidency of Madras. Vols. I - III. Botanical Survey of India, Calcutta.
5. Graham, L. E. 1993. Origin of Land Plants. John Wiley & Sons. Inc., New York.
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11. Jain, S. K. and R. R. Rao. 1977. A Handbook of Field and Herbarium Methods. Today and Tomorrow's Printers and Publishers, New Delhi.
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13. Lawrence, G. H. M. 1951. Taxonomy of Vascular Plants. The Macmillan Company, New York.
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15. Moore, R. and W. D. Clark, K. R. Stern, D. Vodopich. 1995. Botany: Plant Diversity. Wm. C. Brown Publishers, London.
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20. Raven, P. H. and R.F. Evert and S. E. Eichhon. 1992. Biology of Plants. 5th Edition. Worth Publishers. New York.
21. Santapau, H. and H. A. Henry. 1994. A dictionary of the flowering plants in India. CSRI, New Delhi.
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24. Stebbins, G.L. 1974. Flowering Plant – Evolution above Species Level. Edward Arnold Ltd., London.
25. Subramaniam, N. S. 1995. Modern Plant Taxonomy. Vikas Publishing House, New Delhi.
26. Takhtajan, A. 1997. Diversity and Classification of Flowering Plants. Bishen Singh and Mahendrapal Singh, Dehra Dun, India.

CORE – 11. ECOLOGY AND CONSERVATION BIOLOGY

UNIT 1

Climate, soil and vegetation patterns of the world: Life zones; Classification of biomes, major biomes and major vegetation and soil types of the world. Vegetation organization: concept of community and continuum; analysis of communities (analytical and synthetic characters); community coefficients; interspecific associations, ordination; concept of ecological niche. Vegetation and forest types. Vegetation mapping, GIS. Origin of intrapopulation variation: Population and the environment; e-cads and ecotypes; evolution and differentiation of species – various models. Vegetation development: Temporal changes (cyclic and non cyclic); mechanism of ecological succession (relay floristic and initial floristic composition; facilitation, tolerance and inhibition methods); changes in ecosystem properties during succession.

UNIT II

Ecosystem organization: structure and functions; primary production (methods of measurements, global pattern, controlling factors); energy dynamics (tropic organization, energy flow pathways, ecological efficiencies); litter fall and decomposition (mechanism, substrate quality and climate factors); global

biogeochemical cycles of C, N, P and S; mineral cycles (pathways, process, budgets) in terrestrial and aquatic ecosystems. Ecosystem types.

UNIT III

Climate change - Green house gases (CO_2, CH_4, N_2O, CFCs: sources, trends and role); ozone layer and ozone hole; consequences of climate changes (CO_2, fertilization, global warming, sea level rise, UV radiation). Ecosystem stability: Concept (resistance and resilience); ecological perturbations (natural and anthropogenic) and their impact on plants and ecosystems; ecology of plant invasion; environmental impact assessment; ecosystem restoration. Ecological management: Concepts; sustainable development; sustainability indicators.

UNIT IV

Biological diversity - Concept and levels; role of biodiversity in ecosystem functions and stability; speciation and threats, extinction. Distribution and global patterns; terrestrial biodiversity hotspots; inventory. International and national legislations, conventions on CBA and NBA. IUCN categories of RED listed plants and RED DATA BOOK.

UNIT V

Conservation of biodiversity. Strategies for conservation – *in situ* conservation: International efforts and Indian initiatives; protected areas in Indian – sanctuaries, national parks, biosphere reserves, wetlands, mangroves and coral reefs for conservation of wild biodiversity. Strategies for conservation – ex situ conservation: Principles and practices; botanical gardens, field gene banks, seed banks, *in vitro* repositories, cryobanks; national bureau of plant genetic resources (NBPGR), Indian council of agricultural research (ICAR), council of scientific & industrial research (CSIR) and the department of biotechnology (DBT) for conservation, non formal conservation efforts.

