SEMESTER III Core IX – Biostatistics and Bioinformatics			
Code: 17	PBOC33 Hrs / week: 6 Hrs/Semester : 9	0 Credits: 5	
Objectiv	 es: To make them analyze the biological data. To introduce the students to the explorations of 	of advanced sciences.	
Unit I	Measures of central tendency: simple arithmetic me merits and demerits. Measures of dispersion: coefficient of variation and standard error.	an, median and mode - their range, standard deviation,	
Unit II	Probability: definition, types (Apriori probability rules (addition rule and multiplication rule). Theore and normal distribution. Test of significance - steps square analysis. Student's t test. ANOVA - assumpt (one way and two way).	y, Aposteriori probability), etical distributions: binomial s in tests of hypothesis. Chi- tion and analysis of variance	
Unit III	Correlation analysis: definition, types. Methods diagram, graphic method, Karl Pearson's coefficie correlation. Regression analysis: definition, typ equations.	of correlation- scatter plot ent of correlation and rank pes, regression lines and	
Unit IV	Bioinformatics: definition, scope. Biological databa NCBI, EMBL, Genbank and DDBJ. Protein databa Bioinformatics tools – BLAST, FASTA.	ases: Nucleotide databases – ases – PDB, SWISS PROT.	
Unit V	DNA sequence analysis: Global alignment, loc alignment, affine gap penalty alignment. Pairwise matrix. Dynamics programming methods - Sr Needleman -Wunsch algorithm. Scoring matrice Multiple sequence alignment – sum of pairs method	al alignment, gap penalty e sequence alignment – dot nith Waterman algorithm, es - PAM and BLOSUM. and progressive method.	
Books 1. 2.	for Reference: Attwood T.K and D. J. Pary Smith. 2006. Introduction, Ltd. Gurumani N. 2005. An Introduction to Biostatistics.	uction to Bioinformatics Pears . 2 nd edition. M.J.P. Publishe	
3. 4. 5.	Chennaı. Jin Xiong, 2006. Essential Bioinformatics. Cambridg Murthy C.S. V. 2004. Bioinformatics. 1 st edition. Him Palanisamy, S. and M. Manoharan, 1994. Statistical Palani paramount publishers.	e University Press. aalaya Publishing House. methods for biologists. II Editio	
6. 7. 8.	Rastogi, S.C., Namita Mendriata and Parag Rastog and applications. 4 th edition. PHI learning Pvt Ltd. Satguru Prasad, 2003. Fundamentals of Biostatistics. 4 Veera Bala Rastogi, 2009. Fundamentals of Biostatis Ltd. Chennai.	i, 2005. Bioinformatics metho 4 th edition. Emkay Publications atics. 2 nd e dition. Ane Books F	
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Practical Hrs / week:2

- Statistical analysis of leaves and fruits mean, median, mode and standard deviation.
- Graphic representation of data.
- Diagrammatic representation of data.
- Correlation coefficient between length and width of leaves.
- Problem related to chi-square test.
- Study of probability using coin toss.
- Test of significance (Student's t test).
- Practiclas
- Web browsing
- Retrieving data from biological database
- Bibliographic searching
- Sequence alignment and similarity searching
- Gene finding
- Protein prediction
- Biomolecular visualization

Submission - Record Note Book

	Seme	ster IV	
Core X – Plant Biotechnology			
Code: 17PBOC41	Hrs/week:6	Hrs/Semester : 90	Credits: 5

Objectives:

- To enumerate the role of 21st century science (biotechnology) in increasing productivity of crop plants and to enhance the production of high value metabolites.
- To develop skill to get employment in biotechnology laboratories and industries.
- **Unit I:** Biotechnology-scope. Principles of plant tissue culture: totipotency, differentiation, dedifferentiation, redifferntiation. Establishment of plant tissue culture lab: equipment, culture vessels, pretreatment of explants. Composition of various tissue culture media and their preparation. Establishing callus: dynamics of callus growth, factors influencing organogenesis, embryogenesis and somatic embryos.
- **Unit II:** Micropropagation: stages of micropropagation, factors affecting shoot multiplication, induction of roots. Synthetic seeds: methods of making synthetic seeds and applications. Production of virus free plants. Somoclonal variation: isolation and characterization of variants -molecular basis and induced mutations, applications and limitations. Cell suspension culture and production of secondary metabolites.
- **Unit III:** Production of haploids (anther, pollen and ovule), detection of haploids morphology and genetic markers, application of haploids. Protoplast isolation and culture. Protoplast fusion-techniques, selection of fused protoplasts, application. Uses of somatic hybrids and cybrids.
- Unit IV Molecular farming Nutritional quality and quality of seed protein. Immuno protective drugs. Gene therapy types of gene therapy, methods of gene therapy, production of antibodies and vaccines, monoclonal antibodies and its application. Biosafety definition, requirement, biosafety in relation to transgenic research. Intellectual property rights process of patenting, applications. Farmer's Rights and plant breeder's Rights.
- Unit V Biofertilizers: Mass production of *Rhizobium*, *Azospirillum* and Blue Green Algae (BGA), Vesicular Arbuscular Mycorrhizal Fungi (VAM). Single cell protein. Production of antibiotic (Penicillin), organic acid (Citric acid) and vitamin (Vitamin B₁₂). Outline of green synthesis of nanoparticles and their characterization.

Books for Reference:

- 1. Colin Rattledge and K. Bjon, 2001. Basic biotechnology. Cambridge University
- 2. Dubey, R.C. 2005. Textbook of Biotechnology. S. Chand & Co. New Delhi
- 3. George, E.F. and P.D. Sherrington, 1984. Plant propagation by tissue culture. Exegetic Ltd. London.
- 4. Gupta, P.K. 2000. Elements of Biotechnology. Rastogi publication, Meerut.
- 5. Kalyan Kumar De. 2004. An Introduction to Plant Tissue Culture. New Central Book Agency, Calcutta.
- 6. Kumar, H.D. 1993.Molecular biology and Biotechnology. Vikas publishers, New Delhi.
- Mahesh, 2008. Paddy molecular Biotechnology, New age international, publishers. (p) Limited.
- 8. Mukhopadhyay S.N, prabhakar Sharma, and Rabindra Narain, 2011. A text book of DNA recombinant technology. Wisdom press. New Delhi.
- 9. Ramavat, K. G., 2000. Plant Biotechnology, S. Chand & Co., New Delhi
- 10. Reinort, J and M.M. Yeoman, 1983. Plant cell and tissue culture. Narosa publishing house Delhi.
- 11. Satyanarayana U. 2006. Biotechnology. Books and Allied (P) Ltd. Kolkatta.
- 12. Singh, B.D.2005. Biotechnology- Expanding Horizons. Kalyani Publishers, New Delhi.

