Final Revision of UG (Botany) Syllabus:

The papers recognized for 6 Unit Botany are as follows:

First year*(Approved in the BOS meeting held on 11.3.2006):*

Semester I:

Paper I - Diversity and Classification of Plant Kingdom-I

Paper II - Cell biology

Semester II:

Paper III - Diversity and Classification of Plant Kingdom-II

Paper IV - Principles of Biochemistry

Second year*(Approved in the Meeting held on 5th& 10th Feb 2007):*

Semester III:

Paper V - Plant Physiology-I

Paper VI - Plant Ecology -I

Semester IV:

Paper VII - Plant Physiology-II

Paper VIII - Plant Ecology – II

Third year*(The following papers are for 6 Unit students)*

Semester V:

Paper IX - Systematics of Angiosperms

Paper X - Genetics & Plant Breeding

Paper XI - Plant Biochemistry & Molecular Biology

Paper XII - Plant Biotechnology & Genetic Engineering

Semester VI:

Paper XIII - Plant Anatomy and Developmental Biology of Flowering Plants

Paper XIV - Genetics, Plant Breeding and Statistical Methods

Paper XV - Microbiology & Plant Pathology

Paper XV I - Economic & Applied Botany

Third year*(The following papers are for 3 Unit students)*

Semester V:

Paper IX - Systematics of Angiosperms

Paper X - Genetics & Plant Breeding

Semester VI:

Paper XIII - Plant Anatomy and Developmental Biology of Flowering Plants

Paper XV I - Economic & Applied Botany

PAPER I	**DIVERSITY AND CLASSIFICATION OF THE PLANTKINGDOM - I**	
	Course Objectives: 1. To acquire knowledge about prokaryotes and eukaryotes, diversity therein and fossils forms. 2. To understand the origin, evolution, diversity, general characters, classification, ecological and economic importance of Algae, Fungi, Lichens, Mycorrhizae and Bryophytes **3.** To develop skills in identifying Prokaryotes and Eukaryotes with the help of fresh, preserved specimens and permanent slides.	
Theory		
Plant kingdom: Classification of kingdoms and the criteria (according to Meyer, the seven kingdoms, of living organisms); Prokaryotes and Eukaryotes; diversity in habitat, form (Habit), life span, nutrition and ecological status; origin, evolution and phylogeny of land plants; extinctions and possible causes; fossils and living fossils (a brief account).		**(8L)**
Algae: Origin, evolution, diversity, general characters, classification **of all groups and phyla)** (Bold & Wynne), range of thalli and reproductive structures and life cycles**(of all the types)** with minimum one example each, ecological, economic and biotechnological significance		**(13L*)***
Fungi: Origin, evolution, diversity, general characters, nutritional modes, classification (G.C. Ainsworth), range of vegetative and reproductive structures, pleomorphism and parasexuality, important features of Mastigomycotina - *Pythium,;* Zygomycotina-*Mucor;* Ascomycotina - *Saccharomyces, Peziza;*. Basidiomycotina - *Puccinia, Agaricus;* Deuteromycotina-*Cercospora,* general account of Lichens and Mycorrhizae; ecological, economic and biotechnological significance of fungi.		**(13L)**
Bryophytes: Origin, evolution, diversity, general characters, classification (G.M.Smith) and comparative study of morphology, anatomy, reproduction; broad interrelationships of Hepaticae, Anthocerotae and Musci; ecological and economic importance of bryophytes.		**(11L)**
<u>Laboratory Exercises</u>:		
Study of prokaryotic organisms: bacteria *(Bacillus, Staphylococcus, Streptococcus, Spirillum);* Monochrome and Gram's staining; Blue green algae -*Anabaena, Oscillatoria*		**(2 P)**
Study of eukaryotic organisms: a. Algae: *Chlorella, Chlamydomonas, Volvox, Hydrodictyon, Spirogyra, Oedogonium, Cladophora, Chara, Sargassum, Ectocarpus, Polysiphonia.* **(permanent specimen can be shown and a few can be freshly prepared)**		**(4 P)**
b. Fungi: *Rhizopus, Aspergillus, Saccharomyces, Penicillium, Chaetomium, Peziza, Agaricus;* lichen, mycorrhizae		**(4P)**
c. Study of morphology, anatomy and reproductive structures in *Riccia, Marchantia, Anthoceros, Funaria.*		**(4P)**
<u>Learning Outcomes</u>: At the end of the semester, the students will be able to: ➢ Distinguish between algae, fungi and bryophytes with reference to their classification, morphology, anatomy, reproduction and economic/ecological importance		

Suggested Readings (Paper I & III):

1. Bold, H.C., Alexopoulos, C.J. and Delevoryas, T. 1980. Morphology of Plant andFungi (J,n Edition). Harper and Foul Co., New York.
2. Bold H.C. and Wynne M.J. 1978. Algae-Structure and Reproduction.Prentice hall Englewoodcliffs, New Jercy.
3. Clifton, A. 1985. Introduction to the Bacteria. McGraw Hill Co., New York.
4. Chamberlain C.J. 1986.Gymnosperms structure and evolution. C.B.S. publishers and distributers.
5. Chapman V J. and Chapman D.J. 1975. The algae. 2nd edition. Mac.Millan Publ. Inc. New York.
6. Chapman V J. and Chapman D.J.1980. Seaweeds and their uses 3-rd edition.
7. Dodge J.D. 1973.The fine structure of algal cells, Acadameic press New Delhi.
8. Dube, H.C. 1990. An Introduction to Fungi. Vikas Publishing House Ltd., Delhi.
9. Fritsch F.E. (1935). The structure and reproduction of algae Vol. I and II, University press Cambridge
10. Gangulee and Kar, College BotanyVol.I and II.
11. Gifford, E.M. and Foster, A.S. 1989. Morphology and Evolution of Vascular Plants.
12. Kumar, H.D. 1988. Introductory Phycology. Affiliated East:-West Press Ltd., NY.
13. Mandahar, C.L. 1978. Introduction to Plant Viruses. Chand & Co. Ltd., New Delhi.
14. PariharN.S. 1967. An introduction to Bryophyta
15. Parihar N.S.1967. An introduction to Pteridophyta.
16. Prescott G.W. 1981.Algae- A Review.
17. Puri, P. 1985. Bryophytes. Atmaram& Sons, Delhi, Lucknow.
18. Rashid A. 1986. An introduction to Pteridophytes. Vani educational Book.N.D.C.
19. Raven, P.H., Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants. W.H. Freeman & Co., Worth Publ., New York, USA.
20. Smith G.M. 1955.Cryptogamic Botany Vol.I and II. Algae and Fungi, 2nd Edition, McGraw Hill, New York.
21. Sporne, K.R. 1991. The Morphology of Gymnosperms. B.I. Publications Pvt., Bombay, Calcutta, Delhi.
22. Sundarajan. College Botany, Vol.I and II.
23. Wilson, N.S. and Rothwell, G. W. 1993. Palaeobotany and the Evolution of Plants ('2nd Edition). CambridgeUniversityPress, UK.
24. Vasishta B.R. 1988. Algae S.Chand and Company New Delhi.
25. Webster J. (1970). Introduction to Fungi. .Cambridge University Press, New York.

PAPER II	CELL BIOLOGY	
	Course Objectives: 1. To acquire knowledge on various kinds of cells, processes and cell division, cell organelles and techniques in studying cell structure.	