References :

1. Barbour, M. G. and W. D. Pitts. 1987. Terrestrial Plant Ecology. Benjamin/ Cummings publication company, California.

2. Begon, M., J.L. Harper and C.R. Townsend. 1996. Ecology. Blackwell Science, Cambridge, USA.

3. Bredy, N. C. 1990. The Nature and Property of Soils. MacMillan.

4. Chapman, J. L. and M. J. Reiss. 1988. Ecology: Principles and Applications. Cambridge University Press.

5. Heywood, V. H. and R. T. Watson. 1995. Global Biodiversity Assessment. Cambridge University Press.

6. Hill, M. K. 1997. Understanding Environmental Pollution. Cambridge University Press.

7. Kormondy, E. J. 1996. Concepts of Ecology. Prentice Hall of India Pvt. Ltd., New Delhi.

8. Ludwig, J. and J. F. Reynolds. 1988. Statistical Ecology. John Wiley & Sons.

9. Mason, C. F. 1991. Biology of Fresh Water Pollution. Longman.

10. Molden, B. and S. Billharz. 1997. Sustainability Indicators. John Wiley & Sons, New York.

11. Mullaer- dombois, D. and H. Ellenberg. 1974. Aims and Methods of Vegetative Ecology. Willey, New York.

12. Odum, E. P. 1971. Fundamentals of Ecology. Saunders, Philadelphia.

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14. Raven, P. H. and G. B. Johnson. 2002. BIOLOGY 6th ed. McGrawHill. Boston, Madison, New Delhi.

15. Smith, R. L. 1996. Ecology and Field Biology. Harper Collins, New York.

16. Treshow, M.1985. Air Pollution and Plant Life. Wiley Inter science.

PRACTICAL – 7: ECOLOGY AND CONSERVATION BIOLOGY

1. To calculate mean, variance, standard deviation, standard error, coefficient of variation and to use t-test for composing two means related to ecological data.
2. To prepare ombrothermic diagram for different sites on the basis of given data set and to comment on climate.
3. To find out the relationship between two ecological variables using correlation and regression analysis.

4. To determine minimum size and number of quadrates required to reliable estimate of biomass in grass land.
5. To find out association between important grassland species using chi-square test.
6. To compare protected and unprotected grassland stand using community coefficients(similarity indices)
7. To analysis plant communities using Bra-Curtis ordination method.
8. To determine diversity indices (Shannon-Winner, concentration of dominance, species richness, equitability and b- diversity) for protected and unprotected grasslands.
9. Population dynamics of local forest area
10. Regeneration studies in forest species.
11. Morphological and Genetic variations in any common plant species.

Field visits/ Scientific tours

The students should be taken to one of the following:

i. A protected area (biosphere reserve, national park, or a sanctuary)
ii. A wet land
iii. A mangrove
iv. Head Quarters of the Botanical Survey of India or one of its Regional circles.
v. A CSIR laboratory doing research on plants and their utilization.
vi. An ICAR Research Institute or a field station dealing with one major crop or crops (ICRISAT).
vii. A recognized botanical garden or museum (such as those at the Forest Research Institute, Dehra Dun: National Botanical Research Institute, Lucknow; Tropical Botanical Garden and Research Institute, Trivandrum), which has rich collection of plant products.

***Note:** the students are expected to prepare a brief illustrated narrative of the field survey and scientific visits. After evaluation, the marks/grades awarded to the students by the teachers will be added to the final assessment of the practical examination and credits for Field study/tour.

References for practical

1. APHA- Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, DC.
2. Krebs, C. J. 1989. Ecological Methodology. Harper and Row, New York, USA.
3. Ludwig, J. A. and J. F. Reynolds. 1988. Statistical Ecology. Wiley, New York.
4. Magurran, A. E. 1988. Ecological Diversity and Its Measurement. Chapman & Hall, London.
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9. Smith, R. L. 1996. Ecology and Field Biology. Harper Collins, New York.
10. Sokal, R. R and F. J. Rohlf. 1995. Biometry. W.H. Freeman &co., San Francisco.

CORE 12 : BIOETHICS AND INTELECTUAL PROERTY RIGHTS

UNIT-I

Bioethics – definition and history - Bioethics of IPR - ethical criteria in biotechnology- animal ethics; Guidelines for use of lab animals in research centers and Colleges - Licensing of animal house - Human cloning - Ethical issues - Ethical clearance norms for conducting studies on human subjects.

UNIT-II

Biosafety - definitions – bio safety levels - framework of bio safety regulation in India; Structure and functions of Committees; DBT guidelines on bio safety in conducting research in biology / biotechnology. - Regulations of Genetically modified Organisms in India - Biosafety regulation for transgenic plants and animals - labeling of GM foods

Unit III

Biotechnology – Society and Risks. Benefits of biotechnology, ELSI of biotechnology, Recombinant therapeutic products for human health care. Genetic modifications-

recombinant foods, safety of GM foods. Release of genetically engineered organisms-Human embryonic stem cell research-cloning.

