SEMESTER IV					
Common core I – Marine Biology					
Code: 17PBCC41	Hrs/week:6	Hrs/Semester : 90	Credits: 5		

Objectives

- To make the students realize the potentiality of marine environment
- To understand the marine ecosystem threats and conservation
 - Unit I Marine Environment Zonation and Biota
 Sea as a biological environment. Classification of marine environment.Plankton classification (size, life, habitat) and adaptations. Inter-tidal, rocky, sandy and muddy shores –features of the flora, fauna and adaptations. Role of marine micro-organisms (bacteria and fungi) in nutrient cycles (nitrate, phosphate and sulphate)

Unit II Characteristics of Sea Water

Physical properties: waves, tides, currents- types, causes, and their impact on marine organisms. Illumination, temperature, pressure. Chemical properties: nutrients, (major, minor, and trace elements), salinity, pH, density, dissolved gases (oxygen, carbon-di-oxide).

Unit III Marine Ecosystems

Estuaries, salt marshes, mangroves. Coral reef - ecology and types, species interaction, adaptations and importance. Threats and conservation of coastal ecosystems (coral reef and mangroves)

Unit I V Marine Pollution

Sources, effects and control measures of heavy metal, radioactive, oil, and thermal pollutions. Algal blooms-sources and effects. Microbial indicators of pollution. Role of microbes in pollution abatement.

Unit V Wealth of the sea

Living resources: Fishery products- fish meal and fish oil. Natural pearls: formation, ornamental and medicinal importance. Non-living resources: mineral wealth (manganese nodules, beach placers, glauconite and garnet). Bioactive compounds from marine organisms (bacteria, fungi and macro algae and sponges). Phycocolloids, agar-agar and algin.

Books for Reference

- 1. Tait, R.V. and Dipper F.A (1998) Elements of marine ecology.-4thed. British Library Cataloguing in Publication Data.
- 2. Gross, G., 1993.Oceanography: A view of the Earth. Sixth edition. Prentice Hall Inc., New Jersey.
- 3. McCormick, J.M. and J.V.Thiruvathaakal, 1976. Elements of Oceanography. W.B. Saunders Company, Philadelphia.
- 4 .Nybakken, J.W. 1997. Marine Biology An Ecological Approach. Addison Weslay Longman, Inc. California, 477pp.
- 5. Olivia J.Fernando 1999.Sea water-Properties and dynamics, Dhanesh Publications, Ponnagam, Thanjavur
- 6. Russel 1970. Marine Ecology, Academic Press- London and New York
- 7. Nelson and Smith 1973, Oil pollution and Marine Ecology-Plenum press
- 8. Benjamin- Cummings, Menlo Park, California.Vijaya Ramesh, K. (2004). Environmental Microbiology.MJP Publishers Chennai.
- 9. MoshrafuddinAhamed and Basumatary. S.K.(2006). Applied Microbiology. MJP Publishers Chennai

10.Daws, C.J.1981. Marine Botany John Wiley and Sons, New York.

PRACTICALS

Hrs / Week : 2

- 1.Determination of acidity
- 2 Determination of salinity
- 3 Determination of alkalinity
- 4 Determination of total hardness
- 5. Determination of nitrite
- 6. Determination of phosphate
- 7 .Biochemical test for micro-organisms-IMViC
- 8. Collection and identification of marine plankton (any three phyto and zooplanktons)
- 9. Identification and remarks of the following
 - i. Plankton net
 - ii Inter-tidal organisms
 - a. Rocky shore :Sea anemone, *Chiton*
 - b. Muddy shore: Uca, Cerithidia
 - c. Sandy shore: *Arenicola, Murex*
 - ii.Food fishes: Cybium,Sardinella
 - iii Sea weeds: Gracilaria, Sargassum,

10. Submission: Record Note Book

SEMESTER III					
Core VII – Plant Physiology					
Code: 17PBOC31 Hrs/week:6 Hrs/Semester : 90 Credits: 5					

Objectives:

- To facilitate the study of integrated activities in plants.
- To evaluate the stress related mechanisms of plants.
- Unit I Water relations of plants components of water potentials and their relation. Ascent of sap theories. Translocation source sink relationship. Transpiration stomatal movement, antitranspirants. Inorganic nutrient ion uptake passive and active uptake and transport. Mineral nutrition and hydroponics.
- **Unit II** Photosynthesis recent concepts of thylakoid membrane electron transport, redox system of chloroplast, photophosphorylation cyclic, noncyclic, pseudocyclic. Mechanism of photosynthesis OEC (Oxygen evolving complex), C_3 and C_4 cycle, Rubisco, CAM pathway. Photorespiration and its significance.
- **Unit III** Respiration anaerobic, aerobic respiration. Glycloysis, TCA cycle, oxidative phosphorylation, mitochondrial electron transport, inhibitors, uncouplers, glyoxylate cycle and cyanide resistant respiration. Pentose Phosphate Pathway (PPP). Sources of nitrogen nitrogen metabolism nitrogen fixation symbiotic and asymbiotic, nitrogenase biochemistry and mode of action, assimilation of nitrate and ammonia (GS GOGAT pathway)
- **Unit IV** Physiological role and mechanism of action of auxin, gibberellin, cytokinin, ethylene, abscissic acid, morphactins and brassinosteroids. Photomorphogenesis phytochrome mediated photoresponses. Physiology of flowering. Fruit ripening. Physiology of senescence and abscission, Biological clock.
- **Unit V** Stress Physiology biotic and abiotic stress salinity, drought, freezing, radiation and heavy metal stress. Stress proteins in plants. Secondary messengers in plants-cAMP, Ca-calmodulin.

Books for Reference :

1. Beevers, L. 1976. Nitrogen metabolism in plants. William clowes & sons Ltd. London.

- 2. Bidwell, R.G.S. 1979. Plant physiology, Macmillan publishing company, New york
- 3. Devlin, R.M. 1974. Plant Physiology. Narosa publishing House, New Delhi
- 4. Jain, V.K. 2004. Fundamentals of Plant Physiology, S.Chand and Co.Ltd. New Delhi.
- 5. Noggle, G.R. and G.J. Fritz, 2002. Introductory plant physiology. Prentice Hall India, New Delhi.
- 6. Salisbury, F.B. and C.W. Ross, 2007. Plant Physiology. Thomson Wordsworth.
- 7. Taiz, L. and E. Zeiger. 1998. Plant Physiology. Sinauer Associates. Publishers Massachusetts, United States of America

Practical

Hrs/ week: 2

- Hill activity effect of different wave lengths.
- Effect of antitranspirants and determination of stomatal index and frequency (Single leaf method & calcium chloride method)
- Determination of water potential(any one method)
- Membrane permeability studies.(using different solvents and temperature)
- Nitrate reductase activity any one factor (light coditions/age)
- Determination of amylase activity.
- Determination of peroxidase activity
- Estimation of proline (Under normal and stressed conditions)
- Determination of chlorophyll content during aging/ under different light conditions
- Study on ion uptake.
- Determination of sugar content in fruits during ripening process.

Submission - Record Note Book

SEMESTER III					
Core VIII Biodiversity and Conservation					
Code: 17PBOC32 Hrs/week:6 Hrs/Semester : 90 Credits:5					

Objective:

- To create awareness among the students to appreciate the variety in living world and their values.
- To manage and conserve the diversity of biological resource.
- Unit I Biodiversity concepts and scope. Levels of biodiversity genetic diversity –nature and origin ,measurement based on DNA and chromosome ,molecular marker(RFLP,RAPD).Species diversity, methods of assessment – diversity indices, species richness, species abundance, species evenness, taxic diversity, species turnover, species /area relationship and spatial pattern. Centers of Plant diversity.
- Unit II Methods of analysis of vegetation floristic , physiognomic and phytosociological. Remote sensing and Geographic Information System (GIS) application in Biodiversity studies . Values and uses of Biodiversity economic, social, ethical aesthetic,optional and ecosystem services. Endemicplant diversity- endemism- types, endemic plants of India. Hot spots distribution in India and world.
- Unit III Biodiversity global, national and regional level. Loss of biodiversity loss of genetic diversity, process responsible for species extinction. Threatening -causes habitat destruction, over exploitation, introduction of exotics, diseases. Man made causes pollution, industrialization urbanization and deforestation .IUCN threat categories. Common threatened taxa of India. Red data book.
- Unit IV Conservation of biodiversity. Current practices habitat/ecosystem approaches, species based approaches, social approaches- sacred groves and sthalaviriksha. 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. Green movements – Chipko movement and silent valley movement.
- Unit V Organizations associated with biodiversity management, IUCN, WWF, UNEP, BSI, NPBGR, ICAR, WHF. Biodiversity legislations GATT, TRIPS, CITES, Wild life preservation Act (1972), Indian forest Act (1927), Rio Summit Agenda- 21, Convention on biological Diversity, Biodiversity Act (2002). Role of indigenous people in conservation. Biopiracy, sustainable development and management of biodiversity.

Books for Reference

- 1. Agarwal, K.C.2001. Fundamentals of Environmental Biology.S.chand &Co; New Delhi.
- 2. Dash, M.C.2001. Fundamentals of Ecology(2 nd edition). TATA Mc Graw Hill, New Delhi.
- 3. Dash, M.C.2004. Fundamentals of Ecology.TATA Mc Graw Hill, New Delhi.
- 4. Jhoshi, P.C. and Namita joshi . 2004. Biodiversity and conservation. APH Publishing Company, New Delhi
- 5. Khoshoo, T.K. Environmental concerns and strategies. Ashish Publishing House, New Delhi.
- 6. Krishnamoorthy, K.v.2004. An Advanced Text Book of Biodiversity oxford and IBH, New Delhi.
- 7. Odum, E.P. and Gay W. Barrelt, 2004. Fundamentals of Ecology (2 nd edition). TATA Mc Graw Hill, New Delhi .

Practical- Hrs / Week: 2

- Raunkiaers Frequency diagram Quadrant / Transect method.
- Shannon Weiener,s Index and Abundance.
- Raunkiaers Biological Spectrum.
- Estimation of primary productivity of any terrestrial ecosystem (biomass method / Chlorophyll method)
- Determination of primary productivity of an aquatic ecosystem (Light / dark bottle method)
- World map showing hotspots.
- India map showing hotspots
- India map showing Biosphere reserves.
- Endangered / Endemic plants lists and photos (any 2).

Scientific Visits: Visit to any nearby place to observe *insitu* conservation of biodiversity - biosphere reserves, national parks, sanctuaries, wet lands, corals and mangroves.

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	
	27		

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					
Core XI - Plant Ecology					
Code: 17PBOC42 Hrs/week:6 Hrs/Semester : 90 Credits : 5					

Objectives:

- To enhance the understanding of the environment, key ecological issues, concepts and principles of environmental protection to make life on earth more sustainable and beneficial to human.
- Unit I Plant and the environment:climatic factors air, water and temperature; Edaphic factors - types based on texture and colour. Components of soilsoil 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 (Grass land, 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.
- Unit III Ecological succession Definitions, Causes of succession and climax, concept, Monoclimax and poly climax theories, Kinds of succession, Hydrosere and Xerosere. Adaptation of plants- hydrophytes, xerophytes and halophytes,
- **Unit IV** Environmental Management Plan (EMP), ecological indicators. Bioremediation - *In situ* and *ex situ* bioremediation of hydrocarbon, dyes, heavy metals and xenobiotics. Biodegradation of pesticides, biodegradable plastics, bio-augmentation. Bio-filtration - mechanism and microrganisms used. Microbial leaching, bio-mining. Ecology in national affairs- carbon trading, carbon sequestration, blue carbon, climate conference, convention and summit.
- Unit V Global environment problems climate change, global warming, UV -B, green house effect - ozone layer depletion, acid rain , nuclear accidents and holocaust. Disaster management – flood, earthquake and landslides. Eco-management, Environmental Impact Assessment (EIA). Sustainable eco-development, environmental education, Environmental protection Act (EPA)1986. Man and Biosphere (MAB)

Books for Reference :

- 1. Asthana and Meera Asthana, 2001. Environmental problems and solutions. S.Chand and Co. Ltd., New Delhi.
- Balasubramanian,D; C.F.a. Bryee, K.Dharmalingam, J.Green and K. Jeyaraman, 2005. Concepts in Biotechnology. Universities Press.
- 3. Dash, M.C.2001.Fundamentals of ecology. Tata McGraw Hill publishing Co. Ltd., New Delhi.
- 4. Murugesan, A.G.and Rajakumari , 2005. Environmental Science and Biotechnology, theory and Techniques . M.J.P. Publishers, chennai.
- 5. Sharma, P.D1999.Elements of ecology. Rastogi Publications, Shivaji Road, Meerut.
- 6. Trivedi P.R, P.L Sharma and KN Sundarshan 1994. Natural environment and Constitution of India, Efficient offset printers, New Delhi.
- 7. Tyller Miller G., 2004. Environment Science Thompson Brooks/Cole. Singapore.
- 8. Varshney C.K 1989. Water pollution and management, S.P. Printers, Noida.

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 dissolved O₂ in water samples.
- Estimation of BOD in water samples.
- Estimation of COD in water samples.
- Adaptation of plants- hydrophytes, xerophytes and halophytes,

Submission - Record Note Book

SEMESTER III					
Core IX Marine Biotechnology					
19PBOC31Hrs/week:6Hrs/Semester:90Credits:4					

• To give elaborate account on marine environment and its role in controlling the Earth's climate.

Mission:

- To understand the different types of marine habitats and the adaptation of life there in.
- To understand the role of marine products and their socio economic and environmental significance

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	analyze how marine organism adapt to their dynamic environment	5	Un
CO-2	recall how natural events and human activities affect coastal habitats	7	Re
CO-3	critically analyze and evaluate pollution issues, their sources and the influences humans have with the dynamic marine environment	7	An
CO-4	achieve practical skills in processing, preserving and culturing marine plants	6	Ev
CO-5	evaluate the uses of marine resources and realize the role of phytoplankton and bacteria in the economy of the ocean	5	Ap
CO-6	able to signify the characteristic feature of coral reefs and their role in biodiversity conservation	1	An
CO-7	able to identify and understand the role of mangroves in coastal protection and their adaptation to its hostile environment	5	Ap
CO-8	explain the ecological relationship between organisms and their environment	2	An

SEMESTER III					
Core IX Marine Biotechnology					
19PBOC31Hrs/week:6Hrs/Semester:90Credits:4					

Classification of marine habitat - ecology of pelagic, benthic and sublittoral zones, deep sea, sandy muddy and rocky shore. Characteristics of marine habitat – tides and chlorinity, upwelling, plate tectonics, tsunami, green house effect, carbon pump. Ocean and regulation of climate on earth.

Unit II

Marine biodiversity –phytoplankton - characteristics, measuring and sampling. Marine bacteria, marine fungi, seaweeds and sea grasses. Threats and conservation of seaweeds and sea grasses. Nutrient cycling: carbon, nitrogen, sulphur and phosphorus.