Practical

Hrs /week: 2

Practical

- Isolation of *Rhizobium*
- Synthesis of nanoparticles
- \bullet UV visible characterization of nanoparticles
- Preparation of synthetic seeds

Set up / pictures / photographs/ demonstration

- Apical meristem culture
- Cell suspension culture
- Protoplast Culture
- Anther Culture

Submission - Record Note Book

SEMESTER IV

Elective III– Horticulture and Nursery Management

Code:17PBOE41 Hrs/week:6 Hrs/Semester : 90 Credits : 4

Objectives:

- To learn the techniques and applications of horticulture.
- To motivate the students to get acquainted with nursery management
- **Unit I** : Horticulture definition, divisions and importance. Propagation of horticultural crops cuttage, layerage, graftage and budding. Seedage characteristics of good seed, and seed treatment for germination Transplanting of seedling.
- **Unit II** : Plant growing structures objectives and types green houses, hot beds, cold frames and conservatory. Establishment and cultivation of orchard. Gardening outdoor garden –types, principles, designing and garden components.
- **Unit III** : Indoor gardening. Terrarium, hanging basket and bonsai. Commercial gardening cut flowers and economic flowers. Kitchen gardening selection of site, lay out and choice of plants. Storage and preservation of fruits and vegetables.
- **Unit IV** : Nature and scope of nurseries- location and site selection, climate water and soil qualities. Growing media- types of containers, potting mixtures, soil preparation for filed grown plants, , improving soil quality, sanitation and sterilization techniques. Irrigation systemoverhead sprinkler, drip and pulse watering. Pest Managementphysical, biological and chemical control of diseases, Nutrient management- fertilizers, manures and growth hormones.
- **Unit V** : Management plans: Cost efficiency, business planning, work scheduling, labour availability. Marketing strategies: Modifying plant growth- plant uniformity, holding stock, stem sturdier, improving foliage colour, encourage flowering offseason. Selection of marketable plant, developing stock list, clearing surplus stock, surveying customer, terminology

- 1. Choudhri D and Amal Metha 2010. Flower crops cultivation and management Oxford book company . Jaipur
- 2. Edmund Senn Andrew Halfacre. 1977. Fundamentals of Horticulture. Tata Mc. Graw Hill.
- 3. Hartmann & Kester, 1989 Plant propagation. Prentice Hall of India Pvt. Ltd. New Delhi.
- 4. Mallikarjuna Reddy and Aparna rao 2010. Plant propagation in horticulture. Pacific book international. New Delhi.
- 5. Kumar, N. 1997. Introduction to Horticulture. Rajalakshmi Publications, Nagercoil, India.
- 6. Randahawa 1985. Floriculture in India. Allied publishers.
- 7. Utpal Banerji 2008. Horticulture Mangal Deep Publication. Jaipur

Semester III					
Core XII	Core XII Research Methodology				
19PBOC34Hrs/week:5Hrs/Semester :75Credits : 4					

Vision:

• To know the basic tools in research and to facilitate the students to undergo basic and application oriented research

Mission:

- To infuse the practical knowledge of using various instruments into the vast array of techniques in plant science.
- To motivate the students to do research.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	know and explain the importance of the internet in research and be able to use it for gathering their reference materials	1	Un
CO-2	acquainted with different tools and techniques essential for research work	6	Cr
CO-3	examine the basic framework of research process and able to learn how to address research problem and what is to be done to solve it.	8	An
CO-4	develop an understanding of the ethical dimensions of conducting applied research	7	An
CO-5	determine the appropriate quantitative methodologies to be used for the study	1	Ev
CO-6	understand a general concept of paradigms of research design.	7	Un
CO-7	familiarise with mixed methods of research.	6	Cr
CO-8	communicate the research findings to the scientific forums	6	Cr

Semester III				
Core XII	Core XII Research Methodology			
19PBOC34	Hrs/week:5	Hrs/Semester :75	Credits : 4	

Unit I

Microscopy - basic principles, components of compound microscope, phase contrast and fluorescent microscopes. Electron microscopy-principle, components, working mechanism and applications of TEM and SEM. Micro technique: fixatives, stains, dehydration and embedding – sectioning with rotary microtome and staining. Micrometry – principle and methods of measurement of plant cells.

Unit II

pH metry -principle, electrodes, measurement of pH. Spectroscopy- visible and ultraviolet spectrophotometers – Atomic absorption spectrophotometer (AAS). FTIR - principle, working mechanism and its applications. Centrifugations: working principle and applications of clinical centrifuge, high-speed centrifuge, ultra centrifuge and analytical centrifuge.

Unit III

Chromatography- types- adsorption and partition chromatography. Principle and applications of Thin layer chromatography, Gas liquid chromatography and High performance liquid chromatography Photomicrography - principle and methods.

Unit IV

Electrophoresis - basic principles, electrophoretic mobility, factors, isoelectric focusing, types - vertical and horizontal. Agarose and polyacrylamide gel electrophoresis, detection and recovery of electrophorogram. Gel documentation system. Tracer techniques - nature of radioactivity, patterns of radioactive decay, half life - detection, radiation measurement - Geiger Muller counter, Scintillation counter, Autoradiography and applications of isotopes in biology. X- ray crystallography.

Unit V

Choosing the problem for research, literature collection – Primary, secondary and tertiary sources, Bibliography, indexing and abstracting, Reporting the results of research in conferences – Oral and Poster presentation. Manuscript processing –thesis and journal format-preparation of full paper – reviews, bibliometrics, plagiarism

- 1. Anbalagan, K. 1985. *Electrophoresis*. Life Science Book house. Madurai.
- 2. Bryan C. Williams Keith Wilson, 1983. *A biologists guide to practical techniques of practical biochemistry* second edition. Edward Arnold publications.
- 3. Ghatak K. L., 2011, *Techniques and methods in Biology*, PHI Learning Private Ltd, New Delhi.

- 4. Guruamni. N, 2006, *Research Methodology for Biological Sciences*, MJP Publishers, Chennai
- 5. Gurumani N., 2010. *Scientific thesis writing and paper presentation*. MJP Publishers, Chennai
- 6. Jayaraman J., 1985. Laboratory manual in biochemistry, Wiley Eastern Ltd., New Delhi.
- 7. Johansen, M., 1940. Plant Microtechnique Mc. Graw Hill.
- 8. Kothari C.R., 2004. *Research Methodology* Methods and techniques New age International (P) Ltd., Publishers. New Delhi.
- 9. Plummer, D., 1987. An introduction to practical Biochemistry, Tata Mc. Graw Hill.
- 10 Ramadass P. and A. Wilson Aruni. 2009. *Research and writing across the disciplines,* MJP Publishers, Chennai
- 11 Rana S.V.S., 2012, *Biotechniques Theory And Practice*, Rastogi publications, New Delhi.
- 12 Subramanian, 2005. Biophysics principles and Techniques. MJP Publishers, Chennai.
- 13 Veerakumari, L., 2004. Biochemistry M.J.P. Publishers, Chennai.
- 14 Veerakumari, L., 2015. Bioinstrumentation, M.J.P. Publishers, Chennai.
- 15 Wilson, K. and J. Walker, 1997. *Practical biochemistry IV edition*, Cambridge university press.

Practical

Hrs/week: 2

- 1. Preparation of permanent slides using microtome
- 2. Measurement of plant cells using micrometer
- 3. Thin layer chromatographic separation of amino acids
- 4. Analysis of protein by PAGE
- 5. Analysis of DNA by AGE
- 6. Digital photographic display of anatomical samples/ microscopic samples
- 7. Demonstration-AAS and FTIR
- 8. Calculation of citation Index
- 9. Determination of Impact Factor of Author, Article and Journal.

Submission - Record Note Book

- Ruth L Willey, 1971. *Microtechnique: A Laboratory Guide*, The Mac Millan Company, NewYork
- Ponmurugan.P, B. Gangathara Prabhu. 2012. *Biotechniques*. MJP publishers. Chennai.
- Donald Alexander Johansen, 1940. *Plant Microtechnique*. New York; London, McGraw-Hill Book Company, Inc.

SEMESTER I				
Core III Microbiology and Plant pathology				
19PBOC13Hrs/week: 5Hrs/Semester : 75Credits: 4				

Vision:

• To provide information on the classification, growth and morphology of microbes and significance of Plant pathology

Mission:

- To study the growth characteristics of microorganisms enabling the learner to identify microorganisms by themselves.
- To understand the basic principles related to plant diseases.