UNIT IV

Intellectual Property Right (IPR) and Protection (IPP): About Intellectual Property and Intellectual Property Right, Choice of intellectual property protection, IPR and Plant Genetic Resources (PGR), GATT and TRIPs

UNIT V

Objectives of the patent system - basic principles and general requirements of patent law Patenting of biological material: International conventions, international corporations, obligation with, patent applications, implication of patenting of higher plants, patenting transgenic organisms and isolated genes, microorganisms, patenting of genes and DNA sequences, Plant breeders right (PBRs) and Farmers Rights.

REFERENCES:

1. Beauchamp and Leroy. 1999. Contemporary issues in Bioethics; Intellectual property, patents, copy right, trademarks and allied rights. Wards worth Pub. Co., Belmont, California.
2. Beier, F. K., R. S. Crespi and T. Straus. 1985. Biotechnology and Patent protection. Oxford and IBH Publishing Co, New Delhi.
3. Traylor and Fredric Koch. 2002. Bio safety. Michigan sates University pub., USA.
4. Manual of patent practice and procedure. IPR India. 2005. Ministry of commerce and industry, New Delhi, pp.163.
5. John. A. Thomas. 2004. Biotechnology and safety assessment, pp. 333.
6. Mittal, D. P.1997. Indian Patents Law.
7. Dr. Ashk Soni : Complete reference of Intellectual property rights laws- 2 vols.
8. TIFAC New Delhi : Intellectual Property rights.
9. Singh, K. and BCIL. Intellectual Property rights on Biotechnology, New Delhi.
10. www.ipr-helpdesk.org.
11. www.patentoffice.nic.in/ipr/patent/patents.htm.
12. www.bangalorebio.com/GovtInfo/ipr.htm.

CORE – 13. PLANT CONSERVATION BIOTECHNOLOGY

UNIT I

Introduction - Principles of conservation; extinctions; environmental distribution status of plants based on international union for conservation of nature (IUCN). Red data list of Indian plants. Plant conservation Biotechnology – Integration of biotechnology into conservation practices.

UNIT II

Tissue culture techniques : Culture room and lab facilities. Media composition and preparation different types – plant growth regulators, adjuvants; sterilization. Brief history of plant tissue culture, scope, concept of cellular differentiation,Totipotency. Morphogenetic patterns. Callus culture - Subculture, differentiation, and regeneration. Organogenesis, Caulogenesis, Rhizogenesis, Cell Line, Somaclone, Gametoclone, Somatic Embryogenesis and Embryoids, Synthetic seeds.

UNIT III

Applications of plant tissues culture: Micro propagation – Preparative stage: Germplasm acquisition and selection of explants. Establishment stage: Axenic and viable cultures. Multiplication stage. Plantlet production: induction of roots and acclimatization of plantlets to green house condition. Suspension culture, cell immobilization. Plant secondary metabolism- pathways and manipulation, industrial enzymes, edible vaccines and therapeutic proteins.

UNIT IV

Somatic hybridization: Protoplast isolation, fusion types and culture methods, hybrid selection and regeneration, possibilities, achievements and limitations of protoplast research. Anther and pollen culture and production of haploid plants.

UNIT V

Cryopreservation and germplasm storage: Slow or retarded growth. Principles, Cryoprotection, Freezing and long term cryogenic storage, protocols and

recovery of germplasm, DNA banks. Conservation of Rare, endemic, threatened and economically important plants of India.

REFERENCES:

1. Bhojwani, S. S. 1990. Plant tissue Culture: application and Limitations. Elsevier science publishers, New York, USA.
2. Bhojwani, S. S. and M. K. Razdan. 1996. Plant tissue Culture: Theory and Practice (a revised edition). Elsevier science publishers, New York, USA.
3. Collins, H. A. and S. Edwards. 1998. Plant Cell Culture. Bio Scientific Publishers, Oxford, UK.
4. Dixon, R.A. 1994. Plant cell culture, A Practical approach. IRL press. Oxford, London.
5. Dodds, J. H. and L. W. Roberts. 1995. Experiments in plant tissue culture. Cambridge University press, London.
6. Erica E. Benson. 1999. Plant conservation Biotechnology. Taylor and Francis Ltd., UK.
7. Freifelder. D. 1990. Molecular Biology. Narosa publishing house, New Delhi.
8. George, E. F. 1994. Plant Propagation by Tissue culture. Exegectics Ltd., England.
9. Jain, S. M., S. K. Sopory and R. E. Veilleux. 1996. In Vitro Haploid Production in Higher Plants, Vols. 1-5. Fundamental Aspects and Methods. Klumer Academic Publishers, Dordrecht, the Netherlands.
10. Kartha, K. K. 1985. Cryopreservation of Plant Cells Organs. CRC Press, Boca Raton, Florida, USA.
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13. Narayanasamy, S. 1994. Plant cell and tissue culture. Tata McGraw – Hill Publishing co., Delhi.