	2. To understand ultrastructure and functional significance of the above. 3. To understand the principles and applications of various kinds of microscopy in cell study. 4. To develop skills in study of cell structure, cell organelles and cell division and techniques in cell studies.	
Theory		
The Cell: Historical background; cell theory; kingdom-wise cell size and cell structure; viroids and prions; comparative account of prokaryotic and eukaryotic cell; characteristics of archaebacteria, mycoplasma, MLO and PPLO.		**(5L)**
Cell division and its regulation: Mitosis and meiosis -historical perspective and significance; various stages of cell division progression; cytokinesis; role of centromere, telomere, kinetochore and spindle apparatus; animal and plant cell cycle; mechanisms of cell cycle control; **apoptosis.**		**(6L)**
Nucleus and Ribosomes: Ultrastructure; nuclear envelope and nuclear pore complex; nuclear matrix and nucleoplasm; DNA, RNA and histones; nucleosome and higher level of organization; ribosome structure; prokaryotic, eukaryotic and organelle ribosomes and their functional significance.		**(7L)**
Mitochondrion and Chloroplast: Origin of organelles; organelle structure and biogenesis; organelle membranes and organization of macromolecular complexes; variation in size, shape and number; types of plastids; organelle-nuclear interactions; organelle genome organization.		**(8L)**
Structure/function of other Sub-cellular structures: Golgi complex; endoplasmic reticulum; lysosomes; microbodies - peroxisomes and glyoxysomes; cytoskeleton and microtubules.		**(5L)**
Cell wall and Cell membranes: Origin, ultrastructure, chemical constituents and functions of cell wall; models of cell membrane organization; role of various membrane proteins, lipids, carbohydrates and lectins; role of ion channels and pumps in cellular transport and signalling.		**(7L)**
Techniques in Cell biology: Principles and applications of light, phase contrast, fluorescence and electron microscopy (SEM & TEM); micrometry and cell fractionation procedures		**(7L)**
<u>Laboratory Exercises</u>:		
Comparative study of cell structure in onion cells, *Hydrilla*and *Spirogyra*. Study of cyclosis in *Tradescantia* staminal hairs.		**(2P)**
Examination of EM graphs of prokaryotic and eukaryotic cells.		**(1P)**
Study of various stages of mitosis and meiosis using appropriate plant material (e.g. root tips and flower buds of onion).		**(3P)**
Isolation of chloroplasts from leaf material using gradient centrifugation and visualization under microscope		**(1P)**
Micrometry, camera lucida and cytometry (size mesasurements)		**(3P)**
Study of plastid types using microscope.		**(2P)**
Histo-chemical test for cellulose, lignin, chitin and suberin in sections		**(2P)**
Study and working of microscopes, centrifuges, microtomes		**(1P)**
Visit to the facilities of Department of Botany, Goa University (optional)		
<u>Learning Outcome</u>: At the end of the semester, the students will be able to:		

➢ Describe cell and cell organelles with their structure and functions . ➢ Perform various techniques in cell biology.	
Suggested Readings (Paper II & IV): 1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell. Garland Publishing Co., Inc., New York, USA. 2. Avers, C.J. 1986. Molecular Cell Biology. Addison-Wesley Publishing Co., Massachusetts, USA. 3. Campbell, M.K. 1999. Biochemistry (Jd Edition). SaundersCollege Publishing, Philadelphia, USA. 4. Gupta, P.K. 1999. A Text-book of Cell and Molecular Biology. RastogiPublcations, Meerut, India. 5. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology ('2d Edition). HarperCollinsCollege Publishers, New York, USA. 6. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology (1,' Edition). W.H. Freeman and Co., New Yqrk, USA. 7. Nelson, D.L. and Cox, M.M. 2000. Lehninger Principles of Biochemistry (3d Edition). Worth Publishers, New York, USA. 8. Rawn, D.J. 1989. Biochemistry. Neil Patterson Publishers, North Carolina, USA. 9. Stryer, L. 1995. Biochemistry. W.H. Freeman and Co., New York, USA. 10. Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co., California, USA. 11. Zubay, G. 1993. Biochemistry (3d Edition). WCB Publishers, Iowa, USA. **Suggested Readings (for laboratory exercises):** 1. Dryer, R.L. and Lata, G.F. 1989. Experimental Biochemistry. OxfordUniversity Press, New York. 2. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers, Boston, Massachusetts. 3. Harris, N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at OxfordUniversity Press, Oxford, UK. 4. Ninfa, A.J. and Ballou, D.P. 1998. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Fitzgerald Science Press, Inc., Maryland, USA. 5. Wilson, K. and Goulding, K.H. (Eds.) 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.	

PAPER III	**DIVERSITY & CLASSIFICATION OF THE PLANT KINGDOM - II**	
	Course Objectives: 1. To acquire knowledge about Pteridophytes, Gymnosperms and, Angiosperms, diversity therein and fossils forms. 2. To understand vascular plants with regards to their Salient features, evolutionary significance, comparative general study of morphology, anatomy and reproduction and economic importance of Pteridophytes and Gymnosperms.	

	3. To understand vascular plants with regards to their identification, nomenclature and classification; comparison of systems of classification, salient features, primitive and advance features and general account of morphology, anatomy, flower structure, reproduction and seed development in flowering plants. 4. To develop skills in identifying and handling various plant specimens with respect to Pteridophytes, Gymnosperms and, Angiosperms.	
Theory		
Pteridophytes: Salient features of primary vascular plants; classification (Foster & Gifford), comparative study of morphology, anatomy, reproduction; stelar evolution; a general account of evolutionary significance of Psilopsida-, Lycopsida-, Sphenopsida- and Pteropsida-; heterospory and seed habit; economic importance.		**(15L)**
Gymnosperms: Classification (Coulter and Chamberlain) and salient features; evolutionary significance of gymnosperms; comparative general study of morphology, anatomy and reproduction of Cycadales, Coniferales and Gnetales; economic importance.		**(15L)**
Angiosperms: Unique features of angiosperms and diversity; identification, nomenclature and classification; comparison of systems of classification (Bentham & Hooker and Engler & Prantl); primitive and advanced features; salient features of the International code of Botanical Nomenclature; general account of morphology, anatomy, flower structure, reproduction and seed development.		**(15L)**
Laboratory Exercises:		
Study of morphology, anatomy and reproductive structures by sectioning (*Selaginella, Equisetum, Salvinia,)* and using permanent slides (*Psilotum, Lycopodium, Pteris, Lepidodendron, Lepidocarpon).*		**(4P)**
Study of morphology, anatomy and reproductive structures in *Cycas, Pinus, Gnetum*		**(3P)**
A study of the representative members of the following angiosperm families: Magnoliaceae, **Leguminosae (Papilionoideae, Caeselpinioideae, Mimosoideae),** Umbelliferae (Apiaceae), Compositae (Asteraceae), Acanthaceae, Euphorbiaceae, Liliaceae, Graminae (Poaceae). (Bentham & Hooker's Classification)		**(7P)**
Study of tissue types (permanent slides to be shown).		**(1P)**
Learning Outcome: At the end of the semester, the students will be able to ➢ Distinguish between Pteridophytes, Gymnosperms and Angiosperms with reference to their structure, classification, morphology, anatomy life cycles and economic /ecological importance ➢ Sketch various plant parts.		
Suggested Readings (Paper I & III): 1. Bold, H.C., Alexopoulos, C.J. and Delevoryas, T. 1980. Morphology of Plant and Fungi (J,n Edition). Harper and Foul Co., New York. 2. Bold H.C. and Wynne M.J. 1978. Algae-Structure and Reproduction. Prentice hall Englewoodcliffs, New Jercy.		