Unit III

Marine products - traditional uses; human food and agriculture. Marine colloids and hydrocolloids - Agar - agar, algin, alginates, carrageenan, diatomite, marine lipids, flavanoids, and carotenoids. Marine pharmacology –identification of bioactive compounds in marine organisms – mangroves, seaweeds, and sea grasses.

Unit IV

Culture of micro algae –laboratory culture, preservation and maintenance of culture and mass culture. Commercial cultivation of seaweeds. Marine pollution –thermal pollution, oil pollution, heavy metal pollution, radioactive pollution and industrial pollution. Algal blooms. Global climate changes: impact on specific diversity and productivity, ocean as carbon sink, effect on coral bleaching. Biological rhythms.

Unit V

Mangroves and salt marshes: geographical distribution, habit, adaptations, and trophic interactions. Present status and stresses on the mangroves with special reference to Sunderbans. Regeneration of mangroves. Coral reefs –ecology, species interaction, economic importance and conservation.

- 1. Cliton J. Dawes, 1981. *Marine Botany*. A wiley Intersciences publication. John Wiley and sons., New York.
- 2. Dring, M.J. 1982. The Biology of marine plants. Edward Arnold.
- 3. Kumudranjan Naskar and Rathindranath, 1999. *Ecology and Biodiversity of Indian mangroves. Vol. II & I.* Daya publishing House, Delhi, 110 035. Mandal.
- 4. Michael, P. 1986. *Ecological methods for field and laboratory investigations*. Tata McGraw Hill publishing Company Limited.
- 5. Sinha, P.C. 1998. *Marine pollution*, Anmol publications Pvt. Ltd. New Delhi 110 002. (India).

- 6. Tait, R.V. 1978. *Elements of Ecology*. Butter worths, London, Boston Sidney Wellington, Durban Toronto.
- 7. Warren, 1971. *Biology and water pollution control.* W.B.Saunders Company. Philadelphis, London. Toronto.

Practicals Hrs/Week - 2

- 1. Determination of acidity
- 2. Estimation of alkalinity
- 3. Collection and identification of phytoplankton.
- 4. Determination of total hardness
- 5. Estimation of nitrate (Colorimetry)
- 6. Estimation of Phosphate (Colorimetry)

Specimens / photographs / charts

- 1. Plankton net
- 2. Seaweeds
- 3. Sea grasses
- 4. Mangroves
- 5. Alginates
- 6. Carrageenan

Books for Reference

Murugesan A.G. and Rajakumari 2005. *Environmental Science and Biotechnology and Biotechnology, Theory and Techniques, MJP Publishers.*

SEMESTER III				
Core XI Molecular Biology and r-DNA Technology				
19PBOC33	Hrs/week: 5	Hrs/Semester: 75	Credits: 4	

• To understand the recent advancement in the biological study and concepts of gene cloning technology

Mission:

- To upgrade the knowledge about the latest concepts of prokaryotic and eukaryotic genome and their expression
- To make venture into plant genomic research.

CO.No.	Upon completion of this course, students will be able to	PSO	CL.
		addressed	
CO-1	know chemistry of genetic material and details of its replication at molecular level	2	Un
CO-2	understand the general principles of chromosome organization at different phases of cell cycle	2	Un
CO-3	explain gene regulation mechanisms at various levels by which she can learn how it controls growth and development of an organism	4	Cr
CO-4	know complexity of gene expression in eukaryotes over prokaryotes	3	Un
CO-5	understand vector mediated gene transfer techniques including screening and identification of recombinants	6	Un
CO-6	know the gene cloning tools and their mysteries in success of gene cloning technology	8	Un
CO-7	attain hands on experiences in the techniques associated there of	4	Cr
CO-8	practice the advanced techniques in genetic engineering such as DNA sequencing, blotting, DNA amplification and fingerprinting	3	Ар

SEMESTER III				
Core XI Molecular Biology and r-DNA Technology				
19PBOC33 Hrs/week: 5 Hrs/Semester: 75 Credits: 4				

Chemistry of genetic material – DNA double helical structure-Watson and crick model, alternative models. DNA replication- Molecular mechanism of initation of DNA replication in *E. coli*, λ phage and PBR322, elongation, termination. DNA replication in Eukaryotes- initation, cis and transacting elements, elongation and termination. DNA modification, DNA damages and repair mechanism, DNA repair and genetic diseases in human – Bloom's

Unit II

Organisation of genetic material –packaging of DNA-nucleosome model at molecular level; Genetic code- properties, codon assignment, wobble hypothesis; Regulation of gene expression in prokaryotes- General aspects of gene regulation, transcriptional regulation- inducible and repressible system, positive and negative regulation; operon concept- lac operon and tryp operon, relative positions of promotor and operator, master switches; Regulation of translation- protein synthesizing apparatus, molecular mechanism of translation, role of translation factors.

Unit III

Regulation of gene expression in eukaryotes – transcriptional control- initiation, multiple RNA polymerases, transcription factors; core elements; auxiliary elements - enhancers and silencers in transcription. pre initiation complex, elongation- elongation factors and termination-role of termination factors, nucleosome remodeling. Post transcriptional processing - RNA modification, splicing. Translation regulation - molecular mechanisms, initiation, elongation and termination, role of translation factors. Difference between prokaryotic and eukaryotic gene regulation.

Unit IV

Outline of genetic engineering –Enzymes used in rDNA technology, exonuclease, endonuclease, restriction endonuclease, S_i nuclease, DNA ligase, reverse transcriptase and alkaline phosphatase. Cloning vectors – plasmids – pBR ³²², shuttle vectors, M¹³ Bacteriophage vector, Cosmids, Ti plasmid. Isolation of genes from genomic and cDNA library.

Unit V

Gene transfer methods- vector mediated (*Agrobacterium*), direct gene transfer (physical and chemical). Screening and identification of recombinants. Mobile genetic elements – Is elements and transposons in maize and Bacteria. DNA sequencing – Maxam and Gilbert method, Dideoxy nucleotide method, Messing's shot gun method. DNA chips. Hybridization techniques – Southern, Northern and Western blotting. DNA amplification – PCR, RFLP, RAPD and finger printing.

Books for Reference

- 1. Benjamin Lewin, 2004. Genes VII. Pearson Prentice Hall.
- 2. Channarayappa, 2006, *Molecular Biology. Principles and Principles and practices.* Universities Press (India), Pvt. Ltd. 3.5.819. Hyderabad, 500 029.
- 3. David Preifelder, 2006. *Molecular Biology*. Narosa publishing House, Madras, New Delhi.
- 4. Gupta, R.K.2006. *Genetics*. Rastogi publications.
- 5. Nicholl DST, 2001. *An Introduction of genetic engineering*. Cambridge University press.
- 6. Old R.N. and Primrose, S.B. 2004. *Principle of gene manipulation*. Blackwell scientific publication, USA.
- 7. Power C. B. 2007. *Genetics Vols. I and II*. Himalaya publishing House. Kundanal chandak. Industrial Estate. Ghat Road. Nagpur- 440 018.
- 8. Robert H. Tamarin. 2006 *Principles of Genetics*. Tata Mc. Graw Hill publishing company Ltd., New Delhi.
- 9. Sathyanarayana, U. 2006. *Biotechnology*. Book and Allied (P). LTD. Kolkatha.
- 10. Singh, B.D. 2005. Genetic Kalyani publishers, Chennai.

Practicals

Hrs/ week - 2

- 1. Estimation of DNA (Spectrophotometry)
- 2. Hyperchromisity of DNA
- 3. Isolation of DNA/ Plasmid from Bacteria
- 4. Isolation of DNA from plant materials
- 5. DNA amplification using PCR.
- 6. Seperation of DNA using AGE
- 7. Restriction enzyme digestion of DNA.
- 8. Identification of restriction bands.

Books for Reference:

Ponmurugan.P, B. Gangathara Prabhu. 2012. Biotechniques. MJP publishers. Chennai.

SEMESTER IV				
Core: XIII Plant Physiology				
19PBOC41Hrs/week: 6Hrs/Semester : 90Credits: 4				

• Able to understand the organized complexity of life process in plants.

Mission :

- Able to learn the role of physical and chemical process in plant function.
- Able to know about the responses of plant to the environment.

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the water relation and nutritional needs of the	6	Un
	plant from the soil, and assess the symptom specific		
	nutritional deficiencies and the need of fertilizers for crop		
	improvement		
CO-2	discuss how root structure and functions influence the	3	Un
	transfer of inorganic nutrients from the soil into the plants,		
CO-3	analyse the mechanism of their assimilation of inorganic	3	Un
	molecules into organic molecular components.		
CO-4	analyse light enhanced photochemical reactions that	3	Un
	culminates in the synthesis of ATP and NADPH and		
	fixation of carbon dioxide into organic compounds		
CO-5	describe respiration with its associated carbon metabolism	3	Re
	and releasing of energy stored in chemical bonds in a		
	controlled manner for cellular use		
CO-6	investigate plant's functions and adaptations under altered	7	Cr
	environmental conditions		
CO-7	comment on the hormone controlled and light mediated	3	An
	morphogenetic events in plants		
CO-8	design and conduct scientific experiments and analyse the	6	Cr
	data critically		

SEMESTER IV				
Core: XII Plant Physiology				
19PBOC41Hrs/week: 6Hrs/Semester : 90Credits: 4				

Water relations of plants - components of water potentials and their relation. Absorption of water - Mechanism of ascent of sap. Translocation - Mechanism of translocation of solutes- source sink relationship, phloem loading and unloading. Transpiration - stomatal movement, antitranspirants, guttation. Inorganic nutrient - ion uptake - passive and active uptake and transport. Mineral nutrition-mineral deficiencies disrupt plant metabolism and function, hydroponics and its significance.

Unit II

Photosynthesis-General concepts, Principle of light absorption-action spectrum, absorption spectrum. Pigment system and quantum yield. Photosynthetic apparatus-organization of components in the thylakoid membrane, photochemical reaction- LHS, OEC, mechanism of electron transport -z-scheme and cyclic; proton transport and chemiosmotic synthesis of ATP; regulation of photosynthetic machinery; carbon reaction-general aspects, activity of rubisco-Calvin Benson cycle, Inorganic carbon concentrating mechanism- C_4 carbon cycle, CAM, C_2 oxidative photosynthetic carbon cycle (photorespiration) significance of C_2 cycle-ecological aspects of photosynthesis

Unit III

Respiration- overview, glycolysis, regulation of glycolysis, PPP, Mitochondria- Structural organization, Citric acid cycle, e⁻ transport system and chemiosmotic synthesis of ATP; alternative oxidase mechanism in plants (cyanide resistance respiration in plants); respiration and coupling of other metabolism. Assimilation of mineral nutrients in plants- N_2 cycle, Nitrate assimilation. Ammonium assimilation and synthesis of aminoacids (GOGAT). Biological fixation of N_2 . Assimilation of S and P in plants.

Unit IV

Physiological role, biosynthesis and mechanism of action of auxin, gibberellin, cytokinin, ethylene, abscissic acid, morphactins and brassinosteroids. Photomorphogenesis - phytochrome mediated photoresponses. Physiology of flowering; Fruit ripening. Physiology of senescence and abscission, Biological clock-occurrence of circadian rhythm in plants-examples.

Unit V

Stress physiology-Secondary metabolites and plants defense mechanisms to biotic stressdefense against pathogens, insect herbivores. Abiotic stress and mechanism of plants responses to salinity, drought, freezing, radiation and heavy metal stress. secondary messenger in plantscAMP, Ca-calmodulin

- 1. Beevers, L. 1976. *Nitrogen metabolism in plants*. William clowes & sons Ltd. London.
- 2. Bidwell, R.G.S. 1979. Plant physiology, Macmillan publishing company,

New york

- 3. Devlin, R.M. 1974. Plant Physiology. Narosa publishing House, New Delhi
- 4. Jain, V.K. 2004. *Fundamentals of Plant Physiology*, S.Chand and Co.Ltd. New Delhi.
- 5. Noggle, G.R. and G.J. Fritz, 2002. *Introductory plant physiology*. Prentice Hall India, New Delhi
- 6. Salisbury, F.B. and C.W. Ross, 2007. Plant Physiology. Thomson Wordsworth.
- 7. Taiz, L. and E. Zeiger. 1998. *Plant Physiology*. Sinauer Associates. Publishers Massachusetts, United States of America

Practical

Hrs/ week: 2

- 1. Hill activity effect of different wave lengths.
- 2. Effect of antitranspirants and determination of stomatal index and frequency (Single leaf method & calcium chloride method)
- 3. Determination of water potential(any one method)
- 4. Membrane permeability studies.(using different solvents and temperature)
- 5. Nitrate reductase activity any one factor (light coditions/age)
- 6. Determination of amylase activity.
- 7. Determination of peroxidase activity
- 8. Estimation of proline (Under normal and stressed conditions)
- 9. Determination of chlorophyll content during aging/ under different light conditions
- 10. Study on ion uptake.
- 11. Determination of sugar content in fruits during ripening process.

Submission - Record Note Book

Books for Reference:

Francis H Witham, David F Blaydes and Robert N Devlin, 1970. *Experiments in Plant Physiology*. Vanmostrand Rainhold Company, New Delhi.

Semester IV				
Core XIV Plant Biotechnology				
19PBOC42Hrs/week:4Hrs/Semester: 60Credits: 4				

• To apply techniques in biology to explore novel varieties of plants and environmental protection

Mission:

- 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.

CO. No	Upon completion of this course ,students will be able to	PSO addressed	CL
CO-1	understand principles of plant tissue culture and media preparation	3	Re,Un
CO-2	acquire knowledge and skill in various micropropagation techniques.	4	Un,Ap
CO-3	understand meristem culture, Somaclonal variations, haploid plants, androgenesis, gynogenesis, embryogenesis.	4	Un
CO-4	describe meristem culture and clonal propagation of plants	4	Re
CO-5	synthesize synthetic seeds and understand their applications	3	Un
CO-6	understand the fermentation processes and their importance in industries	3	Un
CO-7	study and apply nanotech process for her research pursuit	4	Ap
CO-8	discuss the advances in genetic engineering and production of monoclonal antibodies and their novelty	1	Re

Semester IV					
Core XIV Plant Biotechnology					
19PBOC42Hrs/week:4Hrs/Semester: 60Credits: 4					

Biotechnology: Introduction, scope. **Plant tissue culture**: Laboratory organization, tools and techniques, methods of sterilization, medium and its preparation. **Culture initiation**: callus culture, cell culture, single cell culture. **Regeneration**: organogenesis, factors affecting regeneration, regulation of regeneration.

Unit II

Somatic embryogenesis: Introduction, factors affecting embryogenesis. **Micropropagation methods:** Introduction, stages of micropropagation. Plant protoplast isolation, factors affecting protoplast isolation, protoplast culture. Protoplast fusion and somatic hybridization, regeneration from protoplast, fusion methods, selection of hybrid cells application of protoplast hybridization.