Course Outcome

CO. No	Upon completion of this course, students will be able to:	PSO addressed	CL
CO-1	describe bacterial cell structure, microbial growth, metabolism		
	and the ways to control their growth by physical and chemical	1	Re
	means		
CO-2	differentiate gram positive and gram negative	4	An
CO-3	explain the microbial processes of replication, survival, and interaction with their environment.	3	Un
CO-4	evaluate the beneficial and harmful microbes in plants water, milk and food	4	Re
CO-5	use various microbiological techniques to isolate, characterize and identify bacterial colonies.	4	Ap
CO-6	understand the basic principles related to plant diseases	1	Un
CO-7	provide tools to design innovative, sustainable and tailored control methods to prevent plant diseases or to reduce their impacts	4	Cr
CO-8	understand the role of microorganisms in biotechnology, fermentation, medicine and other industries important to human well being	1	Un

SEMESTER I					
Core III Microbiology and Plant pathology					
19PBOC13Hrs/week: 5Hrs/Semester : 75Credits: 4					

Unit I

Classification of bacteria - Bergey's major groups. Early development of microbiologycontributions of Leeuwenhoek, Robert Koch and Louis Pasteur. Isolation, pure-culture, nutritional requirement, measurement of growth, continuous culture, synchronous culture. Cultural characteristics of bacteria. Ultra structure of bacteria. Antimicrobial components : mode of action of penicillin, gramicidin, streptomycin and sulfonamides

Unit II

Morphology and nature of virus particles, Purification and quantitative assay of plant viruses, Infection and replication with reference to Gemini virus, CaMV and bacteriophage. Antiviral chemotherapeutic agents. General account of mycoplasma and rickettsiales.

Unit III

Types of food spoilage. Methods of food preservation. Milk micro flora and their significance, water microflora and their significance. Micro flora of soil and their role in soil fertility and carbon sequestration, rhizosphere microflora and mycorrhiza.

Unit IV

Introduction: components of disease (disease pyramid), causes of disease, classification of diseases, stages in the development of disease (disease cycle), general symptoms of plant diseases caused by fungi, bacteria and viruses. Dissemination of plant pathogens, Integrated disease management

Unit V

Detailed study of the following: damping off of seedlings, Black stem rust of wheat, wilt of cotton, blight of potato (early and late), downy mildew of grapes, ergot of rye, tundu disease of Wheat and Yellow vein mosaic of bhindi.

- 1. Abbas A.K. and A.H. Lichtmann. 2003. *Cell and Molecular Immunology*. Saunders, Philadelphia.
- 2. Agrios, G.N., 1997. *Plant Pathology*, Academic Press, London.
- 3. Caldwell DR 2005. *Microbial Physiology and Metabolism* Wm.C.Brown publishers. Lnc.
- 4. Dubey, R.C and D.K Maheshwari, 2003. *A text book of microbiology*. S.Chand and company, New Delhi.
- 5. Kumar H D and Swati Kumar 2008, *Modern concepts of Microbiology*. Vikas Publications. New Delhi.
- 6. Mehrotra, R.S. & A. Agarwal, 2003. *Plant Pathology*. Tata McGraw Hill

Publishing Company, New Delhi.

- 7. Pelczar H. and R. Reid, 1998. *Microbiology* Concepts and Applications Tata Mc Grow Hill Publishing company P.Ltd. New Delhi.
- 8. Pelzar M J . ECS Chan and Noel R Krig. *Microbiology*, 2010 Tata Mc Grow Hill Puplishing company P.Ltd. New Delhi.
- 9. Prasad T V S., 2011 *Soil Microbiology*. Dominant Publishers and distributers. New Delhi
- 10. Prescott. L.M., J.P. Harley and D.A.Klein 2002. *Microbiology*. Mc Graw hill, New York.
- 11. Rangaswami, G. 1988. *Diseases of crop plants*. Prentice-Hall International, London.
- 12. Sharma, P.D. 2006. *Plant Pathology*. Narosa Publishing House Pvt. Ltd., New Delhi.

Practical

Hrs / week: 2

- A
- 1. Methods of sterilization, media preparation
- 2. Light microscopic observation of bacteria- wet mount, simple and differential staining– Gram's staining, Hanging drop technique to observe mobility
- 3. Study on production of acid and gas
- 4. Effect of temperature, pH, salinity, disinfectants, radiation on the growth of bacteria.
- 5. Milk bacteriology : Enumeration of bacteria found in milk- SPC method. Testing the quality of milk -Dye-reduction test (Resazurin and Methylene blue).
- 6. Bacterial analysis of water for coli forms MPN
- 7. Enumeration of soil bacteria by serial dilution technique (any three soil types).
- 8. Effect of antibiotics on the growth of bacteria. -Determination of MIC
- 9. Study of infected specimen prescribed in the syllabus

B

- 1. Record of brief life history of scientist related to microbiology
- 2. Drawing the electron microscopic structure of viruses- T_{4} , CaMV.
- 3. Drawing the electron microscopic structure of mycoplasma

Submission - Record Note Book

Books for Reference:

1. Lakshmanan M, Kunthala Jeyaraman, Jeyaraman and Gnanam, 1971. Laboratory experiments in microbiology and molecular biology, Higginbothams Pvt. Ltd.

Semester II				
Core V Horticulture, Plant breeding and Evolution				
19PBOC21Hrs/week:5Hrs/Semester : 75Credits : 4				

Vision:

• To promote, develop and disseminate horticultural and plant breeding technologies through the blend of traditional wisdom and modern scientific knowledge.

Mission :

- To understand the techniques and make significant contribution to an efficient and sustainable production of crops
- To understand the concept of plant breeding and evolution

Course Outcome

CO. No	Upon completion of this course, students will be able to	PSO	CL
		addressed	
CO-1	use the garden implements using in horticultural techniques	4	An
CO-2	identify good and healthy plants and seeds for propagation	4	Ap
	and develop skill in propagation of useful vegetable, fruit		
	and garden plants.		
CO-3	understand basic concepts of gardening and able to layout	4	Un
	different types of gardens and suggest plant choices		
CO-4	understand the use of modern technologies on raising	4, 7	Un
	horticultural plants for economic benefits and adapt		
	modern methods of irrigation system in order to conserve		
	water		
CO-5	equip knowledge on disease management, improved	7	An
	production, storage strategies and business practices.		
CO-6	describe various selection techniques and methods that can	6	Ap
	be used in genetic improvement of self and cross pollinated		
	crops		
CO-7	describe various molecular breeding technique and method	2	Ap
	that could be used for genetic improvements of crops		
CO-8	understand the genetic basis of evolution and evolutionary	1	Ap
	process		

Semester II				
Core V Horticulture, Plant breeding and Evolution				
19PBOC21Hrs/week:5Hrs/Semester : 75Credits : 4				

Unit I

Horticulture – definition, divisions and importance. Plant growing structures – objectives and types – green houses, hot beds, cold frames and conservatory - green house production system. Plant growth environment- Physical environment, Pest management- chemical and biological. Establishment and cultivation of orchard. Gardening - outdoor garden –types, principles, designing and garden components.

Unit II

Parameters associated with sexual propagation. Asexual reproducion - Natural, artificial methods. Seedage – characteristics of good seed, and seed treatment for germination – Transplanting of seedling. Propagation of horticultural crops – cuttage, layerage, graftage and budding.

Unit III

Indoor gardening - Purpose, plant choices, caring, potting media, disease and pest management of growing succulents, Terrarium, hanging basket. Bonsai -types and training of bonsai. Commercial gardening - cut flowers and economic flowers. Kitchen gardening – selection of site, lay out and choice of plants. Storage and preservation of fruits and vegetables.

Unit IV

Plant breeding: Nature and goals of plant breeding; Methods of Breeding self pollinated, cross pollinated and asexually propagated crops, pure line and mass selection. Plant transformation and genetically modified organisms in Agriculture: Role of *A.tumefaciens* in GMO development. Engineering of plasmids. Molecular marker and their role in plant breeding: RFLP's, AFLP's, SSR's and SNP's.

Unit V

Evolution: Introduction, Evolution and life, The genetic basis of evolution. Evolutionary process: Elemental forces, sources of variation, Role of natural selection and genetic Drift. Evolutionary Divergence: Races, species and isolating Mechanisms. The Origin of species Evolution above the species level.