14. Raghavan, V. 1986. Embryogenesis in Angiosperms: A Developmental and Experimental Study. Cambridge University Press, New York, USA.
15. Vasil, I. K. and T. A. Thorpe. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, the Netherlands.
16. Vasil, I. L. and V. K. Vasil. 1992. Plant Biotechnology and tissue culture. Kluver Academic Publishers, Netherlands.
17. Yeomen. 1987. Plant cell culture technology. Narosa Publication, New Delhi.

CORE – 14. PLANT GENETIC ENGINEERING

UNIT I

Recombinant DNA technology: Tools used in rDNA Technology-a) Restriction enzymes (including concepts of restriction, modifications, Restriction endonucleases, types, properties, recognition sites, nomenclature, factors influencing restrictions) b) DNA Polymerase i) Klenow ii) DNA polymerase I iii) T4/T7 DNA Polymerase c) Reverse Transcriptase d) Terminal Transferases e) T4 Polynucleotide kinases & Alkaline phosphatase f) DNA dependent RNA polymerases. g) DNA ligases h) Nucleases: - Bal 31, S1 nucleases, DNase I, Mungbean nucleases, Ribonucleases, EXO III. Thermostable DNA polymerases used in PCR. Gene cloning and techniques, construction of genomic /cDNA libraries, choices of vectors, screening and analysis of recombinants, promoters, linkers.

UNIT II

Genetic engineering of plants: Aims, strategies for development of transgenics (with suitable Examples), *Agrobacterium* - the natural genetic engineer, Hairy roots – Ri and Ti plasmids, role of virulence genes,Ti and Ri as vectors. Use of promoters, selectable markers and reporter genes. T-DNA and transposon mediated gene tagging, chloroplast transformation and its utility. Direct gene transfer mechanisms. (Micro injection, Micro projectile, Electroporation) gene transfer mechanisms. Transgenic Insect resistant Plants- virus resistant, Salinity and drought tolerant plants, Herbicide resistant plants, Plants with increased shelf life of fruits and flowers.- Bt cotton, golden rice, Flavr savr tomato.

UNIT III

PCR Technology: Different types of PCR. Applications of PCR in cloning genes, promoters and flanking sequences. Utilising PCR preparation of probes and DNA sequencing. PCR on molecular marker technology - DNA Profiling- Marker assisted breeding (RAPD, RFLP, STS, SCAR), forensics and paternity determination. Different types of Nuclear and organellar genome.

UNIT IV

Microbial genetic manipulation: Bacterial transformation, selection of recombinants and transformants, genetic improvement of industrial microbes and nitrogen fixers, fermentation technology. Production of transgenic microbes-insulin synthesizing *E. coli*. Microbial genetics, BAC, YAC.

UNIT V

Genomics and proteomics: Genetic and physical mapping of genes, molecular markers for introgression of useful traits, artificial chromosomes, Next 2^{nd} and 3^{rd} generation sequencing, genome projects, functional genomics, its significance. Proteomes: definition of proteomes; genome-proteome relationship; deducing proteome from genome. Tools for proteomics: Isoelectric focusing, 2D protein gels, FPLC, DIGE, ICAT, MS, Tandem mass spectrometry and protein sequencing and peptide fingerprinting.