3. Clifton, A. 1985. Introduction to the Bacteria. McGraw Hill Co., New York.
4. Chamberlain C.J. 1986.Gymnosperms structure and evolution. C.B.S. publishers and distributers.
5. Chapman V J. and Chapman D.J. 1975. The algae. 2nd edition. Mac.Millan Publ. Inc. New York.
6. Chapman V J. and Chapman D.J.1980. Seaweeds and their uses 3-rd edition.
7. Dodge J.D. 1973.The fine structure of algal cells, Acadameic press New Delhi.
8. Dube, H.C. 1990. An Introduction to Fungi. Vikas Publishing House Ltd., Delhi.
9. Fritsch F.E.(1935,45). The structure and reproduction of algae Vol.I and II, University press Cambridge
10. Gangulee and Kar, College Botany Vol.I and II.
11. Gifford, E.M. and Foster, A.S. 1989. Morphology and Evolution of Vascular Plants.
12. Kumar, H.D. 1988. Introductory Phycology. Affiliated East:-West Press Ltd., NY.
13. Mandahar, C.L. 1978. Introduction to Plant Viruses. Chand & Co. Ltd., New Delhi.
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17. Puri, P. 1985. Bryophytes. Atmaram & Sons, Delhi, Lucknow.
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19. Raven, P.H., Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants (Sh edition). W.H. Freeman & Co., Worth Publ., New York, USA.
20. Smith G.M. 1955.Cryptogamic Botany Vol.I and II. Algae and Fungi, 2nd Edition, McGraw Hill, New York.
21. Sporne, K.R. 1991. The Morphology of Gymnosperms. B.I. Publications Pvt., Bombay, Calcutta, Delhi.
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24. Vasishta B.R. 1988. Algae S.Chand and Company New Delhi.
25. Webster J. (1970). Introduction to Fungi. .Cambridge University Press, New York.

PAPER IV	**PRINCIPLES OF BIOCHEMISTRY**	
	Course Objectives: 1. To acquire knowledge in Cellular chemistry, Biomolecules, Energy flow, Enzyme structure, classification and functions and Techniques in biochemistry. 2. To understand Cellular chemistry with respect to water and biological buffers and structure, properties, classification, biological significance and detection of techniques of biomolecules and enzymes. 3. To understand the principles and applications of various kinds of microscopy in cell study.	

	4. To develop skills in qualitative and quantitative analysis of biomolecules.	
Theory		
Cellular chemistry: Bioelements and biomolecules; chemical bonds, interactions and their significance; peptide bonds, disulphide bonds, structure, properties of water and its biological significance; pH, inorganic and biological buffers and their significance		**(6L)**
Biomolecules: Essential and non-essential elements; structure, classification and properties of amino acids, carbohydrates, lipids, proteins and Nucleic acids; primary and secondary metabolites, Isomerism		**(16L)**
Energy flow: Laws of thermodynamics; concept of free energy; energy transfer and redox potential; ATP -the energy currency; phosphorylation / dephosphorylation of proteins		(**5L)**
Enzyme structure, classification and functions: enzymes as biocatalysts; classification and nomenclature of enzymes; physico-chemical properties of enzymes; cofactors and coenzymes; isozymes, kinetics of enzyme action; significance of Km; mechanism of enzyme activity; factors affecting enzyme activity, e.g. temperature, pH; allosteric modification and feedback regulation		(**10L)**
Techniques in biochemistry: Simple chemical detection techniques for biomolecules, principles of various chromatographic, electrophoretic and spectrophotometric techniques		**(8L)**
Laboratory Exercises:		
Preparation of chemical **reagents (molar, molal and normal solutions)** and buffers		(**3P)**
Measurement of pH of different plant extracts **(C3, C4 and CAM plants)**		(**1P)**
Qualitative analysis of biomolecules (amino acids, proteins and carbohydrates)		(**3P)**
Chlorophyll separation and anthocyanin separation using **paper chromatography**.		(**2P)**
Estimation of proteins by Lowry's method		(**1P)**
Micro-chemical detection of reducing sugars in floral nectar using Benedict's reagent		(**1P)**
Determination of pKa value of amino acids (Glycine/glutamic acid)		**(1P)**
Study of amylase activity (substrate base). Effect of pH and temperature on the activity of amylase		(**3P)**
Determination of acid value of fat		**(1P)**
Estimation of RNA by means of orcinol reaction		**(1P)**
Visit to the facilities of Department of Botany, Goa University		
Learning Outcome: At the end of the semester, the students will be able to: ➢ Explain Cellular chemistry, Biomolecules, Energy flow, Enzyme structure, classification, Function and Techniques in Biochemistry. ➢ Perform various techniques involved in biochemistry		
Suggested Readings (Paper II & IV): 12. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell. Garland Publishing Co., Inc., New York, USA. 13. Avers, C.J. 1986. Molecular Cell Biology. Addison-Wesley Publishing Co., Massachusetts, USA.		

14. Campbell, M.K. 1999. Biochemistry (Jd Edition). SaundersCollege Publishing, Philadelphia, USA.
15. Gupta, P.K. 1999. A Text-book of Cell and Molecular Biology. RastogiPublcations, Meerut, India.
16. Kleinsmith, L.J. and Kish, V.M. 1995. Principles of Cell and Molecular Biology ('2d Edition). HarperCollinsCollege Publishers, New York, USA.
17. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology (1st Edition). W.H. Freeman and Co., New Yqrk, USA.
18. Nelson, D.L. and Cox, M.M. 2000. Lehninger Principles of Biochemistry (3d Edition). Worth Publishers, New York, USA.
19. Rawn, D.J. 1989. Biochemistry. Neil Patterson Publishers, North Carolina, USA.
20. Stryer, L. 1995. Biochemistry. W.H. Freeman and Co., New York, USA.
21. Wolfe, S.L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co., California, USA.
22. Zubay, G. 1993. Biochemistry (3d Edition). WCB Publishers, Iowa, USA.

Suggested Readings (for laboratory exercises):

6. Dryer, R.L. and Lata, G.F. 1989. Experimental Biochemistry. OxfordUniversity Press, New York.
7. Gunning, B.E.S. and Steer, M.W. 1996. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers, Boston, Massachusetts.
8. Harris, N. and Oparka, K.J. 1994. Plant Cell Biology: A Practical Approach. IRL Press, at OxfordUniversity Press, Oxford, UK.
9. Ninfa, A.J. and Ballou, D.P. 1998. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Fitzgerald Science Press, Inc., Maryland, USA.
10. Wilson, K. and Goulding, K.H. (Eds.) 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.