Unit III

Somaclonal variation: isolation and characterization of variants -molecular basis and induced mutations, applications and limitations. Production of secondary metabolites (alkaloids). Synthetic seed technology and applications. Production of haploids (anther, pollen and ovule), application of haploids. Meristem culture for virus free plant.

Unit IV

Biofertilizers: Mass production of *Rhizobium*, *Azospirillum* and Blue Green Algae (BGA), Vesicular Arbuscular Mycorrhizal Fungi (VAM). Single cell protein (*Scenedesmus, Spirulina, Saccharomyces*). Nanotechnology: Outline of green synthesis of nanoparticles and their characterization.

Unit V

Molecular farming: Nutritional quality of seed protein. Immuno protective drugs. **Regulations in Biotechnology: Biosafety**: definition, requirement, biosafety in relation to transgenic research, biosafety guidelines and implementation. **Intellectual property rights:** process of patenting of biotechnological products. Farmer's Rights and plant breeder's Rights.

- 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.

- 7. 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

- 1. Isolation of Rhizobium
- 2. Synthesis and characterization of nanoparticles
- 3. Preparation of synthetic seeds
- 4. Callus induction
- 5. Embryo culture
- 6. Single cell Isolation
- 7. Isolation of BGA
- 8. Nodal Culture
- 9. Protoplast isolation

Set up / pictures / photographs/ demonstration

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

Submission - Record Note Book

Books for Reference

• Chawla HS, 2009. *Introduction to Plant Biotechnology*. Oxford & IBH publishing company Pvt., Ltd. New Delhi

SEMESTER I			
Core I Plant Diversity I (Phycology, Mycology, Lichenology and Bryology)			
19PBOC11	Hrs/week: 6	Hrs/Semester : 90	Credit :4

• To have a comprehensive idea on cryptogams.

Mission:

- To understand the taxonomy, characteristics and uniqueness of primitive plants.
- To have a broad knowledge on economic importance and ecological significance of lower plants

CO. NO	Upon completion of this course, students will	PSO	CL
	be able to	addressed	
CO-1	appreciate the uniqueness and distinguish between diverse groups of primitive plants using their characteristic features	1, 2	An
CO-2	discuss the different life cycle patterns of lower plants	1, 2	Cr
CO-3	know the basic skills and techniques in micropreparation of diversified cryptogams	6	Ар
CO-4	apply the practical knowledge to identify a various cryptogams	1,6	Ар
CO-5	understand that the cryptogams are unique in plant kingdom	1, 2	Un
CO-6	describe the economic and ecological significance of lichens	1, 2	Ар
CO-7	know the origin and phylogenetic evolution of Bryophyte	1, 2	Re
CO-8	know the scientific contribution done by eminent scientists in the field of cryptogams	1, 2	Un

SEMESTER I				
Core I Plant Diversity I (Phycology, Mycology, Lichenology and Bryology)				
19PBOC11Hrs/week: 6Hrs/Semester : 90Credit :4				

Algae: Classification of algae by F.E.Fritsh (1954). Contribution of Indian Phycologists: M.O.P. Iyyangar and T.V. Desikachary. General characteristics. Ultrastructure of Prokaryotic and Eukaryotic algal cells and their components: cell wall, protoplasm, flagella, eye spots, chloroplast, pyrenoid, nucleus and reserve foods. Algal cytology and genetics. Economic importance of algae.

Unit II

Habitat, range of thallus structure, vegetative, asexual, sexual reproduction and life cycle patterns of Cyanophyceae, Chlorophyceae, Bacillariophyceae, Phaeophyceae and Rhodophyceae. Fossil algae of above classes.

Unit III

Fungi: Classification of Fungi by Alexopoulos and Mims (1979). General characteristics. Diversity of somatic, reproductive and fruiting structures in different groups of fungi: Myxomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Heterothallism and Parasexuality in fungi. Economic importance of Fungi.

Unit IV

Lichens: A general account of lichens - Structure, nutrition; reproduction, classification, occurrence and Inter-relationship of Phycobionts and Mycobionts, Ecological and economic importance of lichens.

Unit V

Bryophyta: Classification of Bryophytes by Rothmaler (1951). Origin of Bryophytes. General characteristics. Morphological, anatomical structure, vegetative, sexual reproduction and alternation of generation of Marchantiales, Jungermaniales, Anthocerotales, Sphagnales and Polytrichales. Spore dispersal mechanism in bryophytes. Economic importance of Bryophytes.

Algae

- 1. Bilgrami, K.S. and L.B. Sinha, 2004. *A Text Book of Algae*. CBS Publication and distributors, New Delhi.
- 2. Fritsch, F.E. 1972. *The structure and reproduction of algae.Vol.I & II.* Cambridge University Press.
- 3. Kamat, N.D 1982. Topics in Algae.SaikripaPrakasam, Aurangabad.
- 4. Robert Edward Lee, 2008. *Phycology*. Cambridge University Press
- 5. South, G.R. and Whittick, 1987. *Introduction to phycology*, Blank well Scientific Publications, London.

Fungi

Books for Reference:

- 1. Alexopoulos and Mim's, 1983. *Introductory Mycology*, Wiley Eastern Ltd. Hyderbad.
- 2. Johri R.M., Sneh Lata & Kavita Tyagi 2010. *Text Book of Fungi*. Dominant Publishers & Distributors Pvt.Ltd.
- 3. Smith, G.M. 1988. Cryptogamic Botany Vol.I Mc-Graw Hill Book Company, New York.

Bryophyta

Books for Reference:

- 1. Cavers, F. 1964. Inter relationship of the Bryophyta. Dawsons of pall mall. London.
- 2. Peter George 2010. Hand Book of Bryophyta. Rajat Publications .New Delhi.
- 3. Rashid, A. 1999. An introduction to Bryophyta. Vikas Publishing House Pvt. Ltd.
- 4. Watson, E.V. 1971. *Structure and life of Bryophytes*. Hutchinson University Library, London.

Lichen

Books for Reference:

1. Ahmadjian, V. and Mason E. Hale, M.E. 1973. The Lichens. Academic Press, New York

Practical

Hrs/Week - 2

• Algae: *Nostoc, Oscillatoria, Ulva, Padina, Turbinaria, Hypnea, Gracilaria,*. Collection, identification and preservation of fresh water and Marine algae. Preparation of algal herbaria

• Fungi:Xylaria, Polyporus, Agaricus.

Observation and study of fungi under natural habitat.

- Bryophyta : Plagiochasma, Anthoceros, Sphagnum, Polytrichum.
- Lichens: Usnea, Parmelia
- Field visit to any one of the ecosystems rich in algae

Submission

- Record Note Book
- Bottle specimens/herbarium specimens (any five)

- 1. Ashok M. Bendre and Ashok Kumar. 2009. *A Text Book of Practical Botany –Volume 1*. Rastogi Publications, Meerut, India
- 2. Srivastava H. N, 1987. Practical Botany Volume I, Pradeep Publications, Jalandhar

SEMESTER I			
Core II Plant Diversity II (Pteridophytes, Gymnosperms and Paleobotany)			
19PBOC12	Hrs/week: 6	Hrs/Semester : 90	Credit :4

• To have a comprehensive idea on vascular cryptogams and phanerogams.

Mission:

- To understand the taxonomy, characteristics and uniqueness of higher plants.
- To understand the characteristics of fossil vascular plants and their geological age of origin.

CO. No.	CO. No. Upon completion of this course, students will be able		CI
	to	addressed	CL
CO-1	appreciate the uniqueness and distinguish between diverse groups of Pteridophytes and Gymnosperms using their characteristic features	1, 2	An
CO-2	discuss different life cycle patterns in different groups	1, 2	Cr
CO-3	know the basic skills and techniques in micropreparation and formulate methods to identify different groups	1,6	Ap
CO-4	know the evolutionary significance of Pteridophyte	1, 2	Un
CO-5	infer pteridophytes are pioneer in the evolution of seed habit	1, 2	Re
CO-6	compare and contrast the origin and evolution of steles, foliage, seeded and seedless plants.		An
CO-7	compare and contrast the seeded and seedless plants.	1, 2	Ev
CO-8	review critically the biology, ecology of fossils and methods of fossilization.	1, 7	Un

SEMESTER I					
Core II Plant Diversity II (Pteridophytes, Gymnosperms and Paleobotany)					
19PBOC12Hrs/week: 6Hrs/Semester : 90Credit :4					

Pteriodophyta: Classification of Pteridophytes by Smith (1955). Origin and evolution of Pteridophytes. General characteristics. Telome concept. Stelar evolution in pteridophytes. Heterospory and seed habit. Theories and modifications of alternation of generations Economic importance of Pteridophytes.

Unit II

Morphological, anatomical structure, asexual and sexual reproduction of Psilotales (Phylogenetic position of Psilotales), Lycopodiales, Selaginellales, Isoetales and Equisetales, Ophioglossles and Filicales. Life cycle pattern in homosporous and heterosporous pteridophytes.

Unit III

Gymnosperms: Classification of Gymnosperms by K.R.Sporne (1965). General characteristics. Morphological, anatomical structure and reproduction of Cycadaceae, Ginkgoaceae, Cupressaceae, Podocarpaceae, Araucariaceae

Unit IV

Morphological, anatomical structure and reproduction of Ephedraceae, Welwitschiaceae and Gnetaceae. Affinities of Gymnosperms with Angiosperms and Pteridophytes. Economic importance of Gymnosperms.

Unit V

Paleobotany: Geological time scale – fossilization and Fossil types: Compressions, incrustation, casts, molds, petrifactions, coal balls and compactions. General characters of fossil Pteridophytes: *Horneophyton, Sphenophyllum and Calamites*. Fossil Gymnosperms: *Williamsonia and Cordaites*.

Pteridophyta:

- 1. Bower, F.D. 1988. Primitive land plants. Vol.I & 2. Arihant Publishers Jaipur.
- 2. Pandi, S.N., P.S. Trivedi, S.P. Misra, 2006. *A text Book of Botany Vol. II*. Vikas Publishing House Pvt. Ltd.
- 3. Parihar, N.S. 1967. *An introduction to Embryophyta, Pteridophyta*. Central Book Depot Publications in Botany, Allahabad.
- 4. Rashid, A. 1985. An introduction to Pteridophyta, Vani Educational Books.
- 5. Sundara Rajan S. 2009. *Introduction to Pteridophyta*. New Age International Publishers. New Delhi

Gymnosperms:

Books for Reference:

- 1. Chamberlain, C.J. 1986. *Gymnosperms.Structure and evolution*. CBS Publishers & Distributors, Delhi.
- 2. Johri R.M., SnehLata and Kavita Tyagi. 2010. *Text Book of Gymnosperms*. Wisdom Press, New Delhi.
- 3. Sporne, K.R.1974. *The Morphology of Gymnosperms*. B.I. Publications Pvt. Ltd., New Delhi.

Practical :

Hrs/Week – 2

- **Pteridophytes :** *Selaginella, Isoetes, Equisetum, Adiantum, Pteris.*
- Gymnosperms : Cycas, Araucaria, Cupressus, Podocarpus, Gnetum,
- **Fossils:** Sphenophyllum, Calamites (Pteridophytes) Williamsonia and Cordaites (Gymnosperms)

Submission - Record Note Book

- 1. Ashok M. Bendre and Ashok Kumar. 2009. *A Text Book of Practical Botany –Volume 1.* Rastogi Publications, Meerut, India
- 2. Srivastava H. N, 1987. Practical Botany Volume I, Pradeep Publications, Jalandhar

SEMESTER I			
Core III Microbiology and Plant pathology			
19PBOC13	Hrs/week: 5	Hrs/Semester : 75	Credits: 4

• 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.

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			
19PBOC13	Hrs/week: 5	Hrs/Semester : 75	Credits: 4

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				

• 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

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			
19PBOC21	Hrs/week:5	Hrs/Semester: 75	Credits : 4

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 VI	Core VI Biochemistry and Biophysics				
19PBOC22	19PBOC22 Hrs/week: 5 Hrs/Semester: 75 Credits:4				

Vision:

• To enhance knowledge on biomolecules and the metabolism

Mission:

- To study the molecular structure of biomolecules.
- To trace out the various metabolic pathways and their significance.
- To highlight the principles of energy conversion in biological systems.

Course Outcome

CO.No.	Upon completion of this course ,students will be able to	PSO addressed	CL
CO-1	study the polymeric biomolecules and their monomeric building blocks	1	Re
CO-2	outline the metabolic pathways and be able to trace the regulatory process in the biological system	1	Re
CO-3	outline enzyme groups and know the nomenclature that be able to explain the specificity of enzyme's role and mode of action	3	An
CO-4	construct electromagnetic spectrum and understand the properties to relate biological applications.	6	Ap
CO-5	characterise thermodynamic systems at thermal equilibrium	3	Cr
CO-6	sketch molecular structures and bonding of bio-molecules. upon that knowledge be able to deduce the packaging and foldings of biomolecules	4	Re
CO-7	set up and operate variety of experiments to analyse data accompanied by problem solving and documentation.	6	Ар
CO-8	detect the source of vitamins and their chemistry and distinguish their symptoms specific to their deficiency	7	Re

SEMESTER II					
Core VI Biochemistry and Biophysics					
19PBOC22	19PBOC22 Hrs/week: 5 Hrs/Semester: 75 Credits:4				

Unit I

Biomolecules-Structure and properties of carbohydrates: mono-saccharides, disaccharides, polysaccharides and mucopolysaccharides. Biosynthesis and hydrolysis of sucrose and starch. Gluconeogenesis.

Unit II

Amino acids: classification based on R - group, structure and properties. Metabolism of phenylalanine, tyrosine and tryptophan. Commercial polypeptides – ACTH, Thymosin. Proteins: The peptide bond and primary structure. Ramachandran plot. Secondary structure, domain, motif and backbone folding. stabilizing forces in collagen. Tertiary structure (Myoglobin and ribonuclease) and Quaternary structure (hemoglobin).

Unit III

Lipids: classification, structure and properties of simple lipids (triglyceride and wax), compound lipids (phospholipids and glycolipids) and derived lipids.steroids - cholesterol, Terpines. Biosynthesis and degradation of fatty acid. Synthesis of nucleotides.

Unit IV

Enzymes –nomenclature IUPAC 1974. Principles of catalysis, enzyme action, active site, activation energy, enzyme kinetics. Cofactors and inhibitors. Coenzymes NADP, FAD, FMN and Co enzyme A. Secondary metabolites- classification, structure and properties of alkaloids (colchicine and atropine) and glycosides (cordiac and cyanogenic). Vitamins - sources and deficiency diseases.

Unit V

Dual nature of light, electromagnetic spectrum, phosphorescence and fluorescence. Laws of thermodynamics, concept of enthalpy, entropy and free energy. Redox couple, redox potential, coupled reactions, phosphorylation. High energy compound - ATP.

