

  
**ANNAMALAI UNIVERSITY**  
**DEPARTMENT OF BOTANY**  
(UGC-SAP & DST-FIST Sponsored Department)

**Ph.D COURSE WORK**  
(With effect from 2013-14)

**The Syllabus is common to Ph.D. Students of Botany, Plant Biology and Plant  
Biotechnology and Herbal Science**

**Paper – 1: Research Methodology –I**

**Paper – 2: Research Methodology –II**

**Paper – 3: Advances in Botany**  
(Papers 1, 2 & 3 are common to all)

**Paper – 4: Field of Specialization**

(Student should opt any one of the following papers based on their field of research)

- A. PLANT PHYSIOLOGY
- B. BIODIVERSITY, BIOSYSTEMATICS AND PALYNOLOGY
- C. CYTOGENETICS AND PLANT BREEDING
- D. PLANT BIOTECHNOLOGY
- E. ALGAL BIOTECHNOLOGY
- F. BIO-PROSPECTING OF MEDICINAL AND AROMATIC PLANTS
- G. MICROBIOLOGY
- H. ENVIRONMENTAL BIOLOGY
- I. ALLELOPATHY AND WEED SCIENCE

## Paper -1: Research Methodology-I

**UNIT – I: MICROSCOPY:** Principle and application of Light, Polarization, Phase Contrast and Fluorescent Microscope. Bright and dark field condensers. Principle and preparation of material for Transmission Electron Microscope and Scanning Electron Microscope.

MICROMETRY: Stage and Ocular Micrometers, Haemocytometer, Camera Lucida.

MICROTOMY: Paraffin Microtomy – Rotary and Rocking microtomes, Sledge microtome, hand microtome, Ultra microtome, Freezing edge microtome.

CYTOLOGICAL TECHNIQUES: Pre treatment, Fixation, Staining, Mounting, Detailed schedule for making permanent slides of microtome sections, Procedures for making permanent slides of hand sections, Detailed schedule for making root tip squash, Detailed procedure for making smear of anthers.

**UNIT – II: SEPARATION: PRINCIPLES OF SEPARATION TECHNIQUES: METHODS:** General methods of Separation, Detection, Dialysis and Ultrafiltration, Thin Layer Chromatography (TLC), Paper chromatography, High Performance Liquid Chromatography (HPLC), Gas – Liquid chromatography (GLC), Ion – exchange chromatography, Gel permeation Chromatography, Affinity chromatography.

ELECTROPHORESIS: Principles – Paper, Cellulose, Acetate, Agar Starch Electrophoresis, PAGE, SDS PAGE, Separation of proteins through electrophoresis.

CENTRIFUGE: Ultracentrifugation – Ultracentrifuge, refrigerated centrifuge, Cell fractionation.

**UNIT – III: SPECTROSCOPY:** Beer – Lambert relationship, Deviations from the Beer Lambert law Quantitative measurements Absolute methods, Comparative methods, Analysis of mixtures, Different types of Spectroscopy. Visible, UV, IR and Fluorescence Spectrophotometers.

Radiation sources. Monochromators – Glass filters, Interference filters, prisms, Diffraction gratings. Detectors – ultraviolet and visible region of the spectrum, infrared region of the spectrum. Optical materials, Optical system. Atomic absorption, Molecular absorption – ultraviolet and visible region and infrared region, Emission of radiation.

ATOMIC SPECTROSCOPY TECHNIQUES: Flame Emission Photometry, Plasma Emission Spectroscopy, Atomic Absorption Spectrophotometry.

**UNIT – IV: ELECTROANALYTICAL METHODS: POTENTIOMETRY:** Potentiometric measurements, Measurement of pH, Ion selective Electrodes.

CONDUCTIMETRY: Conductimetric measurements, Application of conductimetric measurements.

RADIO – ISOTOPES: Nature of Radioactivity. Types of radioactivity, Decay, Units of radio activity, Safety-Detection and measurement of radioactivity: Gieger – Muller tubes, Scintillation counters, Autoradiography, .Biological uses of isotopes: Tracers, Isotope dilution analysis, Radio activity analysis.

ECOLOGICAL INSTRUMENT: Uses of Luxmeter, Anemometer, Rain gauge, Air samplers and Bomb Colorimeter.

**UNIT – V: EXTRACTION AND ESTIMATION:** Carbohydrates, Amino acids, Proteins, Lipids, Nucleic acids and Pigments (Chlorophyll and Carotenoids). **ESTIMATION ACTIVITIES:** Catalase, Peroxidase, Polyphenol oxidase and Amylases. **TISSUE CULTURE TECHNIQUES:** Explant preparation, Sterilization, Media preparation, Various types of media, Cell culture, Cell suspension culture, Isolation of protoplasts, Protoplast culture, Protoplast fusion, Haploid production, Anther culture, Pollen culture, Embryo Culture, Somatic embryogenesis, Callus induction and Micropropagation.

### **REFERENCE BOOKS**

1. Anbalagan, K. 1985. Electrophoresis – a practical approach. Life Science Book House, Madurai.
2. Aneja, K.R. 1993. Experiments in Microbiology, Plant pathology and Tissue culture. Wiley Eastern Ltd., Madras.
3. Dwivedi, J.N and Singh, R.B. 1990. Essentials of plant techniques. Scientific Publishers, Jodhpur.
4. Gasque, C.E. 1992. A manual of Laboratory Experiences in Cell Biology, Universal Book stall, New Delhi.
5. Holme, D.J and Hazel Peck. 1993. Analytical Biochemistry. John Wiley & Sons Inc. New York.
6. Kumar, N.C. 1993. An introduction to plant tissue and Cell culture. Emkay publications, Delhi.
7. Plummer, D.T. 1998. An introduction to Practical Biochemistry. Tata Mc Graw – Hill Publishing Company Limited, Delhi.
8. Sadasivam, S and A. Manikam. 1992. Biochemical methods. Wiley Eastern Ltd.
9. Sharma, V.K. 1991. Techniques in Microscopy and Cell Biology. Tata Mc Graw - Hill publishing Company Ltd., Delhi.
10. Wilson, K and John Walker. 2000. Principles and Techniques of practical Biochemistry, Cambridge University Press.