PAPER V	**PLANT PHYSIOLOGY -I**	
	Course Objectives: 1. To acquire basic knowledge and fundamental concepts about physical, chemical and biological functioning of plants. 2. To understand mechanism of transpiration, Mineral nutrition, Photosynthesis and translocation. **3.** To understand various physiological mechanisms carried out by plants using simple laboratory techniques.	
Theory		
Plant-water relations: Water transport processes; diffusion and osmosis; water potential and chemical potential; absorption of water, water transport through tracheids and xylem (ascent of sap); transpiration and its significance; factors affecting transpiration; mechanism of stomatal movement, root pressure, guttation, imbibition, mass flow, antitranspirant.		**(12L)**
Mineral nutrition: Criteria of essentiality of elements; macro- and micronutrients; role of essential elements; mineral deficiency symptoms and		**(12L)**

plant disorders; nutrient uptake and transport mechanisms; role of cell membrane, ion pumps and carriers.	
Photosynthesis: Historical background and significance; structure of photosynthetic apparatus; photosynthetic pigments; accessory pigments and the photoprotective carotenoids; reaction center complexes; photochemical reactions; electron transport pathways in chloroplast membranes; photophosphorylation; the Calvin cycle; the C4 carbon cycle; crassulacean acid metabolism; synthesis of starch and sucrose; photorespiration; factor affecting photosynthesis.	**(15L)**
Transport of organic substances: Transport of photosynthates; source-sink relationship; the mechanism of translocation in the phloem; assimilate partitioning.	**(6L)**
Laboratory Exercises:	
Measurement of Relative water content (RWC) of plant tissue.	**(1P)**
To extract and separate photosynthetic pigments by paper chromatography	**(1P)**
Spectral analysis of pigment (to determine B-carotene, Chl a and chl b and other carotene bands) separated by above paper chromatography method	**(2P)**
Determination of chlorophyll a and total chlorophyll in shade and sun plants.	**(1P)**
Photo-oxidation of photosynthetic pigments.	**(1P)**
To determine the osmotic potential of vacuolar sap by plasmolytic method,	**(1P)**
To determine the water potential of given tissue (any tuber).	**(1P)**
To determine stomatal index, stomatal frequency and percentage of leaf area open through stomata.	**(2P)**
Anatomical feature of C3 and C4 plants.	**(1P)**
Nutrient deficiency symptoms. Hydroponically (*Demonstration only).*	**(2P)**
A visit to ICAR (Ela Farm)	
Learning Outcome: At the end of the semester, the student will be able to: ➢ Explain concepts of plant water relation, mineral nutrition Photosynthesis, and Transport of organic substances . ➢ Demonstrates various techniques in plant physiology	
Suggested Readings (Paper V & VII) 1. Galston, A.W. 1989. Life Processes in Plants. Scientific American Library, Springer-Verlag., New York, USA. 2. Hooykaas, P.J.J., Hall, M.A. and Libbenga, K.R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones. Elsevier, Amsterdam, The Netherlands. 3. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA. 4. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (2'd edition). Springer-Verlag, New York, USA. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4h edition). Wadsworth Publishing Co., California, USA. 5. Taiz, L. and Zeiger, E. 1998. Plant Physiology ('I'd edition). Sinauer	

Associates, Inc., Publishers, MassachusettsUSA.

Suggested Readings (for laboratory exercises)

1. Copeland, R.A. 1996. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. VCH Publishers, New York.
2. Dryer, R.L. and Lata, G.F. 1989. Experimental Biochemistry. Oxford, Univeristy Press, New York.
3. Moore, T.C. 1974. Research Experiences in Plant Physiology: A Laboratory Manual. Springer-Verlag, Berlin.
4. Wilson, K. and Goulding, K.H. (Eds.) 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.

PAPER VI	**PLANT ECOLOGY I**	
	Course Objectives: 1. To acquire basic knowledge on fundamental concepts of ecology and ecosystem. 2. To understand structural and functional components of ecology. 3. To understand Concept, components, and organization, diversity, structure and functions of ecosystem. 4. To understand various ecological concepts using simple laboratory techniques.	
Theory		
Introduction: Definition; holocoenotic nature of environment; limiting factors; ecological amplitude; triggering factors (soil, water, atmosphere); inter-relationships between the living world and the environment; the components and dynamism; homeostasis; relevance to man.		**(5L)**
Earth as a system: The biosphere, the hydrosphere, the atmosphere and the lithosphere; Gaia hypothesis; structural and functional components of systems; Biomes - parameters delimiting individual biomes.		**(5L)**
The environment and Ecological adaptations: Soil, water and atmosphere -general account and adaptations; the living world -biotic component of environment; types of biotic interactions; Concept, ecads, ecotypes and ecoclines; adaptive significance of photosynthetic pathways.		**(9L)**
Ecosystem: Concept, components (abiotic and biotic) and organization; structure and functions; homeostasis; energy flow - models; productivity; food chain and food web; trophic organization and ecological pyramids; autotrophy, heterotrophy, parasitism and saprophytism; Biogeochemical cycles - sedimentary (P), gaseous (C, N) and hydrological cycles.		**(14L)**
Diversity of ecosystems: Aquatic, terrestrial and manmade (agricultural). Ecosystems of Goa - Wetlands, Mangroves, Coastal Ecosystems, Sand dunes, Forests.		**(8L)**
Organismal ecology/biotic components: Introduction to **i**ndividuals, species, populations and communities.		**(4L)**
Laboratory Exercises:		
To determine the working and use of instruments for the measurement of temperature (soil, air, water), moisture (rainfall, relative humidity, soil moisture), wind (velocity and		**(2P)**

direction) and light intensity.	
To study selected soil properties by spot test: texture, pH, carbonate, nitrate, base deficiency and reductivity and water holding capacity.	**(3P)**
Titrimetric estimation of total carbonates of soil samples.	**(1P)**
Analysis of different water samples for pH, oxygen, carbon-dioxide (titrimetric estimation), turbidity and temperature.	**(3P)**
To study ecological adaptations (morphological and anatomical) in plants (hydrophytes, xerophytes, epiphytes).	**(6P)**
Learning Outcome: At the end of the semester, the student will be able to: ➢ Explain environment and its components. ➢ Describe various ecological adaptations in plants. ➢ Analyse different components of ecosystem using simple laboratory techniques.	
Suggested Readings (Paper VI & VIII) 1. Ambasht, R.S. 1988. A Text Book of Plant Ecology. Students Friends Co., Varanasi. 2. Barbour, M.G., Burk, J.H. and Pitts, W.O. 1987. Terrestrial Plant Ecology. 3. Benjamin/Cummings Publication Cc California. 4. Botkin, D.B. and Keller, E.A. 2000. Environmental Planet (3rd edition). John Wiley & Sons Inc., New York. 5. Chapman, J.L. and Reiss, M.J. 1995. Ecology: Principles and Applications. CambridgeUniversity Press. 6. Cunningham, W.P. and Saigo, S.W. 1997. Environmental Science: A Global Concern. WCB, McGraw Hill. 7. Dash, M.C. 1993. Fundamentals of Ecology. Tata McGraw Hill Publishing Co. Ltd., New Delhi. 8. Daubenmire, A.F. 1974. Plants and Environment -A Text Book of Plant Ecology *(3d* edition). John Wiley & Sons, New York. 9. Hill, M.K. 1997. Understanding Environmental Pollution. CambridgeUniversity Press. India Pvt. Ltd., New Delhi. 10. Kendeigh, S.C. 1980. Ecology with Special Reference to Animals and Man. Prentice Hall of India Pvt. Ltd., New Delhi. 11. Kormondy, E.J. 1996 (4th Ed.). Concepts of Ecology. Prentice Hall of India Pvt. Ltd., New Delhi. 12. Kumar, H.D. 1996. Modern Concepts of Ecology (4h edition). Vikas Publishing House Pvt. Ltd., Delhi. 13. Kumar, H.D. 1997. General Ecology. Vikas Publishing House Pvt. Ltd.., Delhi. 14. Mackenzie, A. et al. 1999. Instant Notes in Ecology. Viva Books Pvt. Ltd., New Delhi. 15. Miller, W.A. and Donahue, A.L. 1992. Soils ~ An Introduction to Soil and Plant Growth (6h edition). Prentice Hall 16. Odum, E.P. 1983. Basic Ecology. Saunders, Philadelphia. 17. Odum, E.P. 1996. Fundamentals of Ecology. Natraj Publishers, Dehradun. 18. Pickering, K.T. and Owen, L.A. 1997. An Introduction to Global Environmental Issues (2'd edition). Butter and Tanner Ltd., Great Britain. 19. Smith, L.A. 1996. Ecology and Field Biology (Sh edition). Harper Collins College	