Books for Reference :

- 1. Bhutani, S.P. 2009. Chemistry of Biomolecules. Ane Books Pvt. Ltd. New Delhi.
- 2. Conn, E. E. and P. K. Stumpf, 1987. *Outlines of Biochemistry*. John Wiley and Sons, Inc.
- 3. Cox, M. M. and D. L. Nelson. 2008. *Principles of Biochemistry*. 5th edition. Replika Press Pvt. Ltd., India.
- 4. David Rawn, 2004. *Biochemistry*. Panima Publications, New Delhi.
- 5. Ferrier, D. R. 2014. *Biochemistry*. 6th edition. Wolters Kluwer (India) Pvt. Ltd., New Delhi
- 6. Gupta, S.N. 2011. *Biochemistry*. Rastogi Publications, Meerut, India.
- 7. Lehninger, A. L. 1987. *Principles of Biochemistry*. CBS publishers and Distributors. Delhi.

- 8. Nagini, S. 2007. *Text Book of Biochemistry*. 2nd edition. Scitech Publications (India) Pvt. Ltd., Chennai
- 9. Salil Bose, 1982. *Elements of Biophysics*. Jjothi Books, Madurai.
- 10. Sathyanarayana, U and U. Chakrapani. 2006. *Biochemistry*. 3rd edition. Arunabha Sen, Books and Allied (P) Ltd., Kolkata.

Practical

Hrs/Week: 2

- Estimation of sugar. (Benedict's method)
- Titration of amino acid (glycine)
- Estimation of free amino acid from plant tissues (Ninhydrin method)
- Estimation of total soluble protein from plant tissues (Barfoed's test)
- Separation of amino acids (ascending paper chromatography).
- Separation of photosynthetic pigments (column chromatography).
- Absorption spectrum of chlorophyll
- Study of enzyme kinetics and determination of Km value.
- Saponification value of two vegetable oils.
- Qualitative tests for alkaloids, flavonoids, glycosides and phenols.

Submission - Record Note Book

Books for Reference:

Jayaraman. J. 2001. *Laboratory manual in Biochemistry*. New Age International Publishers, New Delhi.

SEMESTER II					
Core VII	Core VII Taxonomy of Angiosperms				
19PBOC23Hrs/week: 5Hrs/Semester : 75Credit : 4					

Vision:

• To provide a deep and practical understanding of floristic features of plants and their systematics

Mission:

- To identify the local flora up to the species level based on their morphological features
- To enable the students to get fair knowledge on different systems of classification and to have an insight on modern trends in classification of Angiosperms.

Course Outcome

CO. No.	Upon completion of this course, students will be able	PSO	CL
	to	addressed	
	apply the basic principles and rules of botanical		
CO-1	nomenclature, and use taxonomic literature and	1	An
	describe the general principles of classification and	1	¹ P
	binomial nomenclature for species naming.		
CO-2	relate taxonomy to other sciences	4	Re
CO 3	understand the preparation and importance of	6	I In
0-3	herbarium, role of BSI	0	UII
	identify the common species of plants growing in		
CO-4	Thoothukudi and their systematic position, their	1	Ар
	distinguishing morphological/ecological attributes.		
CO 5	utilize the taxonomical terminology for identification	1	I Im
0-3	of taxa	1	Un
CO 6	understand the comparative account among the families	Λ	Un
0-0	of angiosperms.	4	UII
CO 7	able to gain proficiency in the use of keys and manuals	7	٨n
0-7	for identifying any unknown plants to species level	/	Ар
	combine classical plant taxonomy with modern	1	A
00-8	molecular phylogeny	1	An

SEMESTER II					
Core VII Taxonomy of Angiosperms					
19PBOC23	19PBOC23Hrs/week: 5Hrs/Semester : 75Credit : 4				

Unit I

Definition and objectives-brief history of plant taxonomy – Botanical Nomenclature- need for scientific names, polynomial and binomial nomenclature- ICN principles, names of taxa - genus, species, infra-specific categories, type method, citation, typification, effective and valid publication, retention and rejection of names-, principle of priority, conservation of names. Identification methods: use of floras, manuals and monographs - dichotomous keys (indented and bracketed key), guidelines for constructing dichotomous keys - interactive keys (computer aided).

Unit II

Taxonomic hierarchy - Ranks in the hierarchical system (order, family, genus, species and intra specific). Classification: relative merits and demerits of major systems of classifications-Linnaeus, Bentham and Hooker's and Angiosperm Phylogeny Group (IV). Current trends in biosystematics - Phenetics - numerical taxonomy- construction of taxonomic groups, applications, merits and demerits. Phylogenetic - Cladistics – phylogenetic terms and phylogenetic diagrams.

Unit III

Taxonomic evidences - Morphology, Cytology, Embryology and chemosystematics (Phytochemicals phenols, alkaloids, flavonoids and terpenoids). Molecular systematics (DNA bar coding). Herbarium methodology- Specimen preparation, maintenance, management and functions. Role of Botanical Survey of India. General account of Central National Herbaria, Calcutta (CAL) and regional herbaria - Madras Herbarium (MH).

Unit IV

A detailed study of vegetative and floral characters of the following families: Ranunculaceae, Capparidaceae, Tiliaceae, Meliaceae, Rhamnaceae, Sapindaceae, Fabaceae, Combretaceae, Asteraceae, Sapotaceae.

Unit V

Solanaceae, Boraginaceae, Convoluvaceae, Scrophulariaceae, Bignoniaceae, Verbenaceae, Nyctaginaceae, Orchidaceae, Commelinaceae and Cyperaceae.

Books for Reference :

- 1. Davis, P.H. and V.M. Heywood, 1983. *Principles of Angiospersm Taxonomy*, Olive & Byod, London.
- 2. Gurcharan Singh, 2004. *Plant Systematics* Oxford & IBH Publishing Co., New Delhi.
- 3. Gurcharan Singh, 2012. *Plant Systematics* Oxford & IBH Publishing Co., New Delhi.

- 4. Harborne, J.B. and B.L. Turner; 1984. *Plant chemo-systematics*. Academic Press, London.
- 5. Jeffrey, C.1982. *Introduction to plant Taxonomy*. Cambridge university Press Cambridge.
- 6. Johri R.M. and Sneb Lafa, 2005. *Taxonomy* Sonali publications, New Delhi.
- 7. Pandey, B.P.2005. Taxonomy of Angiosperms. S.Chand & Company, New Delhi.
- 8. Stace C.A., 1989. *Plant taxonomy and Biosystematics* Edward. Arnold, London.
- 9. Saxena N.B. and S. Saxena, 2010. *Plant Taxonomy*. Pragati Prakashan Publishers.
- 10. Subrahmanyam, N.S. 2007. *Modern Plant Taxonomy*. Vikas Publishing House Pvt. Ltd. New Delhi.
- 11. Vashishta P.C., 1989, Taxonomy of Angiosperms, R.Chand & Co., New Delhi.

Practical

Hrs / Week - 2

- 1. Study of wild taxa representing different families and identification to species level.
- 2. Construction of taxonomic keys (dichotomous).
- 3. Field trips within and around the campus; compilation of field notes and preparation of herbarium sheets of such plants, wild or cultivated, as are abundant.
- 4. Training in using floras for identification of specimens described in the class.

Submission - Record Note Book, five herbarium sheets, fifteen photographs and field note book

Books for Reference

Gample J.S. *Flora of the Presidency of Madras – Vol I & II*, Reprint 1956, Published under Authority of Secretary of state for India in Council.

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.

Books for Reference:

- 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

Books for Reference

- 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 I Plant Diversity I (Algae, Bryophyte, Fungi and Lichen)					
Course Code:21PBOC11	Course Code:21PBOC11 Hrs/week: 6 Hrs/Semester: 90 Credit: 4				

- To have a comprehensive idea on cryptogams.
- To understand the taxonomy, characteristics and uniqueness of primitive plants and their characteristics.
- To have a broad knowledge on economic importance and ecological significance of lowerplants.

Course Outcomes

CO. NO	Upon completion of this course, students	PSO	CL
	will beable to	addressed	
CO-1	recall the distinguishing features of algae, bryophytes, fungi and lichens and appreciate	1, 2	An
CO-2	understand the status of cryptogams in evolution of advanced plant groups	1, 2	Cr
CO-3	understand the basic skills and techniques in micropreparation and formulate methods to identify different plant groups	1, 6	Ар
CO-4	apply the practical knowledge to identify a particular group from a mixed group in the laboratory and in the field	6	Ap
CO-5	know the adaptive features of cryptogams to theirhabitats	1, 2	Un
CO-6	analyse the phylogenetic relationship between the different groups	1, 2	Ар
CO-7	evaluate the economic and ecological significance of lichen	1, 2	Re
CO-8	critically think on the origin and evolution of Bryophyte	1, 2	Un

SEMESTER I Core I Plant Diversity I (Algae, Bryophyte, Fungi and Lichen) Course Code: 21PBOC11 Hrs/week: 6 Hrs/Semester: 90 Credit: 4

UNIT I: Algae: Classification of algae by F.E.Fritsh (1945), Parker (1982).Contribution of Indian Phycologists: M.O.P. Iyengar, T.V. Desikachary and V.K. Krishnamurthy.

Coastal line of India: South East coast of India, West coast of India. General characteristics and life cycle pattern of algae. Special structural features of the algal cell – nucleus, centrosomes, flagella, eye spots, contractile vacuoles, chloroplast, pyrenoid and reserve foods. Phylogenetic relationships with other plant groups. Economic importance of algae.

- UNIT II: General characteristics, ecological, morphological and interrelationships of Chlorophyceae, Xanthophyceae, Bacillariophyceae, Dinophyceae, Phaeophyceae, Rhodophyceae and Myxophyceae. Fossil algae.
- UNIT III: Bryophyta: Classification of Bryophytes by Rothmaler (1951). Origin of Bryophytes. General characteristics. Morphological, anatomical structure, vegetative, sexual reproduction and alternation of generation and interrelationship of Marchantiales, Jungermaniales, Anthocerotales, Sphagnales and Polytrichales. Spore dispersal mechanism in bryophytes. Economic and ecological importance of Bryophytes.
- UNIT IV: Fungi: Classification of Fungi by Alexopoulos and Mims (1979). General characteristics. Diversity of somatic, reproductive and fruiting structures of Myxomycetes, Zygomycetes, Ascomycetes, Basidiomycetes and Deuteromycetes. Heterothallism, Heterokaryosis and Parasexuality in fungi. Economic importance of Fungi.
- UNIT V: Lichens: A general account of lichens. Classification of lichens based on habitat, morphological features, internal structure, nature of fungal components. Occurrence and interrelationship of phycobionts andmycobionts, structure and reproduction in Ascolichens, Basiodiolichens and Deuterolichens. Lichens as indicators of Pollution, Economic importance of Lichens.

Books for Reference:

Algae

- 1. Bilgrami K.S and Sinha L.B *A Text Book of Algae*. New Delhi: CBS Publication and distributors, 2004.
- 2. Fritsch F.E The structure and reproduction of algae.Vol.I & II. UK: Cambridge

UniversityPress, 1972.

- 3. Kamat, N.D Topics in Algae. Aurangabad: Saikripa Prakasam, 1982.
- 4. Robert Edward Lee Phycology. UK: Cambridge University Press, 2008.
- 5. South G.R and Whittick *Introduction to phycology*. London: Blank well Scientific Publications, 1987.
- 6. Chapman V.J and Chapman D.J *The Algae*. London: The Macmillan Press Ltd., andBasingstoke, 1975.

Bryophyta

- 1. Cavers F Inter relationship of the Bryophyta. London: Dawsons of Pall Mall. 1964.
- 2. Peter George Hand Book of Bryophyta. New Delhi: Rajat Publications , 2010.
- 3. Rashid A *An introduction to Bryophyta*. New Delhi: Vikas Publishing House Pvt. Ltd. 1999.
- 4. Watson E.V *Structure and life of Bryophytes*. London: Hutchinson University Library,1971.
- Alain Vanderpoorten and Bernard Goffinet Introduction to bryophytes, UK: CambridgeUniversity Press, 2009.

Fungi

- 1. Alexopoulos and Mim's *Introductory Mycology*, Hyderbad: Wiley Eastern Ltd. 1983.
- 2. Johri R.M Sneh Lata and Kavita Tyagi *Text Book of Fungi*. New Delhi: Dominant Publishers and Distributors Pvt. Ltd. 2010.
- 3. Smith G.M *Cryptogamic Botany* Vol.I New York : McGraw Hill Book Company, 1988.

Lichen

1. Ahmadjian, V and Mason E. Hale M.E *The Lichens*. New York: Academic Press, 1973.

Practical: Hrs/Week - 2

• Algae: Micropreparation of Nostoc, Oscillatoria, Coleochaete, Caulerpa, Codium, Valoniopsis, Enteromorpha, Ulva, Padina, Turbinaria, Hypnea, Gracilaria.

Collection, identification and preservation of fresh water and Marine algae. Preparation of algal herbaria

- Bryophyta: Targionia, Reboulia, Plagiochasma, Pallavicinia, Anthoceros, Sphagnum, Polytrichum.
- Fungi: *Pilobolus, Peziza, Xylaria, Polyporus, Agaricus* Observation and study of fungi under natural habitat.
- Lichens: Usnea, Parmelia

Field visit: No of days: 4 (Collection of Algae, Bryophytes, Fungi and Lichens)

Submission - Record Note Book

Bottle specimens/herbarium specimens (any five)

Laboratory Manuals for Reference:

- Ashok M Bendre and Ashok Kumar A Text Book of Practical Botany Volume I.Meerut: Rastogi Publications, 2009.
- 2. Srivastava H.N *Practical Botany Volume I*, Jalandhar: Pradeep Publications, 1987.

SEMESTER I						
Core II Plant Microbe Interaction						
Course Code: 21PBOC12 Hrs/week: 6 Hrs/Semester: 90 Credits: 4						

- To provide information on the growth and morphology of microbes
- To familiarize the interaction of plants with microbes
- To understand the basic principles related to plant diseases.