REFERENCES:

1. Brown, T. A. 1999. Genomes. John Wiley & Sons (Asia) PVT. Ltd., Singapore.
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PRACTICAL - 8: PLANT BIOTECHNOLOGY

1. Effect Plant Growth Regulators On Seed Germination And Seedling Growth
2. Preparation of Culture media: solid and liquid medium.
3. Sterilization of culture vials, equipments, and culture room.
4. Surface sterilization of explants.
5. *In vitro* germination of Orchid seeds.
6. Callus induction in carrot or any other plant material.
7. Regeneration through callus and somatic embryogenesis.
8. Clonal Propagation by shoot tip/axillary bud culture.
9. Whole cell immobilization.
10. Immobilization of somatic embryos and production of synthetic seeds.
11. Isolation and culture of leaf mesophyll protoplasts.
12. Demonstration of protoplast fusion employing PEG.
13. Demonstration of androgenesis in *Datura.*
14. Visit to Germplasm centers and plant Biotechnology laboratories.
15. Growth characteristics of *E. coli* using plating and turbidometric methods.
16. Isolation of plasmid from *E .coli* by alkaline lysis method and its quantitation spectrophotometrically.
17. Restriction digestion of the plasmid and estimation of the size of varies DNA fragments.
18. Cloning of DNA fragments in a plasmid vector, transformation of the given bacterial population and selection of recombinants.
19. Demonstration of DNA sequencing by Sanger' dideoxy method.
20. Electroporation of protoplast and checking of transient of the reporter gene.
21. Co- cultivation of the plant material (e.g. leaf discs) with *Agrobacterium* and study GUS activity histochemically.
22. Cloning and Transformation in Prokaryotes
23. Vector preparations Insert preparations Ligation Transformation
24. Methods of direct transformation

25. Cloning & Transformation in Eukaryotes

a) Methods of direct transformation : PEG mediated, microinjection, particle bombardment, electroporation

b) Methods of indirect transformation

26. Analysis of the recombinant DNA

27. Isolation of the recombinant plasmid Restriction analysis

28. Excision of the insert Restriction analysis of the excised insert Sequence analysis of the insert Construction of Genomic and cDNA library Gene isolation Promoter analysis Gene expression (reporter gene and immuno detection).

OPTIONAL ELECTIVE 3: ANY ONE OF THE FOLLOWING

Elective: GENOMICS AND BIOINFORMATICS

Unit I

Genome sequencing; chain termination and automated DNA sequencing; shotgun and gene cloning strategies; library construction, sequence assembly and gap closure; genome resources-NCBI map viewer, ORF finder, locus link. Analysis tools for sequence data banks. Pair wise alignment smith Waterman. Multiple alignment-CLUSTAL, PRAS. DNA microarray, Transcripton analysis.

Unit II

BLAST & FASTA types and their algorithms, structural data banks, protein Data bank (PDB), The Cambridge Structural Data base (CSD), Genome data bank, metabolic path way data, Composite protein sequence data bases. Dataware housing, data capture, data analysis, sequence data banks, introduction to sequence data banks-protein sequence data banks NBRF- PIR, SWISSPROT, signal peptide data bank. Nucleic acid sequence data bank, Genbank, EMBL, Nucleotide sequence data bank.

Unit III

Introduction to bioinformatics, scope of bioinformatics, role of computers in biology. The internet, the world wide web, useful search engines-Boolean searching, search engine algorithms. Finding scientific articles-Pubmed, running computer software, computer operating systems. Software downloading and installation. Workstation: The

bioinformatics workstation, Unix system, files and directories in Unix, working on a Unix system. Scripting languages-Perl and Python, Markup languages-HTML, XML.

Unit IV

Databases: Concepts of Database, database system, database management systems-Hierarchical, Rational and Network, Database security. Biological databases, Types-sequence and structures databases. Genome and organism specific databases.

Unit V

Miscellaneous databases. Data submission, data retrieval with Entrez, DBGET/Link Data Base and SRS. sequence filter, Iterative database searches and PSI- BLAST, Multiple sequence alignment-gene and protein families. Phylogenetics-building phylogenetic trees,

REFERENCES

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Elective: BIORESOURCES AND TRADITIONAL MEDICINES

Unit –I

Natural resources – renewable and nonrenewable. Preservation, conservation, and restoration of resources. Recycling, reuse, and substitution. Bio-energy: biomass as energy source, biomass production, energy farming, biomass conversion processes – thermochemical and biochemical. Biodiesel. Environmental consequences of biomass resource harnessing.

Unit-II

Energy sources – resource and reserves. Current national and global energy scenario. Fossil fuels: Oil, Coal, Natural gas, Shale – sources, exploration, exploitation; environmental consequences of overexploitation. Nuclear energy: Nuclear fission and fusion, nuclear minerals, nuclear fuel cycle, nuclear fuel production, nuclear reactors. Advantages and disadvantages of nuclear power. Environmental consequences – safety, terrorism, waste disposal and management. Renewable and alternate energy sources – solar energy and isolation, photovoltaic cells; hydropower; tidal power; wind power; geothermal energy; ocean energy; fuel cells – advantages and disadvantages, environmental consequences.