Publishers, USA.
20. Smith, L.A. and Smith, T.M. 1998. Elements of Ecology (4h edition). An Imprint of Addison Wesley, Longman Ink., California.
21. Tyler, M.G., Jr. 1997. Environmental Science: Working with Earth (6h edition). Wadsworth Publishing Co.
22. Weaver, J.E. and Clements, S.E. 1966. Plant Ecology. Tata McGraw Publishing Co. Ltd., Bombay.

Suggested Readings (for laboratory exercises)

1. Ambasht, R.S. 1990. Environment and Pollution. Students Friends and Co. Varanasi, India.
2. APHA - Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, D.C.
3. Kapur, P. and Govil, S.R. 2000. Experimental Plant Ecology. S.K. Jain for CBS Publishers and Distributors, New
4. Misra, R. 1968. Ecology Work Book. Oxford and IBH. New Delhi.
5. Moore, P.W. and Chapman, S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publication.
6. Moore, P.W.and Chapman, S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publications.
7. Piper, C.S. 1950. Soil and Plant Analysis. University of Adelaide, Australia.
8. Smith, R.L. 1966. Ecology and Field Biology. Harper Collins, New York.
9. Smith, R.L. 1990. (4th edition). Ecology and Field Biology. Harper Collins, New York.
10. Smith, R.L. 1996. Ecology and Field Biology. Harper Collins, New York.

Paper VII:	**PLANT PHYSIOLOGY II**	
	Course Objectives: 5. To acquire basic knowledge and fundamental concepts about physical, chemical and biological functioning of plants. 6. To understand mechanism of Respiration, Nitrogen metabolism, and growth and development. 7. To understand action of growth Regulators, plant movements, Stress physiology and biosynthesis and uses of secondary metabolites. 8. To understand various physiological mechanisms carried out by plants using simple laboratory techniques.	
Theory		
Respiration: Glyc olysis; the TCA cycle and its regulation; electron transport in mitochondria; oxidative phosphorylation; pentose phosphate pathway; cyanide-resistant respiration; ATP synthetase.		**(8L)**
Nitrogen metabolism: Biological nitrogen fixation; reduction of N_2 into ammonia; *nif*genes; regulation of nitrate reductase and nitrogenase; nitrate and ammonium assimilation; Pyridoxal phosphate.		**(6L)**
Growth and development: General aspects -definitions, phases of growth; kinetics of		**(15L)**

growth; physiology of seed dormancy and seed germination; concept of photoperiodism; physiology of flowering; the florigen concept and its role. Photomorphogenesis; discovery of phytochromes and cryptochromes, their role and mechanism of actions. Vernalization; fruit-ripening; importance of respiratory climecteric;	
Growth Regulators: Discovery, physiological role and mechanism of action of the phytohormones -auxins, cytokinins, gibberellins, abscisic acid and ethylene;	**(10L)**
Plant movements -tropic and nastic; biological clocks.	**(2L)**
Stress physiology: In relation to drought, salt, metals and radiations	**(2L)**
Secondary metabolites: Terpenes, phenols, tannins and alkaloids (biosynthesis and uses)	**(3L)**
Laboratory Exercises:	
Qualitative detection of to amylase, lipase, acid phosphatase, catalase, peroxidase	(4 P)
Estimation of nitrate reductase	(1P)
Extraction and spectral analysis of phycocyanin from BGA and spectral	(1P)
Quantitative estimation of A.A. by ninhydrin methods	(1P)
Extraction and separation of falvonoids using paper chromatography and demonstration of 2D with the same plate	(3P)
Comparative study of rate of respiration of various plant parts	(1P)
Role of light in germination of photoblastic seeds, Spinach/tomato	(1P)
Bioassay of plant hormones -auxins, GA, and cytokinin.	(2P)
Determination of IAA oxidase activity	(1 P)
Learning Outcome: At the end of the semester, the student will be able to: ➢ Explain various physiological processes occurring in higher plants. ➢ Demonstrates various techniques in plant physiology	
Suggested Readings (Paper V & VII) 6. Galston, A.W. 1989. Life Processes in Plants. Scientific American Library, Springer-Verlag., New York, USA. 7. Hooykaas, P.J.J., Hall, M.A. and Libbenga, K.R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones. Elsevier, Amsterdam, The Netherlands. 8. Hopkins, W.G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA. 9. Moore, T.C. 1989. Biochemistry and Physiology of Plant Hormones (2'd edition). Springer-Verlag, New York, USA. Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4h edition). Wadsworth Publishing Co., California, USA. 10. Taiz, L. and Zeiger, E. 1998. Plant Physiology ('I'd edition). Sinauer Associates, Inc., Publishers, MassachusettsUSA. **Suggested Readings (for laboratory exercises)** 5. Copeland, R.A. 1996. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. VCH Publishers, New York. 6. Dryer, R.L. and Lata, G.F. 1989. Experimental Biochemistry. Oxford, Univeristy Press, New York.	

7. Moore, T.C. 1974. Research Experiences in Plant Physiology: A Laboratory Manual. Springer-Verlag, Berlin.
8. Wilson, K. and Goulding, K.H. (Eds.) 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.

Paper VIII	**PLANT ECOLOGY II**	
	Course Objectives: 1. To acquire basic knowledge on fundamental concepts of ecology. 2. To understand structural and functional components of Community, Population and Human ecology. 3. To understand principles of Phytogeography and Remote Sensing and its applications. 4. To understand the Role of Governmental and Non-Governmental organizations in environmental management. 5. To understand various ecological concepts using simple laboratory techniques.	
Theory		
Community: Community characteristics, Structure (vertical and horizontal), climax types and theories; niche concept, succession and types**.** Measurement of communities: species diversity (alpha, beta and gamma); quantitative ecology - sampling methods (quadrats, transects, bisects), frequency, density, abundance and Importance Value Index (IVI); species diversity indices; vegetation mapping.		**(13L)**
Population: Concepts; population characteristics; density and pattern; idealized plant life history; population growth; carrying capacity; population regulation and popuation dynamics; r- and K-selection; population interactions.		**(6L)**
Phytogeography: General principles; static and dynamic plant geography; continental drift, age and area hypothesis, land bridge theory; endemism - types and causes; biodiversity hotspots - Eastern Himalayas and Western Ghats; vegetation types of India; vegetation types of Goa.		**(10L)**
Human ecology and ecological management: Human population; renewable and non-renewable natural resources and their management; conservation of biodiversity, endangered species; conventional and non-conventional energy sources.		**(5L)**
Remote Sensing and GIS in Ecological Applications: Remote Sensing - Definition; Electromagnetic radiation and atmospheric windows; EMR and reflectance from vegetation; satellites and satellite remote sensing; application of RS in ecology, forestry, agriculture and environment; GIS - Principles; application of GIS in biodiversity, ecological, environmental spatial management.		**(8L)**
Role of Governmental and Non-Governmental organizations in environmental management: National-Ministry of Environment and Forests, NEERI, TERI, CEE, CHIPKO, MSSRF; International - WWF, IUCN, UNEP, MAB, CITES, TRAFFIC, Green Peace.		**(3L)**
<u>Laboratory Exercises</u>:		
To determine minimum area of sampling unit (quadrat) for the study of grassland community.		**(1P)**
Analysis of the herbaceous vegetation for frequency, density and abundance		**(2P)**