- 1. AllardJohn, R.W. Principles of plant breeding Wiley & Sons, Inc.New York.
- 2. Chopra, V.L *Plant Breeding Theory and Practice*. Oxford and IBH Publishing Co. Pvt.Ltd. New Delhi.
- 3. Choudhri D and Amal Metha 2010. *Flower crops cultivation and management* Oxford book company. Jaipur
- 4. Edmund Senn Andrew Halfacre. 1977. Fundamentals of Horticulture. Tata Mc. Graw Hill.

- 5. Hartmann & Kester, 1989 *Plant propagation*. Prentice Hall of India Pvt. Ltd. New Delhi.
- 6. Kumar, N. 1997. Introduction to Horticulture. Rajalakshmi Publications, Nagercoil, India.
- 7. Mallikarjuna Reddy and Aparna rao 2010. *Plant propagation in horticulture*. Pacific book international. New Delhi.
- 8. Randahawa 1985. Floriculture in India. Allied publishers.
- 9. Sharma, J.R *Principles and practice of plant breeding* TataMcGraw-Hill Publishing Company Limited New Delhi.
- 10. Utpal Banerji 2008. Horticulture Mangal Deep Publication. Jaipur

Practical-Hrs / Week: 2 Horticulture:

- Knowledge of garden implements and tools Spade, Sprayer, Water can, Pruning scissor, Tiller, Digging fork, Pickaxe, Budding and Grafting Knife,
- Preparation of nursery and seed bed.
- Propagation -stem, leaf and root cutting.
- Propagation air layering, budding and grafting technique.
- Designing kitchen garden, Rockery, Hanging basket, terrarium
- Flower arrangement and vegetable carving
- Preparation of potting mixture for different types of garden
- Preparation of natural rooting hormones/ foliage boosters/flowering boosters.

Plant breeding:

- Emasculation, bagging and crossing methods.Demonstration Molecular breeding
- Submission Record Note Book

Books for Reference: Jean Taylor , 1973. *Practical flower arranging*, The Hamlyn Publishing group Ltd., NewYork

SEMESTER II				
Core VIII Biostatistics and Bioinformatics				
19PBOC24Hrs / week: 4Hrs/Semester : 60Credits: 4				

Vision:

- To familiarize in collection of data and analysis of data for scientific solution
- To apply advanced bioinformatics tools in the field of biology

Mission:

- To make them analyze the biological data.
- To introduce the students to the explorations of advanced sciences.

Course Outcome

CO.No.	Upon completion of this course, students will be able to	PSO Addressed	CL
CO-1	understand the fundamentals of statistics and statistical analysis	4	Un
CO-2	apply the learned procedure for collecting data, analyzing and representation of the same	4	Ap
CO-3	calculate the central tendency and dispersion in collected data	4	An
CO-4	do statistical analysis and communicate the results of statistical analyses accurately and effectively	6	Ap
CO-5	apply knowledge of the most important bioinformatics databases and able to identify what information they contain?	4	Re
CO-6	analyze concepts and approaches in bioinformatics and its application in various biological fields	4	An
CO-7	explain the major steps and principles for doing different types of sequence alignments	6	Ар
CO-8	demonstrate the use of bioinformatics tools in biological research	6	Ap

SEMESTER II					
Core X – Biostatistics and Bioinformatics					
Code: 19PBOC24Hrs / week: 4Hrs/Semester : 60Credits: 4					

Unit I

Biostatistics: Introduction, collection, classification and presentation of data. **Descriptive statistics:** Introduction. **Measures of central tendency**: Definition, Types (simple arithmetic mean, median and mode) - **Measures of dispersion**: standard deviation, coefficient of variation and standard error (merits and demerits).

Problems: raw data, discrete data, continuous data – direct method only

Unit II

Inferential Statistics: Introduction. **Test of significance:** Chi-square analysis (goodness of fit, test of independence, test of homogencity). Student's t test (estimation of population mean, matched pair data analysis, comparison of means of two small groups). ANOVA: (one way and two way).

Problems: chi-square, student t test, ANOVA

Unit III

Correlation: Definition. Relationship (mutual dependence, cause and effect relationship), types. Methods of correlation: scatter diagram, correlation graph, Karl Pearson's coefficient of correlation. **Regression**: definition, regression equations, properties of regression lines, difference between correlation and regression.

Problems: Karl Pearson's coefficient of correlation, regression coefficient.

Unit IV

Bioinformatics: definition, scope. **Biological databases:** Nucleotide databases – NCBI, EMBL, Genbank and DDBJ. Protein databases – PDB, SWISS PROT. **Bioinformatics tools** – BLAST, FASTA.

Unit V

DNA sequence analysis: Global alignment, local alignment, gap penalty alignment, affine gap penalty alignment. Pairwise sequence alignment – dot matrix. Scoring matrices - PAM and BLOSUM. Multiple sequence alignment – sum of pairs method and progressive method.

- 1. Attwood T.K and D. J. Pary Smith. 2006. Introduction to Bioinformatics Pearson Education, Ltd.
- 2. Gurumani N. 2005. An Introduction to Biostatistics. 2nd edition. M.J.P. Publishers, Chennai.
- 3. Jin Xiong, 2006. Essential Bioinformatics. Cambridge University Press.
- 4. Rastogi, S.C., Namita Mendriata and Parag Rastogi, 2005. *Bioinformatics methods and applications*. 4th edition. PHI learning Pvt Ltd.
- 5. Satguru Prasad, 2003. Fundamentals of Biostatistics. 4th edition. Emkay Publications.
- 6. Veera Bala Rastogi, 2009. *Fundamentals of Biostatistics*. 2nd e dition. Ane Books Pvt. Ltd. Chennai.

Practical

Hrs / week:2

Biostatistics using excel

- **Descriptive statistics:** mean, median, mode, standard deviation, standard error, confidence interval.
- Graphing data: scatter graphs, bar graphs, error bars, lines
- Association statistics: Pearson coefficient, linear regression
- Comparative statistics: paired and unpaired t-test, Mann-Whitney U-test ANOVA
- Frequency statistics: χ^2 test, χ^2 test of association

Bioinformatics

- Web browsing
- Retrieving data from biological database
- Bibliographic searching
- Sequence alignment and similarity searching
- Gene finding
- Protein prediction
- Structural Visualization of DNA, Proteins by using rcsb website.
- Submission Record Note Book

- 1. Palanisamy, S. and M. Manoharan, 1994. *Statistical methods for biologists*. II Edition. Palani paramount publishers.
- 2. Murthy C.S. V. 2004. *Bioinformatics*. 1st edition. Himalaya Publishing House.

SEMESTER-I					
Core IV	Core IV Histology, Embryology and Morphogenesis				
19PBOCI4Hrs/week:5Hrs/Semester : 75Credits :4					

- Vision: To have comprehensive idea on histology, reproductive biology and morphogenetic events in Angiosperms.
- **Mission:** This course is aimed at understanding the structure and functions of reproductive organs associated with seed development and the internal morphology of Angiosperms

Course Outcome

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	classify the shoot and root apical meristems	1,2	Ev
CO-2	explain the function and types of epidermal tissue systems	1,2	Ap
CO-3	Identify different types of cells through micro preparation and microscopic observation	4	An
CO-4	Give illustrious explanation and differentiate the primary and secondary structure of plant.	1,2	Un
CO-5	understand the mode of development of reproductive structures identify the different stages of dicot and monocot embryo	3,6	Ap
CO-6	explain the fertilization process including pollen pistil interaction and self incompatibility	1	Ev
CO-7	recognize different types of endosperm and their role in seed development	4	Re
CO-8	identify the different stages of dicot and monocot embryo	4	Ар

SEMESTER-I					
Core IV – Histology, Embryology and Morphogenesis					
Code:19PBOCI4Hrs/week:5Hrs/Semester : 75Credits :4					

Unit: I

Meristem- classification, shoot apical meristem and root apical meristem. Simple permanent tissues- parenchyma, collenchyma and sclerenchyma. Epidermal tissue system- Functions and types: Anomocytic, anisocytic, diacytic and paracytic. Trichomes - Stinging hairs, glandular hairs and peltate hair.