Course Outcomes

CO. No	Upon completion of this course, students will be able to:	PSO	CL
		addressed	
CO-1	perform the techniques of isolation, characterization and	4	Re
	measure the growth of bacteria		
CO-2	differentiate the mode of action of antibiotics	1	An
CO-3	outline the stages of disease pyramids and disease cycle.	2	Un
CO-4	know about the enzymes involved in plant diseases	1	Re
CO-5	understand the basic principles related to plant diseases.	2	Ap
CO-6	purify, detect and identify the plant viruses.	3	Re
CO-7	understand the general symptoms of bacterial disease, viral diseases and fungal disease	1	Un
CO-8	provide tools to design innovative, sustainable and tailored control methods to prevent plant diseases or to reduce theirimpacts	6	Cr

SEMESTER I						
Core II Plant Microbe Interaction						
Course Code: 21PBOC12 Hrs/week: 6 Hrs/Semester: 90 Credits: 4						

- **UNIT I:** Early development of microbiology, contributions of Leeuwenhoek,Robert Koch, Edward Jenner, Alexander Flemming and Louis Pasteur.Isolation of pure culture and measurement of growth of bacteria. Purification and quantitative assay of plant viruses. Antimicrobial components: mode of action of penicillin, streptomycin and sulfonamides.
- UNIT II: Introduction: Components of disease (disease pyramid); causes of disease; classification of diseases; stages in the development of disease (disease cycle); Enzymes in plant diseases-pectic enzymes, macerating enzymes and cellulolytic enzymes. Dissemination of plant pathogens, Integrated disease management.
- UNIT III: Characteristic features of plant pathogenic bacteria, general symptoms of \bacterial diseases, Survival and spread of bacterial plant pathogens, control of bacterial disease. Symptoms, morphology of the causal organism, disease cycle and disease management of the following: Angular leaf spot of cotton, Citrus canker and Tundu disease of wheat.
- **UNIT IV:** General characteristic of plant pathogenic fungi, survival, dissemination and spread, general symptoms, control of fungal diseases. Symptoms, morphology of the causal organism, disease cycle and disease management of the following: Wilt of cotton, Downy mildew of grapes and Ergot of rye.
- **UNIT V:** General characteristic of plant viruses, translocation and distributions of viruses of plants, symptoms caused by plant viruses, Purification, detection and identification of plant viruses, control of plant viruses. Symptoms, morphology of the causal organism, disease cycle and disease management of the following: Bunchy top of banana, leaf curl of papaya and Yellow vein mosaic of bhindi.

Books for Reference:

- 1. Agrios G.N. *Plant Pathology*. London : Academic Press, 1997.
- 2. Caldwell D.R. *Microbial Physiology and Metabolism*. United states: Wm.C Brown publishers, 20 05.
- 3. Dubey R.C and Maheshwari D.K. A text book of microbiology. New Delhi:

S.Chand and company,2003.

- Kumar H. D and Swati Kumar. Modern concepts of Microbiology. NewDelhi: Vikas Publications, 2008.
- 5. Mehrotra R.S and Agarwal A. *Plant Pathology*. New Delhi: Tata McGrawHill Publishing Company, 2003.
- 6. Pelczar H. and Reid R. *Microbiology* Concepts and Applications. New Delhi:Tata Mc Graw Hill lPublishing company Pvt.Ltd., 1998.
- Pelzar M. J, Chan E.C.S and Noel. R *Microbiology*, New Delhi: TataMc Graw Hill Publishing company Pvt.Ltd., 2010.
- 8. Prasad T.V.S. *Soil Microbiology*, New Delhi: Dominant Publishers anddistributors, 2011.
- 9. Prescott L.M, Harley J.P and Klein D.A *Microbiology*. London:Mc Graw hill,2002.
- 10. Sharma P.D. *Plant Pathology*. NewDelhi: Narosa Publishing House Pvt. Ltd.,2006.

Practical: Hrs/week: 2

- Record of brief life history of scientist related to microbiology
- Methods of sterilization of glasswares
- Preparation of media
- Serial dilution technique
- Pure culture technique
- Effect of antibiotics on the growth of bacteria. Determination of MIC
- Micropreparation/ study of infected specimen prescribed in the syllabus
- Angular leaf spot of cotton
- Citrus canker
- Tundu disease of wheat
- Bunchy top of banana
- Leaf curl of papaya
- Yellow vein mosaic of bhindi.
- Wilt of cotton
- Downy mildew of grapes
- Ergot of rye

Submission - Record Note Book

Laboratory Manuals for

Reference:

- 1. Lakshmanan M, Kunthala Jeyaraman, Jeyaraman and Gnanam, *Laboratoryexperiments in microbiology and molecular biology*, Higginbothams Pvt. Ltd., 1971.
- 2. Sharma P.D. *Plant Pathology*, NewDelhi: Narosa Publishing House Pvt. Ltd.,2006.

Semester I					
Core IV Phytochemistry and Pharmacognosy					
Course Code: 21PBOC14 Hrs/week: 5 Hrs/Semester: 75 Credits: 4					

- Exploring the plant resources as pharmaceuticals and nutraceuticals.
- To acquire knowledge on identification, extraction and utilization of phytochemical constituents through teaching and training.

Course Outcomes:

CO. No.	Upon completion of this course, students will be	PSO's	CL
	able to	addressed	
CO-1	confirm the promising role of the phytoconstituents	8	Re
	as cytotoxicity and substantiate them for the treatment of fatal diseases		
CO-2	understand the importance of secondary metabolites	6	Un
	and relate them in treating the ailments		
CO-3	identify and categorize medicinal potential of herbs	1	Un
	applications		
CO-4	associate the medicinal compounds with their natural resources	2	An
CO-5	analyse of qualitative and quantitative medicinal compounds in herbal drug preparation.	2	An
CO-6	extract essential oils from natural resources and utilize them effectively as pharamaceuticals and cosmeticals	7,8	Av
CO-7	evaluate the purity of the drugs and able to detect adulterations and substitutions	2,4	Ev
CO-8	screen and elucidate various pharmacologically important phytoconstituents to ascertain its medical quality	5	Ev

Semester I					
Core IV Phytochemistry and Pharmacognosy					
Course Code:21PBOC14	Hrs/week: 5	Hrs/Semester: 75	Credits: 4		

- UNIT I: Phytochemistry, Histochemistry, Biosynthetic pathway for secondary metabolites. Secondary metabolites definition, classification, preliminary phytochemical screening. Glycosides: Definition, properties, classification, natural sources, pharmacological and toxicological effects of glycosides. Terpenoids- β-Sitosterol, Glycyrrhizin. Phenolics Coumarins and Tannins. Steroids and alkaloids.
- **UNIT II:** Flavonoids: Definition, properties, classification, natural sources and therapeutic applications offlavonoids. Medicinal uses of resins.
- UNIT III: Extraction methods Maceration, infusion, percolation, Decoction, soxlet extraction, supercritical fluid extraction, distillation, Counter-current Extraction, and cold extraction. Volatile oils - source, constituents, properties, extraction and utilization of Lemon grass oil, Vetiver oil, Clove oil and Eucalyptus oil. Intellectual property rights and trade of medicinal plants.
- UNIT IV: Pharmacognosy: Definition, scope and applications of herbal medicine. Classification (morphological, therapeutic, chemical. and chemotaxonomic classifications): Collection and processing of crude drugs - adulteration of crude drugs. Pharmacognostical standards, synergy and polyvalent action of secondary metabolites.
- UNIT V: Evaluation of crude drugs Physico-chemical, organoleptic analysis.
 Botanical name, family, useful part, chemical constituents, adulterants and uses of the following drug Glycosides Senna, Aloe, Digitalis, Liquorice; Terpenoids Coriander, Fennel, Cinnamom; Alkaloids Datura, Vinca, Pepper; Lipids Castor, Neem, Sesame oil.

Books for Reference:

- 1. Agarwal S.S. and Paridhavi M. *Crude Drug Technology*, Hyderabad: Universities Press, 2007.
- Evens W.C. *Pharmacognosy Medicinal and Aromatic Crops*, Singapore:Harcourt Brace and company Asian Pvt. Ltd., Universities press, 1987.
- 3. Farooqui A.A and B.S.Sreeramu B.S. *Cultivation of medicinal and aromatic crops*, Pune: Universities press, 2001.
- 4. Gurdeep Chatwal. Organic Chemistry of Natural Products, Mumbai: Himalaya
 Publishing house, 1983.

- 5. Kokate C.K. Purohit A.P. and Gokhale S.R, *Pharmacognosy*, Pune: Nirali PrakshanPublishing House Ltd., 2004.
- 6. Tewari K.S, Vishogi N.K and Mehrotra S.N. *Text Book of Organic Chemistry*, Uttaarpradesh: VikasPublishing House Ltd., 1998.
- 7. Trivedi P.C. *Medicinal Plant conservation and utilization*, Jaipur: Aavishkarpublishers,2004.
- 8. Trivedi P.C and Sharma N.K. *Ethomedicinal Plants*, Jaipur: Pointer Publishers , 2004
- 9. Wallis. Text Book of Pharmacognosy, New Delhi: CBS Publishers, 2003.
- 10. Yohanarasimban S.N. Medicinal plants of India, Jodhpur: 2004.

Practical: Hrs/Week: 2

- Morphology, histology and Powder characteristics, extraction and detection of Cinnamon, Clove, Fennel and Coriander.
- Isolation and detection of active principles:Caffeine from Tea dust Sennosides from Senna Curcumin from Turmeric
- Analysis of crude drugs by chemical tests for the detection of Glycosides -

Senna,

Aloe, LiquoriceTerpenoids – Coriander, Fennel, Cinnamom Alkaloids – *Datura, Vinca*, Pepper Lipids - Castor, Neem, Sesame, Groundnut oilResin – Ginger, Asafoetida.

Volatile oil – Lemon and clove

• Distillation of Volatile oils and detection of phytoconstituents by TLS Jasmine and *Eucalyptus*

Books for Reference:

- 1. Kokate K.C and Gokhale S.B. Practical Pharmacognosy, Pune: 2008.
- 2. Chauhan M.G. and Pillai A.P.G, Microscopic Profile of Powdered Drugs Used in IndianSystems of Medicine. Jamnagar: *Institute of Ayurvedic Medicinal Plant Sciences*, 2005.

SEMESTER II					
Core V Plant Diversity I	Core V Plant Diversity II (Pteridophytes, Gymnosperms and Paleobotany)				
Course Code: 21PBOC21Hrs/week: 5Hrs/Semester: 75Credit: 4					

- To have a comprehensive idea on vascular cryptogams and phanerogams.
- To get an idea on the past history of biosphere and evolution of seed plants.
- To understand the taxonomy, characteristics and uniqueness of vascular plants.

Course Outcomes:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	appreciate the uniqueness and distinguish between diverse groups of Pteridophytes and Gymnosperms using their characteristic features	1, 2	An
CO-2	discuss different life cycle patterns in different groups	1, 2	Cr
CO-3	know the basic skills and techniques in micropreparation and formulate methods to identify different groups	1, 6	Ар
CO-4	know the evolutionary significance of Pteridophyte	1, 2	Un
CO-5	infer pteridophytes are pioneer in the evolution of seedhabit	1, 2	Re
CO-6	compare and contrast the origin and evolution of steles, foliage, seed and seedless plants.	1, 2	An
CO-7	compare and contrast the seed and seedless plants.	1, 2	Ev
CO-8	review critically the biology, ecology of fossils and methods of fossilization.	1, 7	Un

SEMESTER II					
Core V Plant Diversity II (Pteridophytes, Gymnosperms and Paleobotany)					
Course Code: 21PBOC21 Hrs/week: 5 Hrs/Semester: 75 Credit: 4					

- **UNIT I: Pteriodophytes:** Classification of pteridophytes (PPG) by Erics (2016 (upto order level). Origin and evolution of pteridophytes. General characteristics. Telome concept. Stelar evolution in pteridophytes. Heterospory and seed habit. Theories and modifications of alternation of generations. Life cycle pattern in homosporous and heterosporous pteridophytes. Distribution of pteridophytes in India
- UNIT II: Morphological, anatomical structure, asexual and sexual reproduction of Psilotales, Lycopodiales, Selaginellales, Isoetales, Equisetales, Ophioglossles and Polypodiales. Aposory, Apogamy, Vivipary, Parthenogenesis. Economic importance of pteridophytes.
- **UNIT III: Gymnosperms:** Classification of gymnosperms by Christenhusz *et al.* (2011) (Upto family level). General characteristics. Distribution of gymnosperms in India. Morphological, anatomical structure and reproduction of Cycadaceae, Ginkgoaceae, Welwitschiaceae, Gnetaceae and Ephedraceae,
- **UNIT IV:** Morphological, anatomical structure and reproduction of Araucariaceae, Podocarpaceae and Cupressaceae. Affinities of gymnosperms with angiosperms and pteridophytes. Economic importance of gymnosperms.
- UNIT V: Paleobotany: Geological time scale fossilization and fossil types: compressions, incrustation, casts, molds, petrifactions, coal balls and compactions. General characters of fossil pteridophytes: *Horneophyton, Sphenophyllum* and *Calamites*. Fossil gymnosperms: *Williamsonia* and *Cordaites*. Indian Paleobotanists: Birbal Sahni,

D.D. Pant, M. Ramanujam, Osmani.

Books for Reference:

Pteridophytes:

1. Bower, F.D. *Primitive land plants*. Vol. I & 2. Jaipur : Arihant Publishers. 1988.

- Pandey S.N., Trivedi P.S., Misra S.P. A text Book of Botany Vol. II. New Delhi: Vikas Publishing House Pvt. Ltd., 2006.
- Parihar, N.S. An introduction to Embryophyta, Pteridophyta. Allahabad: Central Book Depot Publications in Botany. 1967.
- 4. Rashid, A. *An introduction to Pteridophyta*. New Delhi: Vani Educational Books. 1985.
- 5. Sundara Rajan S. *Introduction to Pteridophyta*. New Delhi : New Age International Publishers. 2009.

Gymnosperms:

- Chamberlain, C.J. *Gymnosperms.Structure and evolution*. New Delhi: CBS Publishers &Distributors, 1986
- Johri R.M., Sneh Lata and Kavita Tyagi. *Text Book of Gymnosperms*. New Delhi : Wisdom Press. 2010.
- 3. Sporne, K.R. *The Morphology of Gymnosperms*. New Delhi: B.I. Publications Pvt. Ltd., 1974.

Practical: Hrs/Week – 2

Pteridophytes:

- Selaginella Habit, Section: T.S. of stem, rhizophore, L.S. of cone
- *Isoetes* Habit, Section: T.S. of leaf

Permanent slide: L.S. of male and female cone

- *Equisetum* Habit, Section: T.S. of internode Permanent slide: L.S. of cone
- *Lygodium* Habit, Section: T.S. of rachis
 - Permanent slide: T.S. of pinnule
- Osmunda Habit, Section: T.S. of rachis Permanent slide: L.S. of cone
 - *Pteris* Habit, Section: T.S. of rachis and pinnule
- Adiantum- Habit, Section: T.S. of rachis and sori
- *Salvinia* Habit, Section: T.S. of stolon
 - Permanent slide: L.S. of cone

Gymnosperms:

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• *Cycas* – Twig, Section: T.S. of corolloid root, rachis and leaflet Permanent slide: L.S. of microsporophyll, male cone (entire),

female cone (entire)

- *Gnetum* Twig, T.S. of stem and leaf Permananent slides: L.S. of male and female cone, wood showing anomalous secondary thickening and seed (entire).
- Araucaria Twig, Section: T. S. of stem

Permanent slide: L.S. of cone

- *Podocarpus* Twig, Section: T.S, of stem, leafPermanent slide: L.S. of cone
- *Cupressus*: Twig, Section: T. s. of stem Permanent slide: L.S. of male cone and female cone

Fossils:

Pteridophytes:

- Sphenophyllum
- Calamites

Gymnosperms

- Williamsonia
- Cordaites

Field study: No. of days 3 (Pteridophytes and Gymnosperms: Western Ghats)

Submission - Record Note Book

Lab manuals for Reference:

- 1. Ashok M. Bendre and Ashok Kumar. *A Text Book* of *PracticalBotany*Volume1. Meerut : Rastogi Publications. 2009.
- 2. Srivastava H. N, *Practical Botany* Volume I, Jalandhar : PradeepPublications, 1987.