Species diversity indices (Simpson's & Shannon-Weiner) of herbaceous vegetation	**(2P)**
Estimation of biomass of aerial parts of herbaceous plants (fresh weight and dry weight).	(2P)
To prepare maps of India with respect to (i) major climatic zones (ii) forest types, and (iii) biogeographical regions and to comment on it. Use of google earth	(2P)
Visual interpretation of remotely sensed image for vegetation types	(2P)
Soil analysis for organic content by titration	(1P)
Soil and water analysis for total phosphorus by spectrophotometic methods	(2P)
Identification and density count of phytoplamkton using heamocytometer	(1P)
Learning Outcome: At the end of the semester, the student will be able to: ➢ Explain the concept of Community, Population, Phytogeography, Human ecology and ecological management, Remote sensing and GIS in ecological applications, Governmental and Non-governmental organizations. ➢ Compute various ecological indices through field techniques	
Suggested Readings (Paper VI & VIII) 23. Ambasht, R.S. 1988. A Text Book of Plant Ecology. Students Friends Co., Varanasi. 24. Barbour, M.G., Burk, J.H. and Pitts, W.O. 1987. Terrestrial Plant Ecology. 25. Benjamin/Cummings Publication Cc California. 26. Botkin, D.B. and Keller, E.A. 2000. Environmental Planet (3rd edition). John Wiley & Sons Inc., New York. 27. Chapman, J.L. and Reiss, M.J. 1995. Ecology: Principles and Applications. CambridgeUniversity Press. 28. Cunningham, W.P. and Saigo, S.W. 1997. Environmental Science: A Global Concern. WCB, McGraw Hill. 29. Dash, M.C. 1993. Fundamentals of Ecology. Tata McGraw Hill Publishing Co. Ltd., New Delhi. 30. Daubenmire, A.F. 1974. Plants and Environment -A Text Book of Plant Ecology *(3d* edition). John Wiley & Sons, New York. 31. Hill, M.K. 1997. Understanding Environmental Pollution. CambridgeUniversity Press. India Pvt. Ltd., New Delhi. 32. Kendeigh, S.C. 1980. Ecology with Special Reference to Animals and Man. Prentice Hall of India Pvt. Ltd., New Delhi. 33. Kormondy, E.J. 1996 (4th Ed.). Concepts of Ecology. Prentice Hall of India Pvt. Ltd., New Delhi. 34. Kumar, H.D. 1996. Modern Concepts of Ecology (4h edition). Vikas Publishing House Pvt. Ltd., Delhi. 35. Kumar, H.D. 1997. General Ecology. Vikas Publishing House Pvt. Ltd.., Delhi. 36. Mackenzie, A. et al. 1999. Instant Notes in Ecology. Viva Books Pvt. Ltd., New Delhi. 37. Miller, W.A. and Donahue, A.L. 1992. Soils ~ An Introduction to Soil and Plant Growth (6h edition). Prentice Hall 38. Odum, E.P. 1983. Basic Ecology. Saunders, Philadelphia.	

39. Odum, E.P. 1996. Fundamentals of Ecology. Natraj Publishers, Dehradun.
40. Pickering, K.T. and Owen, L.A. 1997. An Introduction to Global Environmental Issues (2'd edition). Butter and Tanner Ltd., Great Britain.
41. Smith, L.A. 1996. Ecology and Field Biology (Sh edition). Harper Collins College Publishers, USA.
42. Smith, L.A. and Smith, T.M. 1998. Elements of Ecology (4h edition). An Imprint of Addison Wesley, Longman Ink., California.
43. Tyler, M.G., Jr. 1997. Environmental Science: Working with Earth (6h edition). Wadsworth Publishing Co.
44. Weaver, J.E. and Clements, S.E. 1966. Plant Ecology. Tata McGraw Publishing Co. Ltd., Bombay.

Suggested Readings (for laboratory exercises)

11. Ambasht, R.S. 1990. Environment and Pollution. Students Friends and Co. Varanasi, India.
12. APHA - Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, D.C.
13. Kapur, P. and Govil, S.R. 2000. Experimental Plant Ecology. S.K. Jain for CBS Publishers and Distributors, New
14. Misra, R. 1968. Ecology Work Book. Oxford and IBH. New Delhi.
15. Moore, P.W. and Chapman, S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publication.
16. Moore, P.W.and Chapman, S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publications.
17. Piper, C.S. 1950. Soil and Plant Analysis. University of Adelaide, Australia.
18. Smith, R.L. 1966. Ecology and Field Biology. Harper Collins, New York.
19. Smith, R.L. 1990. (4th edition). Ecology and Field Biology. Harper Collins, New York.
20. Smith, R.L. 1996. Ecology and Field Biology. Harper Collins, New York.

PAPER IX	**SYSTEMATICS OF ANGIOSPERMS**	
	Course Objectives: 1. To acquire knowledge on morphology and evolution of plants. 2. To understand the importance of herbaria, documentation and value of computer data bases for identification. 3. To understand Taxonomic hierarchy**,** Principles and rules of botanical nomenclature, origin, evolution, systems of classification of angiosperms. 4. To understand the systematic position, diagnostic features and important species of few families. 5. To develop skills in identification of plants.	
Theory		
Introduction: Aims, scope and components of systematics; introduction to identification, nomenclature, phylogeny and classification.		**(2L)**
Systematics in practice: Importance of herbarium specimens and their preparation; role of herbaria and botanical gardens; documentation (Floras, monographs, manuals, journals, abstracts, indices and dictionaries); keys for identification of plants -single access and multi access; value of computers and databases for identification.		**(8L)**
Taxonomic hierarchy: Taxonomic category; taxonomic groups; concepts of species, genus and family.		**(2L)**
Botanical nomenclature: ICBN - Principles and rules; ranks and names; type method; principle of priority and its limitations; names of hybrids and cultivars.		**(4L)**
Origin and evolution of angiosperms: A general account of the origin and evolution of angiosperms (special reference to Bennettitalean, Gnetalean, Caytonialean and herbaceous origin theories); primitive living angiosperms; evolution of flower; co-evolution of flowers and insects.		**(6L)**
Systems of classification: Hutchinson's, Cronquist's systems of classification		**(3L)**
Evidence from other fields: Supporting evidences/inputs for taxonomy; evidences from Anatomy, embryology, palynology, ecology, cytology, secondary metabolites and semantides.		**(6L)**
Numericaltaxonomy and cladistics: Concepts, characters, methods, dendrograms / cladograms and their interpretation and applications.		**(3L)**
Systematic position, diagnostic features and important species of following families: Annonaceae, Capparidaceae, Brassicaceae, Tiliaceae, Rutaceae, Myrtaceae, Cucurbitaceae, Rubiaceae, Apocyanaceae, Asclepiadaceae, Solanaceae, Verbenaceae, Lamiaceae, Amaranthaceae, Moraceae, Orchidaceae, Araceae, Palmae, Zingiberaceae, Commelinaceae.		**(16L)**
<u>Laboratory Exercises:</u>		
Phytography		**(1P)**
Use of taxonomic keys and construction of dichotomous keys		**(2P)**
Preparation of herbarium of one terrestrial plant.		**(1P)**
Identification of all the families (Bentham & Hooker's system) studied in theory should be taught from locally available specimens (with floral diagram).		**(10P)**
Taxonomic interpretation of pollen of related species		(1P)
Raphides/Cystoliths in related sp/genera		(1P)