Unit: II

Complex permanent tissues- Components of xylem - Tracheids, Fibres, vessels, parenchyma. Wood anatomy: Xylem- Primary xylem, secondary xylem. tyloses-reaction wood, heart wood and sap wood, growth rings. Phloem- components, sieve elements, fibres, parenchyma. Cambium - origin, structure and function-seasonal activity of the cambium.

Unit: III

Secondary growth in dicot stem- *Polyalthia, Boerhaavia, Achyranthus, Antigonan,* dicot root - *Azadirachta.* Aerial root - *Tinospora* and *Vanda.* Dicot leaf - Dorsiventral and isobilateral leaf and monocot leaf.

Unit: IV

Microsporogenesis - Pollen wall, Pollen development Pollen storage, Pollen allergy,Megasporogenesis. Fertilization - barriers of fertilization. Endosperm - Types and haustoria. Organogenesis of dicot and monocot embryo. Apomixis and Polyembryony

Unit: V

Plant Morphogenesis - Definition – Polarity - as expressed in external and internal structures and in isolated cells. Symmetry - types. Differentiation as expressed in structure- effect of environment on differentiation - Factors controlling morphogenesis.

- 1. Bhojwani S S, S. P. Bhatnagar 2000. The Embryology of Angiosperms McGraw Hill
- 2. Catherine Easu, 1972, *Plant Anatomy*. 2nd Edition . Wiley Eastern Private ltd.
- 3. Chandurkar P. 1977. Plant Anatomy Oxford and IBH
- 4. Cutter, E.G. 1978. Plant Anatomy, Edward Arnold Publishers Ltd; London
- 5. Elezabeth G. Cutter, 1978- 2d ed., *Plant Anatomy*, Reading, Mass: Addison Wesley Pub.Co.
- 6. Fahn A. 1990. Plant Anatomy Pergamon Press
- 7. Maheshwari P 1971 An introduction to the Embryology of Angiosperms Tata McGraw Hill Publishing Co New Delhi
- 8. Pandey B P 1978 *Plant Anatomy* S Chand Co
- 9. Pandey S N A Chadha. 2009. Plant Anatomy and Embryology Sangam Books Ltd

Practical Hrs / week: 2 Anatomy

- Examination of different cells and tissue types
- Examination of Structural detail and identification of wood of some common Indian timbers (any four)
- Anomalous activity of cambium in *Polyalthia, Boerhaavia, Achyranthus, Antigonan,* dicot root -*Azadirachta*. Aerial root *Tinospora* and *Vanda*.
- Double staining technique to study the stem and root prescribed in the syllabus.
- Study of leaf anatomy.

Microsporogenesis

- Pollen germination and pollen tube growth.
- Dissection of dicot embryo (globular, cordate and mature stage).
- endosperm haustorium from suitable seed.

Submission - Record Note Book

- Lamesh Rao and K E S Juneja, 1971. *Field Identification of fifty important timbers of India*, The manager of publications.
- Dnyansagar V R, 1986. *Cytology and Genetics*, Tata McGraw Hill Publishing Company Ltd., New Delhi

Semester I					
Core III Bioinstrum	Core III Bioinstrumentation and Research Methods				
Course Code: 21PBOC13Hrs/week: 5Hrs/Semester: 75Credits: 4					

Objectives:

- To familiarize in collection of data and analysis of data for scientific solution
- To know the basic tools in research and to facilitate the students to undergo basic and application-oriented research
- To infuse the practical knowledge of using various scientific instruments to perform researchwork.
- To motivate the students to do research.
- To make them analyze the biological data.

Course Outcomes

CO.No	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	know microscope as the basic tool for biological research.	6	Ар
CO-2	acquaint with different tools and techniques essential for research work	6	Cr
CO-3	understand the fundamentals of statistics and statistical analysis	4	Un
CO-4	do statistical analysis and communicate the results of statistical analyses accurately and effectively	4	Ар
CO-5	know and explain the importance of internet in research and gather reference materials	6	Un
CO-6	examine the basic framework of research process and able to learn how to address research problem and what is to be done to solve it.	6	An
CO-7	communicate the research findings to the scientific forums	6	Cr
CO-8	develop an understanding of the ethical dimensions of conducting applied research	7	An

Semester I					
Core III	Core III Bioinstrumentation and Research Methods				
Course Code: 21PBOC13	Hrs/week: 5	Hrs/Semester: 75	Credits: 4		

- UNIT I: Microscopy: Principles, working mechanism and applications of Simple, Compound, Phase- Contrast microscopes, Electron microscopy (SEM).
 Principles and operations: pH meter, Electrical conductivity meters. Centrifugation: working principle and applications -differential and density gradient centrifugations; types: clinical/ low-speed, high speed, micro and analytical ultracentrifuges.
- UNIT II: Chromatography: Principles, working mechanism and applications- Paper, Thin Layer, HPTLC, Column, HPLC and GC-MS. Spectrophotometry: Principles, working mechanism and applications -UV- visible, AAS, FTIR, MALDI.
- UNIT III: Electrophoresis principles, electrophoretic mobility, factors affecting electrophoresis, isoelectric focusing, types vertical and horizontal. Agarose and polyacrylamide gel electrophoresis, detection and recovery of electrophorogram, gel documentation systems. Tracer techniques Autoradiography, XRD.
- UNIT IV: Biostatistics: Practice of statistical methods in biological research.
 Descriptive statistics: Measures of Central Tendency Mean, Median and Mode. Measures of Dispersion- Standard deviation, coefficient of variation and standard error. Simple correlation and linear regression analysis.
 Inferential Statistics: Tests of statistical significance Chi-square, t-tests and Analysis of Variance (ANOVA- one way &two-way).
- UNIT V: Types of research, scientific research: hypothesis, experimentation,theory. Preparation of Research Article – Layout of a Research Paper, review article, online publications, thesis writing, Citation, referencing and bibliography, editorial process and proof-reading symbols. Journals in Botany-predatory, peer-reviewed, online journal, SCI journals, Web of science journals. Impact factor of Journals, Ethical issues related to publishing. Citation, google scholar, i-10, H index. Plagiarism and Self- Plagiarism. Oral presentation of research papers in conference.

- 1. Guruamni N. Research Methodology for Biological Sciences, Chennai: MJP Publishers, 2006.
- 2. Gurumani N. Scientific thesis writing and paper presentation. Chennai: MJP Publishers, 2010.

- 3. Boyer R F. *Modern Experimental Biochemistry*. America: 3rd edn. Prentice HallPubl, 2000.
- 4. Kothari C.R. *Research Methodology Methods and techniques*, New Delhi: Newage International (P) Ltd., Publishers, 2004.
- 5. Veerakumari L. Bioinstrumentation, Chennai: M.J.P. Publishers, 2015.
- 6. Gurumani N. *An Introduction to Biostatistics*, Chennai: 2nd edition M.J.P.Publishers, 2005.
- 7. Satguru Prasad. *Fundamentals of Biostatistics*, New Delhi:4th edition EmkayPublications, 2003.
- 8. Veera Bala Rastogi. *Fundamentals of Biostatistics*, Chennai: 2nd edition AneBooks Pvt. Ltd., 2009.

Practical: Hrs/week: 2

- Preparation of Molar, Normal, ppm, percentage and buffer solutions.
- Thin layer chromatographic separation of amino acids
- Separation of protein by PAGE
- Separation of DNA by AGE
- Digital photographic display of anatomical samples/ microscopic samples.
- •Estimation of Na and K using flame photometer
- Demonstration-AAS, Fluorimeter and FTIR
- Data analysis with statistical package (SPSS& Excel) -

mean, median, mode, standard deviation, standard error student t-test, ANOVA

- Preparation of bibliography using reference tool (Zotero)
- Calculation of citation Index
- Determination of Impact Factor of Author, Article and Journal.