## Paper -2: Research Methodology-II

**UNIT – I:** Sampling and sampling theory. Type of sampling – RBD, CRD. - Frequency distribution – Central tendency, mean, mode, median. - Measurement of Dispersion – Deviation, Degree of freedom, confidence limit, standard error - Test for significance – ‘t’ test, one way and two way analysis of variance - Correlation – Types, methods of studying correlation. Co-efficient of determination and non determination, partial and multiple correlations - Regression Analysis – Regression line, partial and co-linear Regression – multiple regression.

**UNIT – II:** COMPUTER: Classification of Computers: - Input and output devices. Compiler, Assembler and Interpreter source and object programmes – Flow chart – software packages used for statistics. MS Word – MS Excel – MS Power point. Use of computers in preparation of graphs, chart, histogram. Bio informatics – Major search engines – Web browsing – Major web sites for journals and scientific information.

**UNIT – III:** General account of: Intellectual Property Rights – Patent, Trade mark, Copyright, Patent application – Notification, sanctioning, Indian Patent Act – TRIPS, Farmer’s Right, Status of WTO. Bio-safety – Regulations, Bioethics, Handling of recombinants in the Laboratory and field experiments. Laboratory safety – Handling of Glasswares, Acids – Alkalines, Poisons and Hazardous chemicals – First Aid.

**UNIT – IV:** General account of- Transgenics and their uses in human welfare. Environment and economics. Economic losses due to deforestation – pollution. Application of Biotechnology for Food, Agriculture, Medicine, Environment and Energy. Biodiversity – meaning – measurement – biodiversity loss – causes of loss – and their impact and conservation. Remote sensing techniques – application in environmental control – Agriculture – Forestry – Oceanography.

**UNIT – V:** SCIENTIFIC WRITING: Choosing the problem for research – Review of literature. Primary, secondary and tertiary sources. Bibliography – indexing and abstracting. Storage and retrieval of information – Reporting the results of research in conference – Oral presentation, poster presentation – written reports. Planning and preparing a thesis and scientific papers. Proof correction. Data bases – Agris – Agricola – Current contents – Biological abstracts.

### REFERENCE BOOKS

1. Rangasamy, R. 1995. A text book of Agricultural statistics. New age international, New Delhi.
2. Sundararaj et al., 1972. Design and analysis of field experiments. University of Agricultural sciences, Bangalore.
3. Ridgman, W.J. 1975. Experimentation in Biology. Blackie, London.
4. Sundara Rao and J. Richard. 1999. An introduction to Bio statistics. Prentice Hall of India Pvt. Ltd., New Delhi.
5. Krishnamoorthy, R. 1994. Computer programming and application. J.J. Publication, Madurai.
6. Nelson, S.L.1999. Office 2000. The complete reference – Tata Mc Graw – Hill publishing company Ltd, New Delhi.

7. Dienes, S.S. 1995. Microsoft office - professional. BPB Publication, New Delhi.
8. Hoffmar. 1996. The Internet - Instant Reference. BPB Publication, New Delhi.
9. Kumar, H.D. 1998. A text book of Biotechnonology. Affiliated East – West Press Pvt. Ltd., New Delhi.
10. Pushparagadan, P., K. Ravi and V. Santhosh. 1997. Conservation and Economic evaluation of Biodiversity – Vol I and II. Oxford and IBH Publishing Company, New Delhi.
11. Agarwal , K.C. 2000. Biodiversity. Agrobios, Jodhpur.
12. Dicastri, E and T. Youues. 1996. Biodiversity Science and Development. CAB International, Cambridge.
13. Pearce and Moran. 1994. The Economic value of Biodiversity. Earth scan publication Ltd., London.
14. Karpagam, M. 1999. Environmental Economics. Sterling Publishers Pvt., Ltd., New Delhi.
15. Day, R.A. 1994. How to write and publish a scientific paper. Cambridge University Press, London.
16. Connor and Peter wood ford. 1979. Writing scientific papers in English. Pitman Medical Publishing Company, London.

## **PAPER- 3: ADVANCES IN BOTANY**

### **Unit – I**

Applications of microbiology in agriculture, industry and medicine. Important crop diseases caused by viruses, bacteria, mycoplasma, fungi and nematodes. Modes of infection and dissemination; Molecular basis of infection and disease resistance/defence- Plant quarantine. Algae, Fungi, Lichens, Bryophytes, Pteridophytes and Gymnosperms - structure and reproduction from evolutionary viewpoint. Type of fossils and their study techniques.

### **Unit - II**

Taxonomic hierarchy; Numerical taxonomy and chemotaxonomy; Origin and evolution of angiosperms; Domestication and introduction of crop plants; Plants as sources for food, fodder, fibre, spices, beverages, edible oils, drugs, narcotics, insecticides, timber, gums, resins and dyes, latex, cellulose, starch and its products- Morphogenesis- Totipotency, polarity, symmetry and differentiation; Cell, tissue, organ and protoplast culture; Somatic hybrids and Cybrids; Micropropagation; Somaclonal variation and its applications.

### **Unit-III**

Prokaryotic and eukaryotic cells - structural and ultrastructural details; Molecular basis of cell cycle; Gene versus allele concepts (Pseudoalleles); Quantitative genetics and multiple factors; Sex chromosomes and sex-linked inheritance, sex determination and molecular basis of sex differentiation; Mutations (biochemical and molecular basis); Methods of plant breeding and use of apomixes in plant breeding; Genetic code and regulation of gene expression; DNA sequencing; Genetic engineering – methods of transfer of genes; Transgenic crops and biosafety aspects; Development and use of molecular markers in plant breeding.

### **Unit - IV**

Photosynthesis; photophosphorylation and carbon fixation pathways; Mechanism of phloem transport; Respiration electron transport chain and oxidative phosphorylation; Nitrogen fixation and nitrogen metabolism; Photoperiodism and flowering, vernalization, senescence; Stress physiology (heat, water, salinity, metal); Fruit and seed physiology; Dormancy, storage and germination of seed; Fruit ripening – its molecular basis and manipulation.