SEMESTER II					
Core VI	Marine H	Botany			
Course Code: 21PBOC22	Hrs/week:	5	Hrs/Semester: 75	Credits: 4	

- To give elaborate account on marine environment and its role in controlling the Earth'sclimate.
- To understand the different types of marine habitats and the adaptation of life there in.
- To understand the role of marine products and their socio economic and environmental significance

Course Outcomes:

CO. No.	Upon completion of this course, students will be	PSO	CL
	able to	addressed	
CO-1	analyze how marine organism adapt to their dynamic	5	Un
	environment		
CO-2	recall how natural events and human activities affect	7	Re
	coastal habitats		
CO-3	critically analyze and evaluate pollution issues, their		
	sources and the influences humans have with the	7	An
	dynamic marine environment		
CO-4	achieve practical skills in processing, preserving and	6	Ev
	culturing marine plants		
CO-5	evaluate the uses of marine resources and realize the	5	Ap
	role of phytoplankton and bacteria in the economy of		
	the ocean		
CO-6	able to signify the characteristic feature of coral reefs	1	An
	and their role in biodiversity conservation		
CO-7	able to identify and understand the role of mangroves		
	in coastal protection and their adaptation to its hostile	5	Ар
	environment		
CO-8	explain the ecological relationship between organisms	2	An
	and their environment		

SEMESTER II					
Core VI Marine Botany					
Course Code: 21PBOC22 Hrs/week:5 Hrs/Semester: 75 Credits: 4					

- UNIT I: Classification of marine habitat ecology of pelagic, benthic and sublittoral zones, deep sea, sandy muddy and rocky shore. Characteristics of marine habitat tides and chlorinity, upwelling, plate tectonics, tsunami, green house effect, carbon pump. Ocean and regulation of climate on earth.
- UNIT II: Marine biodiversity –phytoplankton characteristics, measuring and sampling. Marine bacteria, marine fungi, seaweeds and sea grasses. Threats and conservation of seaweeds and sea grasses. Nutrient cycling: carbon, nitrogen, sulphur and phosphorus.
- UNIT III: Marine products traditional uses; human food and agriculture. Marine colloids and hydrocolloids Agar agar, algin, alginates, carrageenan, diatomite, marine lipids, flavanoids, and carotenoids. Marine pharmacology –identification of bioactive compounds in marine organisms mangroves, seaweeds, and sea grasses.
- **UNIT IV:** Culture of micro algae –laboratory culture, preservation and maintenance of culture and mass culture. Commercial cultivation of seaweeds. Marine pollution –thermal pollution, oil pollution, heavy metal pollution, radioactive pollution and industrial pollution. Algal blooms. Global climate changes: impact on specific diversity and productivity, ocean as carbon sink, effect on coral bleaching. Biological rhythms.
- **UNIT V:** Mangroves and salt marshes: geographical distribution, habit, adaptations, and trophic interactions. Present status and stresses on the mangroves with special reference to Sunderbans. Regeneration of mangroves. Coral reefs ecology, species interaction, economic importance and conservation.

Books for Reference:

- 1. Cliton Jand Dawes. *Marine Botany*. New York: A wiley Intersciences publication John Wiley andsons, 1981.
- 2. Dring M J. The Biology of Marine plants. London: Edward Arnold, 1982.
- 3. Kumudranjan Naskar and Rathindranath. *Ecology and Biodiversity of Indian mangroves. Vol. I & II*, Delhi: Daya publishing House, 1999.
- 4. Michael P. *Ecological methods for field and laboratory investigations*, Uttar Pradesh: Tata McGraw Hill publishing Company Limited, 1986.
- 5. Sinha P.C. Marine pollution, New Delhi: Anmol publications Pvt. Ltd., 1998.

- 6. Tait R.V. Elements of Ecology, London: Butter worths, 1978.
- 7. Warren. *Biology and water pollution* control, London: W.B.Saunders Company, 1971.

Practicals: Hrs/Week: 2

- Determination of acidity
- Estimation of alkalinity
- Estimation of Salinity
- Collection and identification of phytoplankton.
- Determination of total hardness
- Estimation of nitrate (Spectrophotometry)
- Estimation of Phosphate (Spectrophotometry)
- Heavy metal analysis from mangrove sediments

Specimens / photographs / charts

- Plankton net
- Seaweeds
- Sea grasses
- Mangroves
- Alginates
- Carrageenan

Books for Reference

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

SEMESTER II					
Core VII - Developmental Botany					
Course Code: 21PBOC23Hrs/week: 5Hrs/Semester: 75Credit: 4					

- To study the vegetative and reproductive development of seed-bearing plants
- This course is aimed at understanding the structural organization of tissues, organs and their developmental events controlled by environmental cues and genetic factors

Course Outcome

CO No	Upon completion of this course ,students will be	PSO	CL
0.10	ableto	addressed	CL
CO-1	understand the overview of essential aspects of	3	Un
	development, organization and life cycle of seed	C	<u>en</u>
	bearing plants		
CO-2	know how embryo arises and the nature of signals	4	Un
	that guide complex patterns of growth and		011
	differentiation in the embryo		
CO-3	explore and illustrate how the molecular and genetic	4	Re, Un
	approaches provide an insight into the mechanismthat		
	translate cues into organized pattern growth and		
	development		
CO-4	understand cell differentiation, organ development	3	Un
	and network of gene signals that control		
	developmental sequences		
CO-5	role of shoot and root apical meristem in vegetative	3	Re Un
	growth and development	C	1.0, 0.1
CO-6	know the biochemical and physiological changes	4	Un An
	associated with the development of sex organs,	•	01,11р
	fertilization events and fruit development		
CO-7	know how the intrinsic programmes of development		
	coupled to external influences such as nutrient	4	Un
	levels, energy inputs and environmental signals.		
CO-8	acquire hands on training experience related to the	4	Re
	course.		100

SEMESTER II				
Core VII Developmental Botany				
Course Code: 21PBOC23 Hrs/week: 5 Hrs/Semester: 75 Cred				

- UNIT I: Embryogenesis: Basic concept of development. Polarity and cell linages. Principle of determinants in plant embryogenesis – axis and pattern formation – apical, basal and radial; Cell plasticity - Meristem and indeterminate growth; Types of meristem – Root apical meristem (RAM) – quiescent center - development of lateral root and root hair formation position dependent signaling process- hormonal control and maintenance of RAM; Shoot apical meristem (SAM)- organization and activities of SAM, role of gene and transcription factors; vegetative organization, tissue differentiation, leaf initiation and differentiation, Genetic approaches on SAM.
- UNIT II: Seed germination and Seedling establishment: Seed structure, seed dormancy- breaking of seed dormancy; Seed germination phases, mobilization of stored resource, seedling growth growth curve- response to environmental cues- trophism gravitrophism, phototrophism, thigmotrophism role of auxin distribution in trophism; phototrophism-photomorphogenesis- shoot differentiation- vascular tissue differentiation; root growth and differentiation emergence of lateral growth and biochemical and physiological considerations.
- UNIT III: Vegetative growth and organogenesis: Leaf initiation and determination of phyllotaxy, differentiation of epidermal tissues and appendages, mesophyll tissues; venation pattern, role of hormones; primary root system and shoot system architecture; secondary growth in stem and root- secondary tissue and cambial activity- vascular cambium and corkcambium- abnormal secondary growth.
- UNIT IV: Floral development: Floral evocation and development of floral parts Floral meristem, floral organ development gene control mechanism, homeotic gene control organ identity, competency and determination in floral evocation. Integrating environmental cues photoperiodism monitoring day length, circardian ryhythm, vernalization- promoting flowering with cold- temperature control; physiological and molecular control of floral organ development and hormone signals in floral evocation

-, gender expression in flowers, genetic control of floral symmetry.

UNIT V: Developmental biology of floral organs: Anther differentiation – tapetalbehavior, microsporogenesis, pollen development and maturation. Male gametogenesis- pollen germination; megasporogenesis – development of female gametophyte- organization of embryo sac- gene regulation on megagametogenesis- pollen pistil interaction self incompatibility – causes – morphological, cyto genetical reasons – fertilization- development of seed and fruit formation.

Books for Reference:

- 1. Leyser O and Day S *Mechanisms in plant development*. France: Black WellPublishing Company, 2009.
- Howell S.H Molecular genetics of plant development. NY: CambridgeUniversityPress, 1998.
- Taiz L and Zeiger E *Plant Physiology and development*. USA: SinauerAssociates.Sixth Edition. 2010.
- 4. Ragavan V Developmental Biology of flowering plants. NY:Springer. 2000.
- Ragavan V Experimental Embryogenesis in Vascular plants. London: Academic Press Inc., 1976.
- Shivana K.R and Joshi B.M *The angiosperm pollen structure and function*. .Singapore: John Wiley & Sons, 1985.
- Benjamin H Willier and Jane M Oppenheimer Foundations of ExperimentalEmbryology. New Delhi. Prentice of India Private Limited, 1968.

Practical: Hrs/week: 2

- Micropreparation of shoot apex/root apex/flower buds/ anther/ ovary/epidermal appendages formicrotomy
- Directionality of pollen tube growth: protein extraction and protein gelelectrophoresis
- Pollen viability test
- Pollen germination test
- Hand sectioning of anther and ovary
- Dissecting embryo and endosperm

Books for Reference

1. Chawla H.S Introduction to Plant Biotechnology. New Delhi:

Oxford & IBHpublishing company Pvt.,Ltd., 2009.

SEMESTER III				
Core IX Biochemistry and Biophysics				
Course Code: 21PBOC31 Hrs/week: 6 Hrs/Semester: 90 Credits:4				

- To provide updated knowledge of plant's molecular, macro molecular and supra molecular architecture and how they determine the function of plant life.
- To enhance transferable skills such as conduction of quantitative estimation of biomolecule and give mathematical reasoning to interpret the data of the same.
- Familiarise and applies the concept of other branches of sciences that span plant biology such as chemistry, physics and mathematics.

Course Outcomes:

CO.	Upon completion of this course, students will be	PSO	CL
No.	able to	addressed	
CO-1	study the polymeric biomolecules and their	1,2	Re
	monomeric building blocks		
CO-2	illustrate that living organisms and biological system	1,3	Re
	interact via molecular connection		
CO-3	able to realise the importance of structural	1,6	Re
	configuration and atomic rearrangement of		
	macromolecule with respect to their functions		
CO-4	detect the source of vitamins and their chemistry and	2,4	Re
	distinguish their symptoms specific to their deficiency		
CO-5	outline enzyme groups and know the nomenclature	2,3	An
	that be able to explain the specificity of enzyme's role		
	and mode of action		
CO-6	set up and operate variety of experiments to analyse	3,4	Ар
	data accompanied by problem solving and recording.		
CO-7	draw electromagnetic spectrum and understand the	2,7	Ар
	properties of light to relate biological applications.		
CO-8	explain that energy is needed by plant and that is	3,7	Cr
	transformed in biochemical system as governed by		
	the laws of thermodynamics		

SEMESTER III				
Core IX Biochemistry and Biophysics				
Course Code: 21PBOC31 Hrs/week: 6 Hrs/Semester: 90 Credits:4				

- **UNIT I: Biomolecules:** Carbohydrates Classification, Structure of monosaccharides (glucose, fructose galactose, and mannose), disaccharides (trehalose. sucrose. maltose and cellobiose), polysaccharides (starch, cellulose, glycogen, chitin). Properties of carbohydrates. Amino acids: Structure and classification based on R group. Protein: Structural organisation of protein (primary, secondary (keratin), tertiary (myoglobin) and quaternary structure (hemoglobin)), bonds involved in protein structure. Properties of protein.
- UNIT II: Metabolism: Introduction to metabolism. Metabolism of carbohydrate: Gluconeogenesis, metabolism of glycogen, galactose and fructose. Metabolism of aromatic amino acids: Biosynthesis and degradation of phenylalanine, tyrosine and tryptophan. Intermediatory metabolism. Commercial polypeptides ACTH, Thymosin.
- UNIT III: Lipids: Classification, structure and properties of simple lipids (triglyceride and wax), compound lipids (phospholipids andglycolipids) and derived lipids (steroids cholesterol, terpines). Metabolism of lipids: Biosynthesis and degradation of fatty acid and cholesterol. Vitamins: Biochemical functions of vitamin A, B₁₂, C, D.
- UNIT IV: Enzymes –nomenclature IUPAC 1974. Isozymes, Allozymes.
 Principles of catalysis, enzyme action, active site, activation energy, enzyme kinetics (invertase). Cofactors and inhibitors. Coenzymes NADP, FAD, FMN and coenzyme A. Factors affecting enzyme activity.
- UNIT V: Biophysics: Dual nature of light, electromagnetic spectrum, phosphorescence, fluorescence and bioluminescence. Laws of thermodynamics, concept of enthalpy, entropy and free energy. Redox couple, redox potential, coupled reactions, oxidative phosphorylation. High energy compound - ATP.

Books for Reference:

- Bhutani S.P. Chemistry of Biomolecules. New Delhi: Ane Books Pvt. Ltd., 2009.
- 2. Conn E. E. and Stumpf P. K. *Outlines of Biochemistry*. New York: John Wiley and Sons, Inc., 1987.
- Cox M.M. and Nelson D. L. *Principles of Biochemistry*. India: Replika Press Pvt. Ltd., 5th edition, 2008.
- 4. David Rawn. Biochemistry. New Delhi: Panima Publications, 2004.
- 5. Ferrier D. R. *Biochemistry*. New Delhi: Wolters Kluwer (India) Pvt. Ltd., 6th edition, 2014.
- 6. Gupta S.N. Biochemistry. Meerut, India: Rastogi Publications, 2011.
- 7. Lehninger A. L. *Principles of Biochemistry*. Delhi: CBS publishers and Distributors, 1987.
- 8. Nagini, S. *Text Book of Biochemistry*. Chennai, India: Scitech Publications Pvt. Ltd., 2nd edition, 2007.
- 9. Salil Bose. *Elements of Biophysics*. Madurai: Jothi Books, 1982.
- Sathyanarayana, U and Chakrapani U. *Biochemistry*. Kolkata: Arunabha Sen, Books and Allied (P) Ltd. 3rd edition, 2006.