- Jayaraman J. Laboratory manual in biochemistry, New Delhi:Wiley EasternLtd., 1985.
- Palanisamy S and Manoharan M. Statistical methods for biologists, Palani: IIEdition Palani paramount publishers, 1994.
- Ponmurugan P and Gangathara Prabhu B. *Biotechniques*. Chennai: MJPpublishers, 2012.

SEMESTER – II					
Core VIII Genetics and Bioinformatics					
Course Code:21PBOC24 Hrs/Week: 4 Hrs/Sem: 60 Credits: 4					

Objectives:

- To develop an overall understanding on the concepts in genetics and their implications Gain skill on common Bioinformatics tools use in Biology
- To understand Mendel's and T. H. Morgan's theories, on inheritance and their applications
- To practice chromosome mapping, pedigree analysis and basic problems in population genetics
- To comprehend chromosomal aberrations and its implications
- To get trained on Bioinformatics tools used in DNA/RNA/protein sequence analysis
- To get trained on protein structure/visualization and phylogenetic software

Course Outcomes:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	C L
CO-1	predict the possible outcome in a parental cross of known genes	4	Ар
CO-2	associate the physical basis of heredity and the mode of inheritance of a character	2	Un
CO-3	predict the unknown phenotype and genotype in a partially known pedigree	4	Ар
CO-4	map a gene and measure the distance between two genes	4	Ар
CO-5	understand various chromosomal aberrations and various chromosome banding techniques	1,2	An, Un
CO-6	comprehend the operations in population genetics	2	Un
CO-7	predict gene of unknown sequences, similarity between sequences, protein structure, phylogenetic relationships between large groups using genomic data	1, 4	An, Ap
CO-8	learn barcoding techniques and sequence submission	1,2	An, Un

SEMESTER – II						
Core VIII	Core VIII Genetics and Bioinformatics					
Course Code: 21PBOC24	Course Code: 21PBOC24 Hrs/Week: 4 Hrs/Sem: 60 Credits: 4					

- **UNIT I:** A brief account on Mendelian Principles. Sex linked inheritance. Formulating and testing genetic hypotheses: Chi-square test and probability theory in genetics. Pedigree analysis. Genetic counselling. Chromosome basis of inheritance. Linked genes, recombination and crossovers: Classical experiments in *Drosophila*. Chromosome mapping: two point and three point test cross, gene order and distance calculation. Somatic tests to assigning genes to chromosomes. Genetic recombination and gene mapping in eukaryotes e.g. *Neurospora*.
- **UNIT II:** Chemical composition and packaging of eukaryotic chromosomes. Concept of gene. C-Value paradox, Cot-value and its significance. Chromosome structure in eukaryotes: Chemical composition of eukaryotic chromosomes, the three levels of DNA packaging, Ultra structure of centromere and telomere. Repeated nucleotide sequences, satellite DNA.Structural aberrations in chromosomes: Haploidy, Anueploidy, Polyploidy, and their types, cytological study and identification of autopolyploids and allopolyploids, Genetic consequences of ploidy alteration: Evolution of hexaploid wheat. Structural alteration in chromosome: Deletion, Duplication, Inversion & Translocation, hetrozygote. Chromosomal aberreation related syndromes. Chromosome banding: Q-band, G-band, R-band, C-band, *in situ* hybridization: GISH, FISH, Molecular maps.
- **UNIT III:** Population genetics: History, Gene frequencies and Genotype frequencies, Gene pool. Systems of Mating: Random mating and Hardy-Weinberg Principle, Application of Hardy-Weinberg principles: Test for Random mating, Test for sex-linked trait, Test for carrier gene frequency, Test for mode of inheritance, Test for multiple gene. Non-random mating, Positive non-random mating, Negative non random mating.
- UNIT IV: NCBI, DDBJ, EMBL. Submitting sequence: Sesquin. Sequence structure and mapping data bases. Comparing nucleotide and amino acid sequence: BLAST, Multiple sequence alignment: CLUSTALW, CLUSTAL omega. Protein databases: UniProtKB/Swiss-Prot, PIR, PDB, SCOP & CATH, ProDom, PFAM. Protein visualization tools: Swiss PDB Viewer, Pymol. Expasy proteomic tools: AA Compident and Peptide Mass. Motif andpatterns PROSITE, BLOCKS, CADD, Introduction to software: JPred, 3DPSSM, Modeller, ITASSER, Procheck.
- UNIT V: The terminology of phylogenetics- Trees, Root, branches, Node, Leaf, Clade; lineagesorting, orthology, paralogy, xenology; "basal" lineages, crown vs. stem groups, Phylogram vs. cladogram. Multiple sequence alignment & Tree building software ClustalW, Mega, Phylip, Phylodraw, Phyml, RaxML, Treeview.

Books for Reference

- 1. Benjamin Lewin, Genes VII. New Jersey: Pearson Prentice Hall, 2004.
- 2. David Preifelder. Molecular Biology. New Delhi : Narosa publishing House, 2006.
- Dnyansagar, V. R.. Cytology and Genetics. Tata Mc Graw Hill Publishing Company limited, 1986.
- 4. Robert H. Tamarin.. Principles of Genetics. New Delhi : Tata Mc. Graw Hill publishing company Ltd, 2006.
- Rastogi S., C., Mendiratta N., and Rastogi, P. *Bioinformatics: Methods And Applications:(Genomics, Proteomics and Drug Discovery).* New Delhi: PHI Learning Pvt. Ltd., 2013.
- 6. Sathyanarayana, U. Biotechnology. Kolkatha: Book and Allied (P). Ltd., 2006.
- 7. Singh B.D. Genetics. New Delhi: Kalyani Publishers, 2017.
- 8. Snustad D.P. and Simmons M. J. *Principles of Genetics*. New Jersey: Wiley Asia Student Edition. Wileyand Sons, Inc., 2012
- 9. Verma P.S. and Agarwal V.K. Genetics. New Delhi: S. Chand and Co., 1991
- 10. Vijendra Das L. D. *Genetics and plant breeding*. New Delhi: New age International (P) limited Publishers, 2005.

Practicals: Hrs/Week: 2

- Problems coming under Mendelian pattern of inheritance
- Problems using chi-square, probability theory and pedigree
- Countable slides for the metaphase anaphase spread to be prepared each for mitosis and meiosis, and submit at the end of the semester.
- Karyotyping
- Chromosome structural aberration Translocation in *Tradescantia spathacea* (Rhoeo)
- General genetic tests for genetic toxicity
- Test for gene mutations in bacteria –Bacterial reverse mutation Test
- Chromosomal aberrations due to the effect of mutagens EMS/2,4 D/acridine orange in *Allium cepa*
- Sequence analysis using BLAST
- Multiple sequence alignment using CLUSTAL W and CLUSTALX
- Protein structure prediction PDB, JPred, Modeller
- Create Phylogenetic tree using minimum three of the tools mentioned in the syllabus

- Bendre Kumar. A Text book of Practical Botany, Volume I & II (7th Edition). Merrut: RastogiPublications, 2014.
- 2. Proudlock R. *Genetic Toxicology Testing A Laboratory Manual*. USA: Academic Press, CA, 2016.

SEMESTER - III					
Core XII Ecology and Conservation Biology					
Course Code: 21PBOC34 Hrs / Week:5 Hrs / Semester: 75 Credits:4					

Objectives:

- To explore the natural capital asset, ecosystem services provided by the biodiversity and their biogeochemical intersection that shape the environment.
- To realize the current ecological threat associated with biodiversity and learn about global / national level action taken to address the issues of biodiversity.
- To understand the characteristics of community, community dynamics and development of community forest.