Learning Outcome: At the end of the semester, the students will be able to: ➢ States the aims, scope and components of systematic. ➢ Classify plants according to Bentham & Hooker's system ➢ Sketch various plant parts.	
Suggested Readings	
1. Davis, P.H. and Heywood, V.H. 1963. Principles of Angiosperm Taxonomy. Oliver and Boyd, London. 2. Heywood, V.H. and Moore, D.M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London. 3. Jones, S.B., Jr. and Luchsinger, A.E. 1986. Plant Systematics (2'd edition). McGraw-Hili Book Co., New York. Lawrence, G.H.M. 1951. Taxonomy of Vascular Plants. MacMillan, New York. 4. Naik, V.N. 1984. Taxonomy of Angiosperms. Tata McGraw Hill, New Delhi. 5. Radford, A.E. 1986. Fundamentals of Plant Systematics. Harper and Row, New York. 6. Singh, G. 1999. Plant Systematics: Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 7. Jeffrey, C. 1982. An Introduction to Plant Taxonomy. CambridgeUniversity Press, Cambridge, London. 8. Stace, C.A. 1989. Plant Taxonomy and Biosystematics, 2'd ed. Edward Arnold, London. 9. Woodland, D. W. 1991. Contemporary Plant Systematics. Prentice Hall, New Jersey.	

PAPER X	GENETICS AND PLANT BREEDING	
	Course Objectives: 1. To acquire basic knowledge of Cytogenetics and Plant breeding. 2. To understand the concepts of Mendelian genetics, Cytogenetics and Plant breeding. 4. To understand genetics through problem solving skills.	
Theory		
Mendelian genetics and principles of inheritance: Mendel's experiments; backcross and test cross; gene interactions and modified dihybrid ratios - complementary, supplementary, duplicate and epistatic factors.		**(7L)**
Multiple allelism: Multiple alleles in *Drosophila* (eye colour), man (blood groups) and plants (self incompatibility).		**(5L)**
Quantitative genetics: Quantitative traits and quantitative genetics; the multiple factor hypotheses.		**(4L)**
Linkage and recombination: Coupling and repulsion phases; two and three point test cross with their significance in chromosome mapping; interference and co-efficient of coincidence.		**(8L)**
Cytoplasmic inheritance and Maternal influence: Kappa particles in *Paramecium;* CO_2 sensitivity in *Drosophila;* Plasmids in Bacteria; cytoplasmic inheritance in yeast (mitochondria) and *Mirabilis jalapa*(plastids); chemical basis of cytoplasmic inheritance; Shell coiling in snails; eye color in flour moth.		**(8L)**
Sex chromosomes in *Drosophila,* Man and *Melandrium:* Balance concept of sex determination in *Drosophila;* mechanisms of sex determination; sex-linked inheritance in *Drosophila* and man; sex-limited characters.		**(6L)**
Plant breeding: Introduction, history, objectives, achievements and prospects; genetic variability and its role in plant breeding; centres of origin of crop plants; organizations- ICAR, ICRISAT		**(7L)**
Breeding for disease resistance: Physiological races and path types; genetics of pathogenecity; vertical and horizontal resistance.		**(2L)**
Plant breeders' rights; Phytosanitary and seed certifications.		(**3L**)
<u>Laboratory Exercises</u>:		
Determination of chromosome count from dividing pollen mother cells (meiosis) (*Allium cepa / Rheo bicolor)*, root tip (Mitosis) in *Allium cepa*		**(4P)**
Preparation of karyotypes from dividing root tip cells.		**(2P)**
Determination of interspecific variation in chromosome number from locally available taxa (*Amorphophallus/ Urgineaindica*)		**(3P)**
Identification of sex chromosomes and their behaviour during meiosis from grasshopper and any appropriate dioecious plant (*e.g.Coccinia)*		**(4P)**
Detection of anomalies in chromosome pairing and disjunction caused by mutagens and structural alterations of chromosomesin *Rheo bicolor / Setcretia sp*.		**(2P)**
Learning Outcome: At the end of the semester, the student will be able to: ➢ Understand various genetic principles and its applications. ➢ Solve problems related to Mendelian genetics		
Suggested Readings		

PAPER XI	PLANT BIOCHEMISTRY AND MOLECULAR BIOLOGY	
	Course Objectives: 1. To acquire knowledge in Plant Biochemistry and Molecular Biology 2. To understand Carbohydrate, Lipid, Amino acid and protein metabolism 3. To understand the structure and biological activities of Vitamins, antibodies and Nucleic acids 4. To understand the structure, expression and regulation of genes. 5. To develop skills in qualitative and quantitative analysis of biomolecules.	
Theory		
Carbohydrate metabolism: Introduction to glycobiology; plant lectins; biosynthesis and degradation of sucrose, cellulose and starch; bioconversion of carbohydrates to bioethanol.		**(6L)**
Lipid metabolism: Structure and function of membrane lipids; fatty acid biosynthesis; oxidation of fatty acids; storage and mobilization of fatty acids and lipids; liposomes; PUFA.		**(5L)**
Vitamins: Chemistry and biological functions of Vitamin A, B complex, C, D, E, P and K; occurrence in plants.		**(6L)**
Immunochemistry: Type of antigens, immunoglobulins and antibodies, antigen-antibody interactions, biological activities of antibodies; edible vaccines.		**(7L)**
Nucleic acids: Composition of nucleic acids and synthesis of nucleotides; Central and revised Dogma of molecular biology. DNA structure; A,B,C,D and Z forms of DNA; denaturation and renaturation of DNA; chromatin structure; DNA replication and recombination; DNA polymerases; different forms of RNA and their role; RNA silencing		**(10L)**
Amino acid and protein metabolism: Essential amino acids; amino acid biosynthesis; Transamination; peptide bond and polypeptide chain; structure and function of ribosomes; protein biosynthesis and its regulation; post-translational modification of proteins; protein folding and transport; protein secretion and degradation.		**(9L)**
Gene structure, expression and regulation: Gene organization in prokaryotes and eukaryotes; operon concept; gene regulation in prokaryotes and eukaryotes; inducible, repressible, positive and negative gene regulation; interrupted genes in eukaryotes; RNA splicing; mRNA stability.		**(7L)**
Laboratory exercises:		
Estimation of reducing sugars by DNSA method		**(1P)**
Estimation of total sugars using phenol-sulphuric acid method.		**(1P)**
Localization of carbohydrates using I_2KI and PAS.		**(1P)**
Localization of lipids using Sudan III.		**(1P)**
To identify the amino acids in a mixture of standards by resolving through TLC		**(1P)**
Isolation and estimation of total RNA (orcinol method) from plant tissue.		**(2P)**
Isolation and estimation of plant DNA using diphenyl amine method.		**(1P)**