Practical

Hrs/Week: 2

- Estimation of total carbohydrates.
- Titration of amino acid (glycine)
- Estimation of free amino acid from plant tissues (Ninhydrin method)
- Estimation of total soluble protein from plant tissues (Barfoed's test)
- Separation of amino acids (ascending paper chromatography).
- Separation of photosynthetic pigments (column chromatography).
- Absorption spectrum of chlorophyll
- Study of enzyme kinetics and determination of Km value.
- Saponification value of two vegetable oils.
- Enzyme assay- Protease
- Chem sketch/morvin sketch for compound structure prediction
- Pass online analysis
- Submission Record Note Book

Laboratory Manual for Reference:

1. Jayaraman. J. *Laboratory manual in Biochemistry*. New Delhi: New Age International Publishers, 2011.

SEMESTER III				
Core X Taxonomy of Angiosperms				
Course Code:21PBOC32 Hrs/week:6 Hrs/Semester: 90 Credit:4				

- To acquire knowledge on different systems of classification and to have an insight on modern trends in classification of Angiosperms.
- To provide practical understanding of floristic feature of angiosperm that enable to identify plants up to species level in the field / forest inventory
- Infer the significance of taxonomy in understanding the evolutionary relationship between plants and to involve in research practices.

Course Outcomes:

CO. No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the rules of botanical nomenclature and taxonomical hierarchy that enable to organize the plant based on the hierarchical system	1	Ap
CO-2	apply scientific literature for identifying and grouping of underrepresented plants in the taxonomic literature	4	Re
CO-3	to outline different systems of classification and recall the contribution of taxonomist/naturalist in plant systematics	6	Un
CO-4	compare the traditional and modern system of classification and report its merits and demerits.	1	Ap
CO-5	realize the importance of taxonomical literature (flora, monograph, botanical gardens, herbarium and government organization) and utilize them for plant identification and conservation.	1	Un
CO-6	apply effectively the traditional and modern tool (Keys, interactive keys, e-flora, digital herbarium) to develop skill in plant identification	4	Un
CO-7	recognize how the role of cytology, embryology, phytochemistry and molecular biology of plants help to authenticate the identity of plants	7	Ар
CO-8	gain hands on working experience in describing the floristic feature of the plants of specified families and make sketches of that.	1	An

SEMESTER III				
Core X Taxonomy of Angiosperms				
Course Code:21PBOC32 Hrs/week:6 Hrs/Semester: 90 Credit:4				

- **UNIT I:** Definition, objectives and brief history of plant taxonomy. Botanical Nomenclature: need for scientific names, polynomial and binomial nomenclature. ICBN: principles, Rules and Recommendations, the rank of taxa (family, genus, species, infra-specific taxa), type method, typification, author citation, publication, effective and valid publication, retention, rejection of names and principle of priority. Phylocode: principles, rules and advantages. Taxonomic hierarchy: Ranks in the hierarchical system (order, family, genus, species and intra specific)
- UNIT II: Classification: Relative merits and demerits of major systems of classifications: Linnaeus, Bentham and Hooker's and Angiosperm Phylogeny Group (IV). Current trends in Biosystematics: Phenetics: principles of taximetrics. Cladistics: phylogenetic terms and phylogenetic diagrams. Numerical taxonomy: construction of taxonomic groups, applications, merits and demerits.
- **UNIT III**: Tools of taxonomy: Floras, monographs, revisions, websites. Herbarium and botanical gardens: their role in teaching, research and conservation, important herbaria and botanic gardens of the World. Dichotomous keys: guidelines for constructing dichotomous keys (indentedand bracketed key), interactive keys (computer aided). Digital herbaria: e- flora. Taxonomic evidences: anatomy, cytology, embryology and chemosystematics based on the phytochemicals (phenols, alkaloids, flavonoids and terpenoids). Molecular systematics (DNA bar coding).
- UNIT IV: Vegetative and floral characters of the following families: Ranunculaceae, Capparidaceae, Tiliaceae, Meliaceae, Rhamnaceae, Sapindaceae, Fabaceae, Combretaceae, Asteraceae, Sapotaceae.
- UNIT V: Vegetative and floral characters of the following families: Solanaceae, Boraginaceae, Convoluvaceae, Scrophulariaceae, Bignoniaceae, Verbenaceae, Nyctaginaceae, Orchidaceae, Commelinaceae and Cyperaceae.

Books for Reference:

- 1. Davis P.H. and Heywood V.M. Principles of Angiosperm Taxonomy. London: Olive & Byod, 1983.
- 2. Gurcharan Singh. Plant Systematics. New Delhi: Oxford & IBH Publishing Company, 2004.
- 3. Gurcharan Singh. Plant Systematics. New Delhi: Oxford & IBH Publishing Company, 2012.
- 4. Lawrence G.H.M. Taxonomy of Vascular Plants. New Delhi: Oxford & IBH Publishing Company, 1951.
- 5. Naik V.N. Taxonomy of Angiosperms. New Delhi: Tata Mc Graw Hill Publishing Co., 1984.
- 6. Pandey S. N., Misra S.P. Taxonomy of Angiosperms. New Delhi: Ane Books India, 2008.
- 7. Sharma O.P. Plant Taxonomy. New Delhi: Tata Mc Graw Hill Publishing Co Ltd., 1993.
- 8. Singh G. Plant Systematics Theory and Practice. New Delhi: Oxford & IBH, 1999.
- 9. Mathur R.C. Systematic Botany Angiosperms. Agra: Agra Book Store, 1972.

Practical:

Hrs/Week-2

- Study of wild taxa representing different families and identification to species level.
- Construction of taxonomic keys (dichotomous).
- Field trips within and around the campus; compilation of field notes and preparation of herbarium sheets.
- Identification of plants using floras.

Submission - Record note book, five herbarium sheets, photography of five dissected flowers and field note book

Taxonomic Manual for Reference:

1. Gample J.S. Flora of the Presidency of Madras – Vol I & II, Reprint. Authority of Secretary of state for India in Council, 1956.
| SEMESTER - III | | | | | |
|---|--|--|--|--|--|
| Core XI Molecular Biology and Genetic Engineering | | | | | |
| Course Code: 21PBOC33 Hrs/week: 5 Hrs/Semester: 75 Credits: 4 | | | | | |

- To furnish broad insight on chemical nature of hereditary material (DNA), organization of chromosome at different phases of cell cycle, basic rules, governing its replication and to examine genes have the code to life.
- To apply the understanding of DNA and adopt molecular techniques to manipulate gene to get the desired output.
- To educate the students in strategizing research methodologies employing genetic engineering techniques.

CO.No.	Upon completion of this course, students will	PSO	CL
	be able to	addressed	
CO-1	know the chemistry of genetic material and	1	Un
	details of its replication at molecular level		
CO^2	pronounce how errors during replication are	6	Δn
0-2	repaired	0	All
CO-3	infer complexity of gene expression in	2	Un
	eukaryotes over prokaryotes		
CO-4	explain gene regulation mechanisms at various		
	levels by which they can learn how it controls	4	Cr
	growth and development of an organism		
CO-5	Understand the principles of genetic	2	Un
	engineering and basic steps of gene cloning		
CO-6	advocate the role of enzymes and vectors		
	responsible for gene manipulation,	1	Un
	transformation and genetic engineering		
CO-7	grasp different types of gene transfer methods	2	Cr
	employed in gene cloning process		
CO-8	practice the advanced techniques in genetic		
	engineering, investigate the different strategies	3	Ар
	of recombinant DNA technology and resolve		
	the problems encountered		

SEMESTER - III					
Core XI Molecular Biology and Genetic Engineering					
Course Code: 21PBOC33Hrs/week: 5Hrs/Semester: 75Credits: 4					

- UNIT I: Replication of DNA: Molecular mechanism of DNA replication in prokaryotes (activation, initiation synthesis of new strands of DNA, termination and helix formation) and eukaryotes (replication of the ends of eukaryotic chromosomes, telomerase enzyme), Enzymology of DNA replication (DNA polymerase enzymes in prokaryotes and eukaryotes and DNA ligase enzymes), replication models (theta replication of DNA, rolling circle model and D-loop model). DNA repair: necessity of DNA repair, mistakes in DNA (types), Biochemical mechanism of DNA repair (mismatch repair and repair of thymidine dimers).
- **UNIT II:** Gene expression: Definition of gene, types of genes, functions of genes, transcription and processing of RNA in prokaryotes and eukaryotes, genetic code, translation in prokaryotes (initiation, elongation, termination) and eukaryotes (initiation, elongation, termination) and eukaryotes (initiation, elongation, termination and polypeptide folding), post translational processing of protein (protein folding).
- **UNIT III: Regulation of gene expression:** Gene regulation in prokaryotes: Coordinated gene regulation, strategies of gene regulation, mechanism of gene regulation at transcriptional level induction (*lac* operon – structure, functioning) and repression (*trp* operon – structure). **Gene regulation in eukaryotes:** genome level (presence of multigene families, gene alteration, gene arrangement), transcription level (acetylation of histones, euchromatin remodeling complexes, methylation of nucleotides, control elements, transcription factors, mediators, insulator, regulatory proteins, hormones and chromosome level), post-transcriptional level (post-transcriptional control by choice of splice site, polyproteins, regulation of gene expression by RNA, control on transport of RNA, control at translation of RNA, mRNA degradation control, protein folding level and protein degradation control).
- **UNIT IV: Genetic Engineering:** Discovery, denaturation and renaturation of DNA, artificial synthesis of gene, restriction enzymes types, target sites, DNA cleavage styles (sticky and blunt end style). Biologicaltools for recombinant DNA technology (enzymes, linkers, foreign DNA and cloning vectors). Vectors cloning and expression vector, plasmid vectors types, characteristics (pBR322 and pUC8), bacteriophage vectors (lambda phage and M13 vectors), cosmid vectors (pJB8), phagemid vectors (pBluescript), artificial chromosome vectors (BAC and YAC), shuttle vectors, fosmid vectors.
- **UNIT V: Techniques used in Genetic Engineering:** Generation of DNA fragments (DNA cleavage by restriction enzymes, Southern blotting technique, Northern blotting and Western blotting). Artificial synthesis

of gene (Chemical assembly of oligonucleotides, enzymatic assembly of oligonucleotides and complementary DNA synthesis). Joining of foreign DNA fragment to a cloning vector (sticky, blunt end ligation and homopolymer tailing method). Introduction of recombinant DNA into host cell (transformation, transduction, electroporation, liposomes, microinjection and microprojectile). Selection and screening of transformed cells (reporter genes, elimination of non-transformed cells, identification of clones having rDNA, selection, formation and expression of cloned genes). Genetic engineering and human welfare.

Books for Reference:

- 1. Veer Bala Rastogi. Principles of Molecular Biology. India: MEDTECH.2016.
- 2. Brown T.A. *Gene cloning and DNA analysis, An Introduction.* Manchester: John Wiley & Sons. 2010.
- 3. Primrose S.B and Twyman R. *Principles of gene manipulation and genomics*.Wiley. 7th edition 2006.
- 4. Verma P.S. and Agarwal V.K. Genetic Engineering. New Delhi: S. Chand & Company. 2010.
- 5. Benjamin Lewin. Genes VII. Burlington: Pearson Prentice Hall. 2004.
- 6. Channarayappa. *Molecular Biology. Principles and Principles and Practices.* India: Universities Press Pvt. Ltd., 2006.
- 7. Nicholl D.S.T. *An Introduction of genetic engineering*. UK: Cambridge University press. 2001.
- 8. Robert H. Tamarin. *Principles of Genetics*. New Delhi: Tata Mc. Graw-Hill publishing company Ltd., 2006.
- 9. Sathyanarayana U. *Biotechnology*. Kolkatha: Book sand Allied (P). Ltd., 2006.
- Glick B.R, Pasternak J.J and Patten C.L. *Molecular Biotechnology: principles* and applications of recombinant DNA. Washington: ASM Press. 4th edition 2010.

Practicals

Hrs/ week - 2

- Estimation of DNA by diphenylamine method.
- Estimation of RNA by Orcinol method.
- Isolation of bacterial genomic DNA.
- Isolation of genomic DNA from plant tissue.
- Separation of DNA fragments using AGE.

- Digestion of DNA with restriction enzymes.
- Vecscreen software to detect foreign DNA.
- Protein translation using p BLAST.

Laboratory Manual for Reference:

 William D. Stansfield, Jame S. Colome and Raul J. Cano. *Theory and Problems Molecular and cell biology*. Schaum's outline series, 1st edition McGraw-Hill. 2019.

SEMESTER - IV				
Core: XIII	ore: XIII Plant Physiology			
Course Code: 21PBOC41	Hrs/week: 6 Hrs/Semester : 90 Credits: 5			

- To make them understand the organized complexity of the life process in plants.
- To investigate how the physical process and chemical connection determine plant's function and to layout practical skills in conducting a physiological experiment.
- To comprehend how the environmental cues sensitize chemical signals to regulate a lot of physiological functions.

CO.No.	Upon completion of this course, students will be able to	PSO addressed	CL
CO-1	understand the effect of the soil-plant-water continuum (SPWC) and assess the need of mineral nutrients and symptoms specific to nutrient deficiency.	6	Un
CO-2	discuss how root structure and functions influence the transfer of inorganic nutrients from the soil into the plants,	3	Un
CO-3	analyse the mechanism of assimilation of inorganic molecules into organic molecular components.	3	Un
CO-4	analyse light enhanced photochemical reactions that culminates in the synthesis of ATP and NADPH and fixation of carbon dioxide into organic compounds	3	Un
CO-5	describe respiration with its associated carbon metabolism and releasing of energy stored in chemical bonds in a controlled manner for cellular use	3	Re
CO-6	review systematically how plant's manage physiologically with respect to environmental stress.	7	Cr
CO-7	Remark on the hormone controlled and light mediated morphogenetic events in plants.	3	An
CO-8	design and conduct scientific experiments and analyze the data critically	6	Cr

SEMESTER - IV					
Core: XIII Plant Physiology					
Course Code: 21PBOC41 Hrs/week: 6 Hrs/Semester : 90 Credits: 4					

- **UNIT I:** Water relations of plants components of water potentials and their relation. Absorption of water Mechanism of ascent of sap. Translocation Mechanism of translocation of solutes- source sink relationship, phloem loading and unloading. Transpiration stomatal movement, antitranspirants, guttation. Inorganic nutrient ion uptake passive and active uptake and transport. Role of mineral nutrients-deficiency and toxicity symptoms. Hydroponics and its significance.
- **UNIT II:** Photosynthesis-General concepts, Principle of light absorption-action spectrum, absorption spectrum. Pigment system and quantum yield. Photosynthetic apparatus-organization of components in the thylakoid membrane, photochemical reaction- LHS, OEC, mechanism of electron transport -Z-scheme and cyclic; proton transport and chemiosmotic synthesis of ATP; regulation of photosynthetic machinery; carbon reaction-general aspects, activity of rubisco- Calvin Benson cycle, Inorganic carbon concentrating mechanism- C4 carbon cycle, CAM, C₂ oxidative photosynthetic carbon cycle (photorespiration) significance of C_2 cycle-ecological aspects of photosynthesis. Accumulation and partitioning of photosynthates.
- **UNIT III:** Respiration- overview, mitochondria-structural organization, glycolysis, regulation of glycolysis, PPP, Citric acid cycle, e⁻ transport system and chemiosmotic synthesis of ATP; alternative oxidase mechanism in plants (cyanide resistance respiration in plants); respiration and coupling of other metabolism. Assimilation of mineral nutrients in plants- N₂cycle, Nitrate assimilation. Ammonium assimilation and synthesis of aminoacids (GOGAT). Biologicalfixation of N₂. Assimilation of S and P in plants.
- **UNIT IV:** Growth hormone- history, biosynthesis, molecular mechanism of action and physiological role of auxin-regulators of cell elongation, phototropism and gravitropism; gibberellin-regulators of plant height; cytokinin-regulators of cell division in shoots and roots, movement of nutrients, chloroplast development; abscisic acid-seed maturation, antistress signal (closes stomata in response to water stress), ethylene-fruit ripening, senescence, abscission, morphactins and brassinosteroids. Photo morphogenesis-phytochrome-mediated photo responses. Physiology of flowering. Biological clock-occurrence of circadian rhythm in plants-examples.
- **UNIT V:** Stress physiology-concepts; types; biotic stress- role of secondary metabolites in plants defense mechanism against pathogens, insect and herbivores. Abiotic stress-types-salinity, drought, freezing, radiationand heavy metal. Biological impacts-morphological, anatomical, metabolical and physiological. Regulatory mechanism-stress sensing, signal transduction pathways, transcriptional regulation, regulatory hormones, ROS, phytochelatins, secondary messenger in plants-

cAMP, Ca-calmodulin.