### **Unit - V**

Concept of ecosystem; Ecological factors; Concepts and dynamics of community; Plant succession; Concept of biosphere; Ecosystems; Conservation; Pollution and its control; Plant indicators; Environment (Protection) Act. Forest types of India - Ecological and economic importance of forests, afforestation, deforestation and social forestry; Endangered plants, endemism, IUCN categories, Red Data Books; Biodiversity and its conservation; Convention on Biological Diversity. Global warming

and climatic change; Invasive species; Environmental Impact Assessment; Phytogeographical regions of India.

**Books:**

1. Gilbert Smith. 1976. Cryptogamic Botany. Tata McGraw Hill Book Company Ltd, New Delhi.
2. Parihar, N.S. 2005. An introduction to Embryophyta – Pteridophytes – Central Book Depot, Allahabad.
3. Rashid A. 2007. An introduction to Pteridophyta – Vikas Publications, New Delhi.
4. Dubey, R.C. and D.K. Maheswari, 2007. A textbook of Microbiology, S. Chand & Company, New Delhi.
5. Singh. R.S. 2009. Plant Diseases. Oxford & IBH publishing Co. Pvt Ltd. New Delhi.
6. Kalyan Kumar D.E. 1992. Plant tissue culture, Agrobios, New Delhi.
7. Chaudhari, H.K. 1984. Elementary Principles of Plant Breeding. Oxford IBH. New Delhi.
8. Edmend W. Sinnott. 1960. Plant Morphogenesis. McGraw Hill Book Company, Inc-USA.
9. Gardner, Simmons, Snustad; 2006; Principles of Genetics; Wiley student edition.
10. Phillip Sheeler; Donald E. Bianchi 2004; Cell and Molecular biology; John Wiley & Sons.
11. Rastogi, S.C. 2004. Cell Biology. New age International Pub. New Delhi.
12. Naik, V.N. 2002. Taxonomy of Angiosperms, Tata McGraw Hill.
13. Stace, C.A, 1999. Plant Taxonomy and Biosystematics. Edward Arnold, London.
14. Subramaniam, N.S. 1995. Modern Plant Taxonomy. Vikas Publishing House, New Delhi.
15. Sambamurty A.V.S.S.; 2008; Molecular Biology; Narosa Publishers, New Delhi.
16. Ignachimuthu, S. 1997. Plant Biotechnology, Narosa Publishing House, New Delhi.
17. William G. Hopkins, 1999. Introduction to Plant Physiology, John Wiley and sons, INC, New York.
18. Monaj and Goze (2012) Plant Physiology, New Central agency, Calcutta , India.
19. Krishnamurthy, K.V. 2004. An advanced text book of Biodiversity. Oxford & IBH, New Delhi.
20. Odum, E.P. Gary W. Barrell, 2004. Fundamentals of Ecology – 15<sup>th</sup> edition, Thomson Asia Pvt., Ltd.,

# Ph.D - FIELD OF SPECIALIZATION

## PAPER – 4 (A): PLANT PHYSIOLOGY

**Unit: 1 Cell organelles and water relations:** Cell organelles and their physiological functions, structure and physiological function of cell wall, cell inclusions. Properties and functions of water in the cell, water relations- cell -water terminology, water potential of plant cells. Mechanism of water uptake by root. Transpiration - movement of water in plants, water loss from plants. Evapotranspiration. Transpiration – Driving force for transpiration. Stomata- Structure and function, Mechanism of stomatal movement, factors influencing transpiration rate, antitranspirants.

**Unit: 2 Metabolic Processes:** Photochemical process –Chloroplast and its structure, photochemical reactions, CO<sub>2</sub> reduction in Calvin cycle, Supplementary pathway of Carbon fixation in C<sub>4</sub> and CAM plants and its significance. Rubisco structure and regulations. Photorespiration and its significance, effect of environmental factors on photosynthetic rates. Translocation of photosynthates. Respiration- Glycolysis, Krebs's cycle, Electron Transport system.

**Unit: 3 Abiotic stress responses in Plants:** Definition, types and adaptive mechanisms in response to environmental stress. Physiological processes affected by drought. Drought resistant mechanism. Osmotic adjustment, Osmoprotectants, Stress proteins. Molecular responses to water deficit. Oxidative stress: Reactive Oxygen Species [ROS]. Role of scavenging systems [antioxidant enzymes]. Salinity: Salinity effect at cellular and whole plant level. Salt tolerance mechanisms in Glycophytes and Halophytes.

**Unit: 4 Plant growth regulators and Plant Development:** Classification–site of synthesis, biosynthetic pathways and metabolism and the influence on plant growth and development of individual group of hormones - auxins, gibberellins, abscisic acid, ethylene and Jasmonic acid. Hormonal regulation of gene expressions at various developmental stages of plant [flowering, seed maturity and seed dormancy]. Action of hormones on cellular functions and Synthetic growth regulators –Classification - their effect on plant growth and development. Practical utility in agriculture and horticulture. Herbicides, classification and their mode of action.

**Unit: 5 Mineral Nutrition and Post Harvest Physiology:** Importance of mineral nutrients in plant growth. Classification and essential criteria. General mechanisms- concept of apparent free space and nature of bio-membranes. Dual mechanism and other concept of ion uptake. Functions of Individual mineral elements. Senescence hormone Regulation, leaf senescence, Chloroplast degradation, Monocarpic and whole plant senescence. Physiological and biochemical changes during fruit ripening. Transgenic technology for improvement of Shelf-life of plant produce.