Course Outcomes:

	Unon completion of this course students will be	PSO	
CO. No	able to	address ed	CL
CO-1	reveal the range of plant diversity in terms of structure, function and their environmental relationships.	5	Un
CO-2	describe the climatic and edaphic factors and ecological succession	5	Un
CO-3	categorize the plants based on adaptation	3	An
CO-4	address the global environment crisis and the strategies applicable for environmental problem mitigation	7	Ev
CO-5	learn the global level environmental summit organized that focused for sustainable future	7	Cr
CO-6	know the importance of remote sensing in finding the current status of global health	7	Cr
CO-7	recognize the causes of environmental problems	7	Un
CO-8	manage and conserve the biological resources	7	Cr

SEMESTER - III Core XII Ecology and Conservation Biology Course Code: 21PBOC34 Hrs / Week:5 Hrs / Semester: 75 Credits:4

- UNIT I: Plant and the environment: climatic factors air, water and temperature;
 Edaphic factors types based on texture and colour. Components of soil- soil air, soil water, pH, mineral matter, organic matter, soil profile
 soil organisms reclamation of soil erosions and conservation. Biotic Factors, positive and negative interactions. Structure and function of major ecosystems terrestrial (Grassland, forest and desert) aquatic (pond).
- UNIT II: Population structure and dynamics: Basic concepts characteristics of population, size and density, dispersion, age structure, natality, mortality, biotic potential and life table. Population dynamics theory of population growth, Plant population dynamics, Regulation of population growth, Evolution among population and population interaction. Ecological succession Causes of succession, Kinds of succession and process of succession. Climax concept mono climax and poly climax theories. Adaptation of plants- hydrophytes and xerophytes
- UNIT III: Environmental Management Plan (EMP), ecological indicators. Bioremediation – *in situ* and *ex situ* bioremediation: Bioremediation of hydrocarbon, dyes, heavy metals and xenobiotics. Bio- augmentation – principles and use of enzymes. Bio-filtration – biofilters, microorganisms used and mechanism. Bioleaching - microorganisms used, leaching process, examples of bioleaching. Ecology in national affairs- carbon trading, carbon sequestration, blue carbon, climate conference, convention and summit.
- UNIT IV: Conservation of biodiversity *In situ* conservation National park, wild life sanctuaries and Biosphere reserve, afforestation, social forestry, agro forestry. *Ex situ* conservation field gene bank, seed bank, pollen bank, tissue culture, DNA bank and cryopreservation methods. Species based approaches, Social approaches- sacred groves and sthalaviriksha. Green movements Chipko movement and Silent valley movement.

UNIT V: Organizations associated with biodiversity management, IUCN, WWF, UNEP, NBPGR, ICAR, WHF. Biodiversity legislations – GATT, TRIPS, CITES, Wild life preservation Act (1972), Rio Summit – Agenda- 21, Convention on biological Diversity, Biodiversity, Act (2002). Role of indigenous people in conservation. Biopiracy, sustainable development and management of biodiversity.

Text Books:

- 1. Sharma, P.D. *Elements of ecology*. Meerut: Rastogi Publications. 1999.
- 2. Shukla, R.S. and Chandal, S.S. *Plant Ecology*. New Delhi: S. Chandal and Co.1991.

Books for Reference:

- Asthana and Meera Asthana. *Environmental problems and solutions*. New Delhi: S.Chand and Co. Ltd., 2001.
- Balasubramania, D., Bryee C.F., Dharmalingam, K., Green J. and Jeyaraman K. *Concepts in Biotechnology*. Universities Press.2005.
- Dash M. C. *Fundamentals of ecology*. New Delhi: Tata McGraw Hill publishing Co. Ltd.2001.
- 4. Murugesan, A.G. and Rajakumari *Environmental Science and Biotechnology, theory and Techniques.* Chennai: M.J.P. Publishers, 2005.
- 5. Sharma, P.D. *Elements of ecology*. Meerut: Rastogi Publications. 1999.
- 6. Trivedi P.R, Sharma, P.L. and Sundarshan, K. N..*Natural environment and Constitution of India*. New Delhi: Efficient offset printers. 1994.
- 7. Tyller Miller G. *Environment Science*. Singapore: Thompson Brooks / Cole. 2004.
- 8. Varshney C. K. Water pollution and management. Noida: S.P. Printers. 1989.

Practical Hrs/week: 2

- Determination of soil pH (at least 3 types of soil)
- Determination of soil texture.
- Determination of soil moisture.
- Determination of soil bulk density.
- Determination of soil porosity.
- Determination of soil organic matter content.

- Estimation of calcium.
- Estimation of magnesium.
- Estimation of sodium.
- Estimation of potassium.
- Estimation of nitrogen.
- Adaptation of plants- hydrophytes, xerophytes and halophytes,
- India map showing grass land, forest and desert.
- India map showing hotspots
- India map showing Biosphere reserves.
- Endangered / Endemic plants lists and photos (any2).

Scientific visits: Visit to any nearby place to observe the ecosystem their communities and their succession.

Submission - Record note book.

Book for Reference:

1. Murugesan A.G. and Rajakumari *Environmental Science and Biotechnology Theory and Techniques.* Chennai: MJP Publishers.2005.

SEMESTER IV				
Core XIV Horticulture and Seed Technology				
Course Code: 21PBOC42 Hrs/week:4 Hrs/Semester: 60 Credits: 4				

Objectives:

- To promote, develop, disseminate horticultural and strengthen in the field of seed science & technology.
- To understand the techniques and make significant contribution to an efficient and sustainable production of crops.
- To understand the importance of seed certification and seed testing.

Course Outcomes:

CO. No	Upon completion of this course, students will be able to	PSO address ed	CL
CO-1	understand the scope and potential of horticulture	4	Un
	product in India and Tamil Nadu		
CO-2	classify the horticulture plants based on soil and climate	4	Ар
CO-3	Illustrate different systems of planting in orchard and suggest plant choices	4	Ap
CO-4	demonstrate the methods and types of pruning and explain the basics of soil science and justify the role of soil as a medium for plant growth	4, 7	Un
CO-5	explain about integrated nutrient management and demonstrate the skills of soil testing	7	An
CO-6	identify the diseases and pest of crops and their management	6	Ap
CO-7	acquire skills & handling operations of different equipment's inseed science laboratory	2	Ap
CO-8	learn the techniques of seed processing for quality up gradation and of storage for maintenance of seed quality.	1	Un

SEMESTER IV Core XIV Horticulture and Seed Technology Course Code: 21PBOC42 Hrs/week:4 Hrs/Semester : 60 Credits : 4

- UNIT I: Introduction to Horticulture definition, special features of horticulture, divisions of horticulture, importance of horticulture. Plant growing structure Hot beds, cold frames, green houses. Nutrition of horticulture plants, irrigation of horticulture plants.
- UNIT II: Pomology: Definition, establishment of orchard: location and site, preliminary operation, planning of an orchard, laying out of the orchard, planting distance, planting season, planting method and transplantation. Training, pruning, cropping, harvesting, handling, storage and preservation of fruits.
- **UNIT III:** Olericulture: Definition, Climate and soil requirement, spacing, water and weed management, nutrient requirement and management, training system for vegetables, harvest and yield of important vegetablecrops tomato, brinjal, chilly, Bhendi, cluster beans, dolichous bean, onion, cucumber, bitter guard. Storage and preservation of vegetable.
- UNIT IV: Seed technology: definition, importance, principles of seed production.
 Foundation and certified seed production of varieties and hybrids.
 Principles of GM crop and organic seed production. Seed storage principles- factors affecting seed longevity during storage Seed treatments and packaging materials measures for pest and disease control during storage and godown sanitation. Post-harvest handling of seeds threshing methods drying methods of seed drying Seed processing seed cleaning and grading Processing equipment -cleaner cum grader -Upgrading equipment specific gravity separator, colour sorter, indented cylinder separator, spiral separator, magnetic separator, needle separator working principles Seed quality enhancement techniques importance seed fortification, seed priming, seed coating, seed pelleting.
- **UNIT V:** Seed Quality and seed testing: Seed certification phases of certification, procedure for seed certification, field inspection, field counts, field and seed standards. Post-harvest inspection processing,

bagging and tagging. Seed testing: seed viability and longevity, pre and post-harvest factors affecting seed viability. Seed ageing – physiology of seed deterioration liquid peroxidation seed viability. Seed vigourand its concept, vigour test method. Factors affecting seed vigour.Physiological and basis of seed vigour in relation to crop performance and yield.