Books for Reference

- 1. Beevers, L. *Nitrogen metabolism in plants*. London: William clowes& sons Ltd., 1976.
- 2. Bidwell, R.G.S. *Plant physiology*. New York: Macmillan publishing company. 1979.
- 3. Devlin, R.M. Plant Physiology. New Delhi: Narosa publishing House.1974.
- 4. Jain, V.K. *Fundamentals of Plant Physiology*. New Delhi: S.Chand and Co. Ltd., 2004.
- 5. Noggle, G.R. and Fritz, G.J. *Introductory plant physiology*. New Delhi: Prentice Hall. 2002.
- 6. Salisbury, F.B. and Ross. C.W. *Plant Physiology*. Thomson Wordsworth, 2007.
- 7. Taiz, L. and Zeiger. E. *Plant Physiology*. United States of America: Sinauer Associates. Publishers Massachusetts.1998.

Practical Hrs/ week: 2

- Hill activity effect of light quality.
- Effect of antitranspirants in transpiration and determination of stomatalindex and frequency (Single leaf method & calcium chloride method)
- Determination of water potential(any onemethod)
- Membrane permeability studies.(using different solvents and temperature)
- Nitrate reductase activity any one factor (light conditions /age)
- Determination of amylase activity.
- Determination of peroxidase activity
- Estimation of proline (Under normal and stressed conditions)
- Determination of chlorophyll content during aging/ under different light conditions
- Study on nutrient ion uptake.
- Determination of sugar content in fruits during ripening process.

Submission - Record Note Book

Laboratory Manual for Reference:

1. Francis H Witham, David F Blaydes and Robert N Devlin, *Experiments in Plant Physiology*. New Delhi: Vanmostr and Rain hold Company. 1970.

SEMESTER IV					
Core XV Plant Biotechnology					
Course Code: 21PBOC43 Hrs/week: 4 Hrs/Semester: 60 Credits:4					

- To acquire knowledge on laboratory organization and handling the tools of invitro culture of plant that of novel quality
- To understand the role of 21st century science (biotechnology) in increasing productivity of crop plants and to enhance the production of high value metabolites.
- To advance laboratory skill to get employment in biotechnology laboratories and industries.

CO.	Upon completion of this course, students will be	PSO	CL
No.	able to	addressed	
CO - 1	comprehend the basic principal of in-vitro tissue culture and develop skills in methods of tissue culture	3	Re, Un
CO - 2	practice <i>in-vitro</i> tissue culture techniques for getting required plants from explants	4	Un, Ap
CO - 3	expound <i>in-vitro</i> somatic hybridization and formation of somaclonal variation and its commercial application	4	Un
CO - 4	substantiate tissue culture is the viable option for the conservation of endangered plants	4	Re
CO - 5	grasp the techniques of mass cultivation of biofertilizer and defend biofertilizer a boon to sustainable agriculture	3	Un
CO - 6	categories different methods of synthesis of nanoparticles and understand the wide range of application of nanotechnology.	3	Un
CO - 7	describe what is plant molecular farming and highlight that transgenic plants are bioreactor for production of quality protein and other metabolites valuable to medicine and industries	4	Ар
CO - 8	utilize transferable skills obtained through the course for the professional accomplishment	1	Re

SEMESTER IV					
Core XV Plant Biotechnology					
Course Code: 21PBOC43 Hrs/week: 4 Hrs/Semester: 60 Credits:4					

- UNIT I: Biotechnology: Historical development, scope. Plant tissue culture: Laboratory organization, preparation of different media and role of growth hormones in *in-vitro* plant development. Plant regeneration pathway: direct embryogenesis, organogenesis: organ culture – nodal culture, internodal culture. Embryo culture: embryo rescue, breaking of seed dormancy. Factors affecting regeneration, regulation of regeneration. Production of haploids: Anther and pollen culture. Callus culture.
- UNIT II: Cell culture: single cell culture and production of secondary metabolites (Alkaloids) Somatic embryogenesis: Introduction, factors affecting embryogenesis. Protoplast Culture: Plant protoplast isolation, factors affecting protoplast isolation, Protoplast fusion and production of somatic hybrids, selection of hybrid cells and application of protoplast hybridization. Somaclonal variation: Isolation and characterization of variants -molecular basis and induced mutations, applications and limitations. Micropropagation methods: Apical meristerm culture and production of virus free multiple shoots.
- UNIT III: Industrial Biotechnology: role of microbes, strain development, fermentation Types of fermentors: process optimization and recent development in fermentation technology. Commercial production: Biopesticide, bio diesel, SLF, alcohol production, pharmaceutical and cosmetics from higher plants. Enzyme technology: Cellimmobilization and microbial enzyme production at commercial scale.
- UNIT IV: Phytoremediation: Microbial degradation of toxic chemicals from soil and water: Plants as a phytoremediating agents. Biofertilizers: Mass production of *Rhizobium*, *Azospirillum* and Blue Green Algae (BGA), Vesicular Arbuscular Mycorrhizal Fungi (VAM), Single cell protein (*Scenedesmus, Spirulina, Saccharomyces*). Algae in bioengineering.

Nanotechnology – role of bio sensor in environmental monitoring. Outline of green synthesis of nanoparticles and their characterization.

UNIT V: Transgenic plants: Transformation for resistance to biotic stress – pathogens, insects, virus and bacteria. Transformation for resistance to abiotic stress – herbicide resistance, resistance to drought. Transgenic plant and improved quality: extended self life, fruit ripening and prevention of discoloration of fruits. Transgenic plant for improved nutrition – golden rice, improved seed quality. Transgenes and immune protective drugs – edible vaccine, plantibody Regulations in Biotechnology: Biosafety: definition, requirement, biosafety in relation to transgenic research, biosafety guidelines and implementation. Intellectual property rights: process of patenting of biotechnological products. Farmer's Rights and plant breeder's Rights.

Books for Reference:

- Colin Rattledge and K. Bjon. *Basic biotechnology*. New York: Cambridge University Press, 2001.
- 2. Dubey R.C. *Textbook of Biotechnology*. New Delhi: S. Chand & Co. 2005.
- George E.F. and Sherrington P.D. Plant propagation by tissue culture. London: Exegetic Ltd. 1984.
- 4. Gupta, P.K. *Elements of Biotechnology*. Meerut: Rastogi publication 2000.
- 5. Kalyan Kumar De. *An Introduction to Plant Tissue Culture*. Calcutta: New Central Book Agency 2004.
- 6. Kumar, H.D. *Molecular biology and Biotechnology*. New Delhi: Vikas publishers 1993.
- 7. Mahesh. *Paddy molecular Biotechnology*. New age international, publishers. (p) Ltd. 2008.
- 8. Mukhopadhyay S.N, Prabhakar Sharma and Rabindra Narain. *A text book* of DNA recombinant technology. New Delhi: Wisdom press, 2011.

- 9. Ramavat K. G. Plant Biotechnology, New Delhi: S. Chand & Co. 2000.
- 10. Reinort J and Yeoman M. M. *Plant cell and tissue culture*. Delhi: Narosa publishing house 1983.
- 11. Satyanarayana U. Biotechnology. Kolkatta: Books and Allied (P) Ltd. 2006.
- 12. Singh, B.D. *Biotechnology Expanding Horizons*. New Delhi: Kalyani Publishers 2005.

Practicals:

(Hrs. /week - 2)

- Isolation of Rhizobium
- Isolation of rhizosphere bacteria
- Isolation of phosphate solubilizing microorganism
- Synthesis and characterization of nanoparticles
- Preparation of synthetic seeds
- Isolation of protoplast
- Callus induction
- Embryo culture
- Single cell Isolation
- Isolation of BGA
- Nodal Culture
- Protoplast isolation

Set up / pictures / photographs/ demonstration

- Golden rice
- Edible vaccine
- Fermentor

Submission - Record Note Book

Laboratory Manual for Reference:

 Chawla, HS. *Introduction to Plant Biotechnology*. New Delhi: Oxford & IBH publishing company Pvt. Ltd. 2009.

Submission: Record Note Book

SEMESTER - IV					
Core Elective Entrepreneurship Botany					
Course Code: 21PBOE41 Hrs / Week: 4 Hrs / Semester: 60 Credits: 4					

- To able to understand the available natural resources and explore the greatest opportunity to increase and achieve sustainable competitive business advantage.
- To introduce organizations and agencies that can backup entrepreneurial initiatives.
- To expose students to various business opportunities emerging from the plant resources.

CON	Upon completion of this course, students will	PSO	C L
CO.NO.	be able to	addressed	
CO-1	adapt the methods of preservation of vegetables	6	Un
	and fruits and identify the industrial scope of these		
	resources		
CO-2	determine the quality of oil and prepare aesthetic	6	Ар
	product to find out good marketing capacity		
CO-3	understand contemporary opportunities in business	6	Un
	situations of value added products and develop		
	skills needed to successfully convert them into		
	entrepreneurial ventures		
CO-4	explore how the value added products can enhance	6	Un
	the profitability of local farmers		
CO-5	acquire knowledge on primary forest product, wood	2,6	Un
	products and secondary wood products and infer		
	wood industries are major sector in many economy		
CO-6	able to differentiate natural and synthetic wood able	3	Un
	to dictate the their pros and cons		
CO-7	develop ideas that will lead them to start their own	6	Ap
	business and enable them to be professionally		
	competent		
CO-8	able to start entrepreneurship (small scale/medium	6	Re
	scale industries), extract the financial support		
	available and manage the targeted customers to		
	enhance profitability		

SEMESTER - IV				
Core Elective Entrepreneurship Botany				
Course Code: 21PBOE41 Hrs / Week: 4 Hrs / Semester: 60 Credits: 4				

- **UNIT I: Fruits and Vegetables preservation:** Fruits and vegetables preservation methods: Dehydrating, canning, salting, pickling and freezing. Fruits and Vegetables Products: tutti frutti, health drink, mango pulp, pickle, jam, jelly, amla candy and raisin. Factors influencing the growth of microorganisms in food. Sources of contamination of fruits. Types of spoilage.
- **UNIT II: Bioventure:** Industry, overview of *Spirulina*, *Pleurotus* sajor-caju, *Ganoderma*, *Lentinus edodes*, drumstick and coconut. Straight Vegetable Oil (SVO) and Pure Plant Oil (PPO): methods and marketing. Fresh and dry flowers for aesthetics.,
- **UNIT III:** Value added plant based products: Mushroom recipes (soup, omelette, pakoda and briyani). Preparation of Coco peat, Banana products, Palm products, fiber products; Packing techniques low, trans wrap, deep drawing, doy, sachet, top seal, vacuum: Cost management and estimation.
- **UNIT IV: Commercial Wood products:** Natural durability of wood. Wood preservation: Nonpressure processes, Pressure process, Chemical processing of wood. Commercial wood species and identification, Synthetic woods, Marine plywood, Fuel wood, pulp and paper making woods, matchstickwood. Economic importance of pulp and wood
- **UNIT V:** Marketing and trade : Steps for starting a small scale industry. Registration as SSI. Role of SIDBI. Advantages and problems of SSI. Government Schemes for SSI: NABARD, NCDC, MSME, NSIC. Marketing and entrepreneurship: different types of marketing, identification of types of consumer and their needs, building consumer relationship. FSSAI, FAO, ICDS, import and export businessdevelopment and strategies.

Text Books:

- 1. Bahi N. *Hand Book on Mushrooms*. New Delhi: Oxford and IBH Publishing Co. Pvt. Ltd. Print, Fourth edition, 2015.
- 2. Desrosier N.W. and Desrosier J.N. *The Technology of Food Preservation*. New Delhi: CBS Publishers & Distributors. Fourth edition, 1987.
- 3. Narayanaswami R.V. and Rao K.N. *Outlines of Botany*, Chennai: India: Esvee Press, 1976.

Books for Reference

1. Taneja S. and Gupta S.L. *Entrepreneurship development*, New Delhi: New venture creation, Galgeha Publication Company, 2015.

- 2. Desai V. *Entrepreneurship development*, Mumbai: Himalaya publication house, First edition, 2015.
- 3. Khanna S.S. *Entrepreneurial development*. New Delhi: S. Chand Company Ltd., 2016.
- 4. Manohar D. *Entrepreneurship of small scale industries*, New Delhi: Deep and deep publication, 1989.
- 5. Lal G., Siddhapa G.S. and Tandon G.L. *Preservation of fruits and vegetables*. New Delhi: Indian council of Agricultural Research (ICAR), 2009.
- 6. Ranganna S. *Hand book of analysis and quality control of fruits and vegetable products*. New Delhi: Tata mcgraw hill, Second edition, 2001.
- 7. Cruses W.V. and Fellows P.J. *Commercial fruits and vegetable processing*. United States: CRC press, 2000.
- 8. Franz F.P. Kollmann. *Wood Science and Technology*. New York: Springer Verlag, 1988.
- 9. Pearson and Brown. *Commercial Timbers of India*. New Delhi: Government of India Publication, 1984.
- 10. Tieuran H.D. Wood Technology. New York: Pituran Publishing Company, 1951.