### References:

1. Thimann, K.V. 1980. The Senescence in Plants. CRC press Boca Raton Florida, USA
2. Moore, T.C.1989. Biochemistry and Physiology of Plant Hormones [2<sup>nd</sup> Edition]. Springer-Verlag, New York,USA
3. Salisbury,F.B. and Ross,C.W.1992. Plant Physiology [4<sup>th</sup> edition]. Wadsworth Publishing Co, California, USA



4. Seymour, G.B., Taylour, J.E., and Tucker, G.A.1993. Biochemistry of fruit ripening. Chapman and Hall, London, UK.
5. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley and Sons, Inc., New York, USA
6. Harold, A.2003. Response of plants to multiple stresses, Academic Press Inc. UK.
7. Heldt, H.W.2005, Plant Biochemistry, Academic Press, London.
8. Helgi Opik and Stephen Rolfe. 2005. The Physiology of Flowering plants. Cambridge University press., London.
9. Lincoln Taiz and Eduardo Zeiger, 2005. Plant Physiology, Sinauver Associates Inc. Publishers, Sunderland, Massachusetts.
10. Park.S.Nobel. 2005. Physicochemical and Environmental Plant Physiology. Elsevier Academic press, New York. Oxford.
11. Parohit,S.S. 2005.Plant Physiology. Student Edition:Jodhpur.
12. Verma,V.2007. Textbook of Plant Physiology. Ane Books India, New Delhi.
13. Shinha.R.K.2007. Modern Plant Physiology. Narosa publishing House, New Delhi.
14. Willey, N. 2007, Phytoremediation: Methods and Reviews, Humana Press, London.
15. Salisbury, F.B and Cleon Ross, 2007. Plant Physiology, Wadsworth publishing company, Belimont.
16. Jain,V.K. 2008. Fundamentals of Plant Physiology. S.Chand & Company Ltd., Ram nagar, New Delhi.
17. Hopkins W.G. and Huner. N.P.A.2009. Introduction to Plant Physiology 2<sup>nd</sup> Ed. John Wiley, New York, USA.

## Paper –4 (B): BIODIVERSITY, BIOSYSTEMATICS AND PALYNOLOGY

**Unit – I Biodiversity:** Concepts and components of biodiversity, genetic, species and ecosystem diversity; Biodiversity as an important resource, human population growth and its implications on biodiversity, biodiversity indices, value of biodiversity –Elements/ types of biodiversity – genetic, species (alpha, beta, gamma), Ecological diversity – Biodiversity hotspots in the world, National and Global red data lists, categories of species and their management, biodiversity prospecting.

**Unit- II Biodiversity Conservation:** Threats : Habitat loss and Fragmentation – Invasive species – Global change and species extinctions – endangered & endemic species of plants – Mangroves biodiversity: Ecological and physiological adaptation of mangroves – Biodiversity conservation – future strategies for India – *in situ* & *ex situ* conservation – Earth summit and follow up action, convention on biodiversity.

**Unit – III Biosystematics:** Systematic plant taxonomy and classification, hierarchies. Plant nomenclature, rules and regulations of IPN. Taxonomic evidence from morphology, anatomy, Palynology, cytology and phytochemistry. Numerical and Molecular taxonomy. Ethnobotany – subdisciplines and applications. Phytosociology and its importance. Computer taxonomy- Phylogeny-cladistics- ontology – building phylogenetic trees – distance matrix method – UPGMA – WPGMA- Maximum parsimony – Phylogenetic software.

**Unit – IV Biosystematics:** Herbarium preparation and methods. Micromorphology and External morphology of plants. Ethnobotanical research and floristic survey – mapping, collection, identification and documentation. Modern scientific approach – quantitative evidence, use value, cultural significance, utility. Doctrines of signature. Traditional botany and its role in human welfare. Sacred groves – documentation and its significances.

**Unit – V Palynology:** Fossils – Types and methods of fossilization, mega and micro fossils. Major fossil assemblages in India. Geological time scale. Dating of fossils. Concepts of organ and form genus, reconstruction. Palynology and its sub\_disciplines. Fossils – method of study, peel technique, maceration, acetolysis technique. Spore and Pollen aperture types, NPC classification, Pollen wall and sporopollenin, stratification and enumerations.

### Reference Books

- 1) Krishnamoorthy, K.V 2003. Text Book of Biodiversity, Science Publishers Inc, United States of America.
- 2) Wilson, E.O. and Frances M. Peter 1988. Biodiversity, National Academy Press, Washington.
- 3) Kelvin J Gaston and John I Spicer 2005. Biodiversity an Introduction, Blackwell publishing company, Australia.
- 4) Negi, S.S. 1993. Biodiversity and Conservation in India, Indus publishing, New Delhi.
- 5) Arnold, C. 1990. An Introduction to Palaeobotany, McGraw-Hill Book Company, London.
- 6) Cronquist, A. 1988. The Evolution of Classification of Flowering Plants (2<sup>nd</sup> Ed.) Allen press.
- 7) Davis, P.H. and Heywood, V.H. 1991. Principles of Taxonomy. Today and Tomorrows Publication, New Delhi.
- 8) Das, A.P and Pandey, A.K. 2007. Advances in Ethnobotany. Bishen Singh and Mahendra Pal Singh, Dehradun.
- 9) Davis, P.H. and Heywood, V.H. 1991. Principles of Taxonomy. Today and Tomorrows Publication, New Delhi.

- 10) Erdtman, G., 1992. Erdtman's handbook of Palynology. Verlag Munksgaard, Copenhagen.
- 11) Gurucharan Singh, 2007. Plant systematics: Theory and Practice. Oxford and IBH Publishing Co.Pvt. Ltd. New Delhi.
- 12) Jain, S.K. 1999. A Handbook of Ethnobotany. Bishen Singh Mahendra Pal Singh, Dehradun.
- 13) Jain, S.K. and Rao, R.R. 1997. Handbook of Field and Herbarium Methods. Today and Tomorrows Printers and Publishers), BSI , Calcutta.
- 14) Jone, T.P., and Rowe, N.P.1999. Fossil plants and spores-Modern techniques. The Geological Society, London.
- 15) Martin G. 1995. Ethnobotany - A Method Manual. Chapman and Hall, London.
- 16) Naik, V.N.1984. Taxonomy of Angiosperms. Tata McGraw-Hill Publishing Company Ltd. New Delhi.
- 17) Nayar, S.V. 1987. Fundamentals of Palaeobotany, Chapman and Hall, London.
- 18) Stewart, W.N. and Rothwell, G.W. 1999. Palaeobotany and the evolution of plants 2<sup>nd</sup> Ed. Cambridge University press, Cambridge.
- 19) Stussey, T.F. 2002. Plant Taxonomy: The Systematic Evolution of Comparative data. Bishen Singh and Mahendra Pal Singh, Dehradun.