Unit-III

Forests as biological resources – importance, types of forests, deforestation, reforestation, conservation of forests. Biodiversity and its importance: Types of biodiversity - wild biodiversity, agro-biodiversity, domesticated biodiversity. Values of biodiversity, ecosystem functions and biodiversity, mobile links and valuating ecosystem services. Drivers of biodiversity loss. Tools and techniques for biodiversity estimation: Biodiversity indices; methods of biodiversity monitoring. Uses of biodiversity – source of food, medicine, raw material, aesthetic and cultural values. Threats to biodiversity; natural and anthropogenic, species extinctions, IUCN threat categories, red data book. Extinction: Types, Causes –population growth, overconsumption, pollution, climate change. Indian Biodiversity Act 2002 and Rules.

Unit- IV

Herbs and healing: Historical perspectives: local, national and global level; Herbal cultures: origin and development of human civilizations; Ethnobotany and Ethnomedicine; Development of European, South and Central American, African, Indian, Chinese, and South East Asian Herbal Cultures

Unit-V

Classical health traditions: Systems of medicine: origin and development of biomedicine; Indian Systems of Medicine (Ayurveda, Siddha, Unani, Tibetan) Ayurveda: Historical perspective, Swasthavritta (measures to be adopted for maintaining the health of healthy person in a positive way through prevention, promotion and correction), *Athuravritta* (disease management and treatment which involves eight specialties including Internal medicine and Surgery); Fundamental principles of Ayurveda: Panchabhootha theory, Thridosha theory, Saptadhatu theory and *Mala* theory; Ayurvedic Pharmacology, Ayurvedic Pharmacopoeia; *Mrigayurveda* and *Vrikshayurveda*

REFERENCES

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Elective: FOREST ECOLOGY AND WESTERN GHATS

UNIT-I

Tropical forest types, Structure and biota: Rain forests and monsoon forests semi-evergreen, deciduous forests, tropical dry evergreen forests and mangroves; distribution and characteristics. Forest synusiae; stratification, growth forms in plant life and seasonal rhythms; Animal life: Richness, diversity and carrying capacity. Niches in the forests and their utilization by animals.

UNIT-II

Plant species diversity and its maintenance: Tropical forest Tree & Liana diversity; Analysis of population structure of forest trees, regeneration status and implications for conservation; Diversity & ecology of forest understory species.

UNIT-III

Forest functioning: Growth of the forest, plant-plant interaction: Diversity & ecology of epiphytes: Complex web of floral, faunal interactions and implications for conservation. Forest dynamics: Micro climates, disturbance regimes in forests: tree falls and gap dynamics; silviculture & forest regeneration, tree species recruitment and mortality and stand dynamics, lessons from long term permanent plots.

UNIT-IV

Nutrient cycling in forests: Soils and their nutrients; nutrient uptake and accumulation in biomass; Nutrient return to the system: litter fall, seasonality and litter decomposition; nutrient conserving mechanisms in forest. Role of arthropods, birds and mammals in forest functioning.

UNIT-V

Sacred groves; Social forestry and Agro-forestry Human impacts on forests: Population growth and forests timber extraction; Non-timber forest produce; Forest fire, Rainforest destruction; Trends and causes for concern; Management and conservation. Western Ghats – Geography, Landscape, Forest Types, Plant Wealth And Distribution, Floras, Threat Factors, Tourism, Recognitions – Hotspot, Biosphere Reserve, KMTR, UNESCO Heritage Site.

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2. Laurence, W. F. and R. O. Bierregaard. 1997. Tropical Forest Remnants. The University of Chicago Press.
3. Richards, P. W.1996. Tropical Rainforest, 2nd Edition Cambridge Univ., Press.
4. Singh, J. S., S. P. Singh and S. R. Gupta. 2006. Ecology, Environment and Resource Conservation. Anamaya Publ., New Delhi.
5. Sutherland, W. J. 2000. The Conservation Handbook, Blackwell, Oxford.
6. Sutton, S. L., T. C. Whitmore and A.C. Chadwick (Eds). 1983. Tropical Rainforests Ecology Management. Blackwell Sci., Publ. Oxford.
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