Books for Reference:

- 1. Allard John, R.W. *Principles of plant breeding New York:* Wiley & Sons, Inc. 1960.
- 2. Chopra, V.L *Plant Breeding Theory and Practice*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd., 2000
- 3. Choudhri D and Amal Metha *Flower crops cultivation and management*. Jaipur: Oxford Book Company, 2010.
- 4. Edmund Senn Andrew Halfacre. *Fundamentals of Horticulture*. Tata Mc. Graw Hill, 1977.
- 5. Hartmann & Kester, *Plant propagation*. New Delhi: Prentice Hall of India Pvt. Ltd., 1989.
- 6. Mallikarjuna Reddy and Aparna Rao *Plant propagation in horticulture*.New Delhi: Pacific book international. 2010
- 7. Randahawa Floriculture in India. Allied publishers, 1985.
- 8. Utpal Banerji Horticulture. Jaipur: Mangal Deep Publication, 2008.
- 9. Agarwal, R.C. Seed Technology. New Delhi: Oxford and IBH Publishing Co., 1996.

Practicals:

Hrs / Week: 2

- Knowledge of garden implements and tools Spade, Sprayer, Water can, Pruning scissor, Tiller, Digging fork, Pickaxe, Budding and Grafting Knife,
- Preparation of nursery and seed bed.
- Propagation stem, leaf and root cutting.
- Propagation air layering, budding and grafting technique.
- Designing kitchen garden, Rockery, Hanging basket, terrarium
- Seed sampling and testing: Physical purity, germination, viability, etc.
- Seed and seedling vigour test.

Laboratory Manual for Reference:

- 1. Horticulture Science lab manual. Dr. Chiwan W. Lee. Department of Plant Science, North Dakota State University
- 2. A Practical Manual of Seed Science and Technology Volume-1. Dr.Satya Prakash Gupta.

SEMESTER – IV				
Core Elective Nanobiotechnology				
Course Code: 21PBOE42	Hrs/Week: 4	Hrs/Semester: 60	Credits: 4	

Objectives:

- To provide a broad overview of fundamental principles and current research directions and future scope in nanoscience and nanotechnology.
- To familiarise in synthesis, detection and characterization of nano particle using modern tools.
- To apply nanotechnology for developing new products for various industries (good/ agriculture/ health/ cosmetics)

Course Outcomes:

	Upon completion of this course,	PSO's	CL
CO.No.	students will be able to	Addressed	•
CO-1	understand the fundamental principles of	1	Un
	nanotechnology and types of nano particle		
CO-2	apply engineering and physics concepts to	2	Cr
	the nano-scale and non-continuum domain.		
CO-3	understand the wide range of applications of	1	Re
	nanotechnology and its interdisciplinary		
	aspect		
CO-4	apply and transfer interdisciplinary systems	3	Re
	ngineering approaches to the field of bio-		
	and nanotechnology projects		
CO-5	practice and explain state-of-the-art	4	An
	characterization methods for nanomaterials,		
	understanding and critiquing nanomaterial		
	safety and handling methods required during		
	characterization		
CO-6	correlate the impact of nanotechnology and	6	En
	nanoscience in a global, economic,		
	environmental, and societal context.		
CO-7	gain a knowledge in nanotechnology	4	An
	techniques (synthesis, fabrication,		
	characterization) and its applications in the		
	various field like engineering, biomedicine		
	and agricultural/environmental issues		
CO-8	identify career paths at the interface of	6, 7	An
	nanotechnology, biology, environmental		
	and agricultural engineering and medicine		

SEMESTER – IV			
Core Elective Nanobiotechnology			
Course Code: 21PBOE42	Hrs/Week:4	Hrs/Semester: 60	Credits: 4

UNIT I: Nanoparticles – definition and historical background of nanotechnology. Principles: quantization effects - inverse relationship between size and reactive surface area. Properties: surface effects, the effects of size, shape, surface and bulk composition, and solubility and persistence. Types of nanoparticles: liposomes, albumin-bound, polymeric iron oxide, quantum dot and gold.

- **UNIT II**: Physical, chemical and biogenic synthesis of nanomaterials biomimetics, green plants, and microorganisms. Role of biomolecules reducing and/or capping agents: proteins, viruses and carbohydrates.
- **UNIT III:** Detection and measurement of nanoparticles physicalcharacterization by UV, FTIR, SEM, FESEM, DLS, X-ray diffraction and Zeta potential.
- **UNIT IV:** Targeted nanoparticles: active & passive targeting. Application: medicine, manufacturing & materials, delivery vehicles, cancer therapy, tissue engineering, fluorescent biological labels, biological assays, imaging agents and biosensors.
- **UNIT V:** Interactions between nanoparticles and living systems, interaction with cells, exposure of living systems to nanomaterials toxicityeffects. Factors influencing the interaction of nanomaterials over mammalian cells: uptake, transport and biodistribution of nanoparticles in living system, toxicity on cellular processes.

- 1. Pradeep Kumar Srivastava, *Nanotechnology, The Hidden potential of science*. New Delhi: MPS Publisher & Distributors, 2008.
- 2. Shanmugam S. *Nanotechnolgy*, www.MJP publishers.com, 2010.
- 3. Barbara Panessa-Warren. Understanding cell-nanoparticle interactions making Nanoparticles more biocompatible. Upton: Brookhaven National Laboratory, 2006.
- 4. Bhushan Bharat (Ed.) Encyclopedia of Nanotechnology, Springer, 2012.
- 5. Chand A., Mirkin, Christof Niemeyer. *Nanobiotechnology II: more concept and applications*. New Jersey: Wiley-VCH Publisher, First edition, 2007.

- 6. Jain K.K. Nanobiotechnology molecular diagnostics: Current techniques and application (Horizon Bioscience). United Kingdom: Taylor & Francis, First edition, 2006.
- 7. Johan Ach, Ludwig Siep. *Nano–Bio–Ethics: Ethical dimension of nanobiotechnology*. New York City: lit ver leg publication, First edition, 2007.
- 8. Jain, K. K. Handbook of Nanomedicine, New York: Springer, 2012.
- 9. Kelsall Robert W., Ian Hamley, Mark Geoghegan. *Nanoscale Science and Technology*, New Jersey: Wiley Eastern, 2004.
- 10. Mark Ratner and Daniel Ratner. *Nanotechnology: A gentle introduction tothe next big idea*. New York: Pearson Education Publishers, 2002.
- Michael Kohler, Wolfgang, Fritzsche. Nanotechnology: Introduction to Nanostructuring Techniques. New Jersey: Wiley publishers, 2004.
- 12. Sharon, M. & Sharon, M. Bio-Nanotechnology- Concepts and Applications. Florida: CRC Press, 2012.
- 13. Volker Mailander and Katharina Landfester. *Interaction of nanoparticleswith cells. Biomacromolecules.* Washington: ACS Publication, 2009.
- 14. Yao N. and Zhong Ling Wang. *Hand book of microscopy for nanotechnology*. Amsterdam: kluwer academic publishers, 2005.

Online Resources:

http://ieet.org/index.php/IEET/more/bionanotechnology20141007 Institute ofEthics & Emerging Technologies https://phys.org/news/2014-10-endless-possibilities-bio-nanotechnology.html http://www.particle-works.com/applications/controlled-drug-release/Application https://jnanobiotechnology.biomedcentral.com/articles/10.1186/1477-3155-2-3 DOI: 10.1186/1477-3155-2-3

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3865110/ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC419715/