## **Paper- 4 (C): CYTOGENETICS AND PLANT BREEDING**

### **Unit -I**

Chromosome: Structure and components, cell division- Events of cell divisions and Difference between Mitosis and Meiosis, Chromosome banding and chromosome painting, FISH characteristics of chromosome in different plant groups and sex chromosome differentiation in plants, Karyotype analysis.

### **Unit- II**

Principles, strategies and scope of Chromosome image Analysis System (CHIAS). Sex linked inheritance in Plants, Linkage and Crossing over, Chromosome Mapping, quantitative inheritance. Random Amplified Polymorphic DNA (RAPD) analysis. Arbitrarily primed Polymerase chain reaction (AP-PCR).

### **Unit -III**

Mutation in crop improvement: Spontaneous and induced mutations – structural changes of chromosomes – Molecular basis of gene mutation – Physical and chemical mutagens, Molecular mechanism of mutations, Point, frame shift and suppressor mutation. Gene regulatory mechanism – Insertional mutagenesis – Reverse mutation –Transposable elements.

### **Unit- IV**

DNA structure, Methods of breeding in self and cross pollination crops. Polyploidy in plant breeding: Types of changes in chromosome number – Application of Auto and Allopolyploidy in crop improvement – Origin and evolution of polyploidy – Recent advances in plant genetic engineering - Applications and limitations of mutation breeding.

### **Unit-V**

Principles of plant breeding, Methods of selection, Polyploidy in Plant breeding, Heterosis, Male Sterility and its application- Hybridization – Intergeneric and interspecific hybridization, viability and germination, Mutation breeding in crop improvement.

## **REFERENCES**

1. Sambamurty A.V.S.S. 2008. Molecular biology; Narosa Publishers, New Delhi.
2. Sharma,A.K. and A. Sharma, 1980. Chromosome techniques theory and practice. Oliver and Boyd, London.
3. Singh.B.D. 2001. Plant breeding, Principles and Methods. Kalyani Publication New Delhi.
4. Singh.B.D.2005.Genetics.Kalyani Publishers. New Delhi
5. Swanson, C.P.1972. Cytology and cytogenetics, McMillan, New York.
6. Vijendra Das, L.D.2005. Genetics and plant breeding. New Age International.
7. Gerald Karp.2010. Cell Biology. Wiley & sons.Inc
8. Robertis , E.D.P.DE. and Emf. De.Robertis.2011. Cell and Molecular Biology. Wolters Kluwer (India) pvt.ltd.

## **Paper -4 (D): PLANT BIOTECHNOLOGY**

### **Unit – I**

Biotechnology – Introduction, scope and importance. Vital roles of bio-technology in Microbial, Industrial, Agricultural, Medicinal and Environmental sectors. Role of Biotechnology in Agriculture, Medicine, industries – production of insulin, organic acids- Bioreactors.

### **Unit- II**

Tissue culture –Principles of tissue culture- Totipotency of plant cell, Micropropagation – shoot and root culture, explants, nutrient medium , establishing and maintenance of culture, hardening techniques.

Somatic embryogenesis, Protoplast culture, Somatic hybridization, Haploid culture, in vitro secondary metabolites production, synthetic seed production.

### **Unit – III**

Molecular Biology – Introduction, basic principles, scope and importance of molecular biology in gene structure, DNA replication, Transcription, Genetic code and translation and gene expression studies.

Molecular Biology: Fine structure of DNA – Replication of nuclear DNA – DNA polymerase – mechanism of replication- DNA repair- DNA recombination. Organellar DNA- DNA transcription – characters and functions of RNA – RNA processing – Transcriptions in Prokaryotes and Eukaryotes.

### **Unit – IV**

Protein synthesis – post translational modification of proteins – protein degradation – Bt genes – Recombinant DNA technology – vectors- DNA Bar coding – Introduction, basic principles, characteristic features of barcode, potential uses and advantage of bar coding. Conserved sites of genome, primer and primer designing, detailed protocol in barcode studies.

### **Unit – V**

Nanotechnology – Introduction, basic principles, scope and importance of nano-technology. Role of computer in nano-tech. Carbon nanotube, Nano DNA- tech, Biosynthesis – Metal nanoparticles, Microscopic measurement and characterization of nanoparticles. Therapeutic applications of nano particles.

### **Reference Books**

- 1) Chawla, H.S. 2000. Introduction to Biotechnology. Oxford & IBH publishing Co.Pvt.Ltd, New Delhi.
- 2) Jagdand, S.N.2001. Advances in Biotechnology. Himalaya publishing House, New Delhi.
- 3) Manipal Singh Shekhawant Vikrant. 2011. Plant Biotechnology –In vitro- principles, techniques and Applications. MJP, Chennai.
- 4) Walker, J.M and R.Rapley. 2003. Molecular Biology and Biotechnology, IV Edition, Panimalar publishing Corporations, Bangalore.
- 5) Watson.Baker Bell, Gana Levine Losick.2004. Molecular Biology of the gene. V.Edition, Pearson Education.
- 6) Paul Singleton. 2010. Dictionary of DNA and Genome Technology, Wiley Blackwell.
- 7) Ralph Rapley and Stuart Harbon.2001. Molecular Analysis and Genome Discovery. John wiley & sons Ltd, England.

- 8) Niemeyer, Cistf Mand Mirkia Chad A. 2004. Nano-biotechnology: Concepts, Applications and Perspectives. Wiley-VCH
- 9) Handbook of Nanostructure Biomaterials and their applications in Nanobiotechnology. Hari Singh Nawla.
- 10) Challa, SSR Kumar, Josef Hormes Carola Leuschover. 2005. Nanofabrication towards Biomedical Application, techniques, tools, applications and impart. Wiley –VCH.
- 11) Philip Sheelar, Donald E. Bianchi. 2004. Cell and Molecular Biology. John Wiley & sons. Inc, Singapore

## Paper- 4(E): ALGAL BIOTECHNOLOGY

### Unit-I

Classification of Algae by F.E. Fritsch and Modern Classification of Algae. Ecology – Diversity and distribution - Detailed studies and Salient features - Range of structure, Reproduction, Life history and evolutionary trends in Chlorophyceae, Phaeophyceae, Rhodophyceae and Cyanophyceae.

### Unit – II

Ecology of Freshwater, brackish water and Marine algae – Physical chemical parameter studies on freshwater and marine environment – Anatomical studies of green, brown, red and blue green algae – protein – Carbohydrate – lipids of seaweeds - Scanning and Transmission Electron microscopic studies of Green, Brown and Red and Blue green algae.

### Unit – III

Ultra structure of Brown and Red seaweeds – Cell wall, pit-connections, polysaccharides - Elemental composition – Histochemical with special reference inter and intra cellular inclusions – Enzymes -  $\alpha$  amylase,  $\beta$  amylase and starch phosphorylates – Growth hormones – Identification, Characterization, Purification, Processing and Packaging – Pharmaceutical, Cosmeceutical and Nutraceutical values and functional and Therapeutic aspects of Marine Bioactive compounds.

### Unit – IV

Culture of freshwater algae and different types of culture medium – Importance of nutrient composition – Cultivation of seaweed *in vitro* and *in vivo* condition - Protoplast isolation and regeneration - Algal herbarium preparation – Preservation technique – Importance of Herbarium – Detailed study of Sargassum, Turbanaria, Gelidium, Hypnea and Gracillaria species.

### Unit – V

Seaweed Products – Nanoparticles studies of Algae (Gold and Silver nanoparticles) – Industrial utilization of Spirulina – Chlorella – Isolation of Agar-agar- Alginate – Different types of Carrageenan (Kappa Carrageenan, Lambda Carrageenan and Iota Carrageenan). Waste water treatment using cyanobacteria – Role of algae in Sustainable aquaculture - Biosorption of seaweeds – Influence of petroleum oils on algae and cyanobacteria – Future prospects of algal research and utilization in India and Abroad.

### Reference:-

1. Amrik Singh Ahluwalia. 2003. Phycology, Principles, processes and Applications. Daya publishing house 481pp.
2. Ashok Pandey., DJ Lee; Yusuf chisti; Carlos Ricardo. 2013. Biofuels from algae. Amsterdam : Elsevier.
3. Chapman, V.J and D. J. Champan.1980. Seaweed and their uses, 3rd Edition, Chapman & Hall, New York, 63-85.
4. Christiaan Hoek. 1995. Algae - An Introduction to Phycology. Cambridge University Press, Science - 623 pp.
5. Cole, K.M. and Sheath, R.G. 1990. Biology of Red algae. Cambridge, Cambridge University press. 517 pp.
6. Fritsch F. E.1972. Structure and reproduction of Algae VI. I and II. Cambridge Univ. Press.
7. Kaur, I., 1997. Potentials and future prospects. In: structure, Ultrastructure and reproduction APH Publishing Corporation 306 pp.
8. Lobban, C.S. and Harrison, P.J. 1997. *Seaweed Ecology and Physiology*. Cambridge University Press.
9. Sarabhai, B.P and C. K. Arora. 1995. Textbook of Algae, Anmol Publications Pvt. Limited, - 368 pp.
10. Sambamurthy A. V. S.S. 2005. A Textbook of Algae. I.K. International Pvt. Ltd, New Delhi.
11. Sharma O.P, 2007; Textbook of Algae; Tata McGraw – Hill Publications Pvt., New Delhi.
12. Suresh Kumar. 2009. An Introduction to Algae; Campus Books International Publications – New Delhi.
13. Vijayaraghavan,M.R and Bela Bhatia. 1997. Studies in cryptogamic botany Red algae,

## **Paper- 4 (F): BIO PROSPECTING OF MEDICINAL AND AROMATIC PLANTS**

### **Unit – I:**

Medicinal and Aromatic Plants – Importance and Scope – Classification of medicinal plants – based on morphology of useful parts, habit, taxonomical , pharmacological , chemical and Ayurvedic formulations – Cultivation of medicinal and aromatic plants – Processing and utilization – Storage of crude drugs. Herbal Medicine – History of herbal medicine- Contribution of the Egyptians, Chinese, Greeks, Arabs and Indians -Different systems of herbal medicine: Ayurveda, Siddha and Unani.

### **Unit – II:**

Quality control for medicinal and aromatic plant materials: Microscopic and Macroscopic examination – Visual examination and odour – Histochemical detection of cell walls and contents. Drug Evaluation: Methods of drug evaluation: Organoleptic, Microscopic, Physical, Chemical and Biological evaluation. Chemical nature of drugs: Crude drugs – Preparation and preservation - Chemical nature and Methods of tests for Carbohydrates, Glycosides, Tannins, Volatile oils, Lipids, Resinous substances and Proteins. Secondary Metabolites - Classification , General characters, Chemical nature, Extraction and Estimation methods for Terpenoids – Phenolic compounds and Alkaloids - Separation, Identification and Characterization of the potential bioactive compounds using UV, FTIR, <sup>1</sup>H NMR, <sup>13</sup>C NMR, 2D NMR, GC-MS and XRD.

### **Unit – III:**

Identification of bacteria and fungi – Morphology, staining methods, Culture media and culture methods. Antimicrobial assays: Diffusion and dilution techniques – Various types of diffusion and dilution techniques, Merits and demerits and its application. General properties of Alcohols, Aldehyde, Glutaraldehyde, Halogens, Phenols, Gases, Surface active agents and Metallic salts ; Testing of disinfectants – merits and demerits – its applications ; Bioactive molecules – Antibacterial, Antifungal, Antiplasmodial, Larvicidal and Antiviral drugs – mode of its action.

### **Unit – IV:**

Antioxidant metabolism: Plant defense mechanism – Antioxidants – Reactive oxygen species – Enzymes and non enzymatic antioxidants –Role of antioxidants –Estimation of antioxidants – Ascorbic acid, alpha Tocopherol and antioxidant enzymes – Peroxidase, SOD and Catalase. Free radicals, types of free radicals, Production of free radicals, Lipid peroxidation process and antioxidants (Enzymic and Non-enzymic).Antioxidant Assay of Free radical Scavenging activity on DPPH, ABTS<sup>+</sup> assay, Ferric-reducing antioxidant power(FRAP) assay, Hydroxyl radical scavenging activity, Metal chelating activity.



## **Unit – V:**

Post-harvest technology in medicinal plants: scope and importance. Adulteration with reference to plant drugs, types of adulterants and methods of adulteration, Identification of adulterants. Biodiversity act and Intellectual Property Rights in the area of medicinal plants - Importance of herbal marketing -Future prospects and constraints of the herbal drug industry - Regulatory status of herbal medicine in India.

### **References:**

1. Farooqi, A.A. and B.S.Sreeramu, 2004. Cultivation of medicinal and aromatic crops. Revised edition, Universities Press (India) Private Limited, Hyderabad.
2. WHO, 2002. Quality control methods for medicinal plant materials, World Health Organization, Geneva, A.I.T.B.S., Publishers and Distributors, New Delhi.
3. Harbone, J.B. 1998. Phytochemical Methods; A guide to modern techniques of plant analysis. 3<sup>rd</sup>Edn., Springer (India) Private Limited , New Delhi.
4. Mc.Kane, L. and J. Kandel. 1996. Microbiology: Essential and Applications. 2<sup>nd</sup>Edn., McGraw – Hill, Inc, New Delhi.
5. Ananthanarayan, R. and C.K.J. Paniker. 1996. Text book of Microbiology. 5<sup>th</sup>Edn., Orient Longman Ltd., Chennai.
6. Halliwall, B. and J.M.Gutteridge. 1985. Free radicals in Biology and medicine. Oxford university press.
7. Roxanne Rutledge, C. 2008. Mosquitoes (Diptera: Culicidae). Encyclopedia of Entomology, Springer Science\* Business Media B. V. Berlin.
8. Tyagi, B.K. 2003. Medical Entomology: A Hand book of Medicinally important Insects and other Arthropods. Scientific Publishers (India), Jodhpur.

## Paper –4 (G): MICROBIOLOGY

### Unit I

**Identification of bacteria and fungi:** Classification, Morphology, staining methods, Culture media, culture methods. Microbial Physiology: Microbial growth, photosynthesis, respiration and fermentation.

**Antimicrobial assays:** Diffusion and dilution techniques – Various types of diffusion and dilution techniques, Merits and demerits and its application.

**Sterilisation:** Physical Agents, Chemical agents: Antiseptic – General properties; Disinfectants – General properties; Alcohols, Aldehydes, Glutaraldehyde, Halogens, Phenols, Gases– Merits and demerits and its application.

### Unit II

**Chemotherapy:** General features, Mechanism of antimicrobial activity. Antibiotics: general features, Sources, Classification, Bactericidal, Fungicidal, Bacteriostatic and Fungistatic based on mechanism of action and Mechanism of drug resistance.

### Unit III

**Vermicompost:** Introduction: organic farming, soil fertility -Distribution and Ecology of Earthworms - Earthworm taxonomy - Morphological and Anatomical characteristics of Earthworm - Food habits, excretion and life cycle. Types of Earthworms- Exotic and native species, used for vermi composting. Collection and maintenance of earthworms for vermicomposting and culturing techniques of earthworms. Different methods of Vermicomposting. Changes during vermicomposting, Nutrient value of vermicomposting and problems in vermicompost preparation.

### Unit IV

**Bioremediation-** Role of microbes in remediation, Microbial degradation of environmental pollutant, Bioremediation practices & Technologies, Molecular basis of bioremediation. *In situ* Bioremediation , *Ex situ* Bioremediation, Solid and Slurry –Phase bioremediation, Liquid – phase Bioremediation.

### Unit V:

**Biofertilizers:** Introduction – Historical development – Types of Biofertilizers – *Rhizobium*, *Azotobactors*, *Azospirillum*, Phosphate Solubilizers and Mycorrhiza – Importance of biofertilizers in integrated nutrient management – sources of biofertilizer - Isolation, Purification and preservation methods of bacteria and fungi –Screening of efficient strain- Production and Quality control of different biofertilizers – Storage, application methods of various fertilizers –economics of Biofertilizer application and plant response.

### Reference Book

1. Mc.Kane, L. and Kandel, J. 1996. Microbiology: Essential and Applications. 2<sup>nd</sup> Edn., McGraw – Hill, Inc, New Delhi.
2. Ananthanarayan, R. and Paniker, C.K.J.. 1996. Text book of Microbiology. 5<sup>th</sup> Edn., Orient Longman Ltd., Chennai.

3. Crawford,R.L and Don.L. Crawford 1996. Bioremediation principles and applications. Cambridge university press, New York.
4. Edwards, C.A., and Bohlen, P.J., 1996. Biology and Ecology of Earthworms, Chapman and Hall, London.
5. Ismail, S.A. 1997. Vermicology: The Biology Earth worm Orient Longman
6. Kale Radha, D. 1998. Earthworm: Cinderella of organic farming. Prism Books Pvt. Ltd., Bangalore.
7. Satchell,J.E. 1983. Earthworm ecology: From Darwin to Agriculture. Chapman and Hall, London
8. Stephenson. J. 1923. The fauna of British India -Oligo.
9. Black, J.G. 2005. Microbiology: Principles and Explorations, John Wiley, USA.
10. Prescott, M.J., Harley, J.P., and Klein, D.A. 2002. Microbiology. 5<sup>th</sup> Edition, WCB Mc GrawHill, New York.
11. Singh, T. Purohit, S.S. and Parihar, P. 2010. Soil Microbiology. Mrs. Saraswati Purohit, India.
12. Stuart Hogg.2013. Essential Microbiology. 2<sup>nd</sup> Edition. Wiley-Blackwell, USA.

## Paper – 4 (H): ENVIRONMENTAL BIOLOGY

**Unit – I Ecosystem:** Concepts of ecosystem – Food chain, Food web, ecological pyramids, trophic level, energy flow. Types of ecosystem: Aquatic ecosystem, terrestrial ecosystem. Autecology, Synecology. Biochemical cycles – Water, carbon, phosphorus and nitrogen cycles. Application of remote sensing in vegetation study.

**Unit – II Environmental Pollution :** Pollution – Definition, causes, effects, control measures of air, water, soil, radioactive and noise pollution. Impact of pollution on vegetation. Climate change, Acid rain, global warming – Ozone layer depletion – Deforestation. Floods, Volcanoes, Earthquake, Cyclone, Tsunami, Landslide – cause, effect and productive measures.

**Unit – III Heavy Metals and Industrial Effluents:** Industrial effluents as source of water pollution – Major effluent discharging industries. Primary, secondary and tertiary treatments to industrial effluents. Effluent toxicity in Agricultural crop plants. Types of heavy metals, Sources of heavy metals, Metal toxicity in crop plants.

**Unit – IV Phytoremediation:** Phytofiltration, phytoextraction, phytoimmobilization, phytostabilization, phytodegradation and rhizofiltration. Halophytes – Types – Tolerance mechanisms, role in reclamation studies – Hyperaccumulators. Advantages and disadvantages of phytoremediation, role of transgenic plants in phytoremediation.

**Unit – V Environmental law:** Common laws against pollution, the legislation relating to conservation and protection of forest, wild life and endangered, species, marine life, coastal ecosystem and lakes. Law relating to environmental protection – National environmental tribunal and national environmental appellate authority. Reliefs against smoke and noise pollution.

### References

1. Trivedy, R.K., P.K. Goel and C.L. Trisal. 1998. Practical methods in ecology and environmental science. Enviromedia Publication, Karad.
2. Augustine Selvaseelan, 2001. Course manual on bioremediation of polluted soil and water ecosystem. TNAU, Coimbatore.
3. Manivasagam. 1997. Industrial Effluents. First Edition. Sakthi publications. Coimbatore.
4. Prasad, MNV. 2004. Heavy metal stress in plants from biomolecules to ecosystem. Narosa Publishing House, New Delhi.
5. Pawl Robbins, John Hintz, Sash A.Moore. 2013. Environment and society. Wiley-Blackwell, USA.
6. Trivedi, P.C. 2008. Pollution and bioremediation, Aavishkar Publication, Jaipur.
7. Rajendran, P. Gunasekaran. 2007. Microbial Bioremeidation MJP Publication, Geneva.
8. Environmental Studies (A text book) Dr. N. Nandini, Dr. N. Sunitha, Mrs. Sucharita, Tandon Bangalore Sapna Oline [www.sapnaonline.com](http://www.sapnaonline.com).
9. Robert V. Percival, Christopher H.Schrooder, Alan S.Miller and James P. Leape. 2009. Environemntal regualtion, law, sceince and policy Aspen publishers.

## PAPER – 4 (I): ALLELOPATHY AND WEED SCIENCE

**UNIT-I: ALLELOPATHY:** Definition, terminology, brief history and pioneers of allelopathy, Allelopathic research in India and world. Significance of allelopathy in water, forest and crop field ecosystems. Allelochemicals- origin and nature of allelochemicals, occurrence- mode of allelochemical release- volatilization-leaching- root exudation. Mode of action of allelochemicals on plant growth and soil health- physico-chemical and biological properties of soil.

**UNIT-II: ALLELOPATHIC INTERACTIONS:** Allelopathy between plant communities, crop-crop interaction, crop-weed interaction, weed-weed interaction, crop rotation, phytotoxicity of mulches and cover crops, Allelochemical mediated mechanisms in plant growth. Tree allelopathy in agro forestry. Autotoxicity-Weed allelopathy on growth and productivity of crops and other plant species.

**UNIT-III: SECONDARY METABOLITES :** Types- sources-production pathway of secondary metabolites in plants - Alkaloids, flavonoids, terpenoids, saponins, phenols and tannins- their types and biological functions.

**UNIT-IV: WEED SCIENCE:** Introduction to weed science-Classification of weeds- grassy, broad leaf, aquatic, forest, crop field weeds and their distribution-population dynamics of weeds and their impacts on quantity and quality crop yield. Biology and bionomics of monocot and dicot crop field weeds of the country- Invasive alien weeds – characteristics and their impacts on natural and native flora.

**UNIT-V: WEED CONTROL:** Principles of weed control- traditional, biological, mechanical, chemical methods. Integrated weed management in crop fields. Herbicides-Selective and non-selective synthetic herbicides-mechanism and mode of action of herbicides. Bioherbicides from plant source- current researches on commercial bioherbicides- Application of vegetable oil and allelochemicals as herbicides.

### Reference Books:

1. Bonner, J. and Varner, J.E., 1965. Plant Biochemistry, Academic Press. London.
2. Das.T.K.2008.Weed science-Basics and Applications. Jain Bros., New Delhi.
3. Goodwin, T.W. and Mercer, E.I., 1972. Introduction to Plant Biochemistry, Pergaman Press.UK.
4. Hance, R. J., 1999.Weed Control Principles. Weimar, Texas.
5. Jean-Philippe Deguine, 2009. Crop Protection from Agrochemistry to Agroecology, Enfield Publishing & Distribution Co. Enfield, New Hampshire, USA.
6. Narwal,S.S. 2004,Allelopathy in Crop Production, Scientific Publishers (India) Jodhpur.
7. Rao.V.S. 2000, Principles of Weed Science, Enfield Publishing & Distribution Co. Enfield, New Hampshire, USA.
8. Rice, E.L. 1984. Allelopathy- 2<sup>nd</sup> Edition. Academic press, London.
9. Robert L.Zimdhal.2013.Fundamentals of Weed Science. Elsevier Pub. New York.
10. Street, H.E and W. Cockborn. 1972. Plant Metabolism, Cambridge University Press.
11. Taiz and Zeiger, 2002. Plant Physiology, Sinaur Associates, Sunderland, New York.