Estimation of Ascorbic Acid.	**(1P)**
Separation of protein by SDS-PAGE (casting of gel, sample preparation, running of gel and development of gel)	(3P)
Preparation of agarose gel and running of DNA	(2P)
Estimation of vitamin A in different plant tissue	(1P)
Learning Outcome: At the end of the semester, the student will be able to: ➢ Explain about biomolecules and their metabolism**.** ➢ Perform various methods of Biochemistry and molecular biology**.**	
Suggested Readings	

Paper XII	**PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING**	
	Course Objectives: 1. To understand Laboratory organization, concepts of Cellular differentiation and techniques in somatic hybridization. 2. To understand various techniques in obtaining recombinant DNA and the varied applications of genetic engineering. **3.** To develop skills in performing plant tissue culture and genetic engineering techniques.	
Theory		
Plant biotechnology: Concept and scope - an overview.		**(1L)**
Laboratory organization and techniques in Plant Tissue Culture: Tissue culture laboratory; culture media, media preparation, aseptic transfer.		**(4L)**
Concept of differentiation: Cellular differentiation and totipotency; effect of growth regulators on differentiation; callus and suspension culture; somaclonal variation; meristem culture, anther and pollen culture, embryo culture, organogenesis and embryogenesis.		**(9L)**
Somatic hybridization: Protoplast isolation, fusion and culture; immobilization and synthetic seeds; cybrids.		**(5L)**
Recombinant DNA technology: Restriction endonucleases, ligases, methylases; prokaryotic and eukaryotic cloning vectors; genomic and cDNA libraries; Southern, northern and western analysis; various techniques DNA fingerprinting (RFLP, RAPD, AFLP); polymerase chain reaction; DNA isolation and sequencing.		**(10L)**
Genetic engineering of plants: Introduction; selectable markers and reporter genes; methods of gene delivery (***Agrobacterium and gene gun)***; hairy-root culture; **Plastid transformation**, salient achievements in crop biotechnology (with suitable transgenic examples) and prospects.		**(10L)**
Plant genomics and bioinformatics: *Arabidopsis* and rice genome; bioinformatics: introduction; scope and application in plant genomics		**(4L)**
Bio-energy and bioremediation: Composition of biomass, methods of energy production, methane, bioethanol, petroplants - *Jatropha* and biodiesel. Bioremediation of waste water and polluted soils by plants		**(6L)**
Proteomics, metabolamics and functional genomics		**(1L)**
<u>Laboratory exercises</u>:		
Preparation of tissue culture media (carrot culture), sterilization and inoculation of plant		**(3P)**

material.	
Morphological studies of callus (sectioning and microscopic studies)	**(1P)**
Sub culture of callus for shoot induction	(2P)
Sub culture for callus for root induction	**(2P)**
Embryo culture of Maize	**(2P)**
Isolation of plant protoplasts (e.g. tobacco, petunia) using enzymes available commercially and estimation of their yield.	**(3P)**
Preparation of synthetic seeds.	**(1P)**
Single cell isolation.	(1P)
Learning Outcome: At the end of the semester, the students will be able to: ➢ Explain various types of plant tissue culture media and its components. ➢ Demontrates different steps taken to establish and optimize media for growing plant species.	
Suggested Readings 1. Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J.D. 1999. Molecular Biology of Cell. Garland Publishing Co., Inc., New York, USA. 2. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA. 3. Buchanan, B.B., Gruissem, W. and Jones, R.L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists, Maryland, USA. 4. Collins, H.A. and Edwards, S. 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford, UK. 5. Dennis, D.T., Turpin, D.H., Lefebvre, D.O. and Layzell, D.B. (eds) 1997. Plant Metabolism (~d Edition). Longman, Essex, England. 6. Lea, P .J. and Leegood, R.C. 1999. Plant Biochemistry and Molecular Biology (2'd Edition). John Wiley and Sons..Chichester, England. 7. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and' Darnell, J. 2000. Molecular Cell Biology (4' Edition). W.H. Freeman and Co., New York, USA. 8. Old, R.W. and Primrose, S.B. 1989. Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford, UK. Raghavan, V. 1986. Embryogenesis in Angiosperms: A Developmental and Experimental Study. CambridgeUniversityPress, New York, USA. 9. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, TheNetherlands.	

PAPER XIII	**ANATOMY AND DEVELOPMENTAL BIOLOGY OF FLOWERING PLANTS**	
	Course Objectives: 1. To acquire basic knowledge and fundamental concepts of Anatomy& Embryology of plants. 2. To understand various tissue organization in primary and secondary structure of plants, anatomical adaptations, embryo, endosperm and	

	seed structure. 3. To develop skills in identification and comparison of anatomical, palynological and embryological structures in plants.	
Theory		
Phanerogams, the seed bearing plants: General characteristics and types		**(1L)**
Meristems and development: Shoot apical meristem, root apical meristem, lateral meristems and their functions.		**(5L)**
Secondary body of the plant: Vascular cambium; secondary xylem, wood anatomy; secondary phloem and periderm.		**(7L)**
Organography and anatomy: leaf morphology, histology and venation; nodal anatomy; root-stem transition; general concepts of floral anatomy.		**(10L)**
Flower: Evolution; concept of flower as a modified determinate shoot; genetic control of floral organs; functions of flower.		**(5L)**
Structure of anther: Microsporogenesis; formation of pollen grains (male gametophyte); pollen germination; pollen tube growth.		**(7L)**
Structure of pistil: Ovules; megasporogenesis; female gametophyte; development of embryo sac (monosporicpolygonum type; bisporic allium type; tetrasporicfritillaria type).		**(5L)**
Mechanisms and agencies of pollination: Nectaries (floral and extra floral) - structure and function; Pollen-stigma interaction; self- incompatibility.		**(5L)**
Fertilization: Double fertilization; endosperm - types; embryogenesis - Onagrad type, Triticum type. Apomixis and Polyembryony.		**(5L)**
<u>Laboratory exercises:</u>		
Study of meristems from permanent slides.		(1P)
Comparative anatomical structure of wood of *Artocarpus, Tectona grandis, Terminalia crenulata* from sections (T.S., T.L.S. and R.L.S.) and macerations.		(3P)
Distinct anatomical features of leaf (*Nerium*, Grass, *Nymphaea*).		(1P)
Study of leaf appendages, venation and stomata types.		(2P)
Pollen studies: Chitaley's method for analysis in *Ipomoea, Ocimum, Hibiscus, Acacia auriculiformis*and Grass.		(1P)
Microsporogenesis and male gametophyte development in angiosperms through Permanent slides		(1P)
Pollen grain germination by hanging-drop and sitting-drop techniques in *Impatiens, Catharanthusroseus*(= *Vincarosea)*		(1P)
Diversity in the structure of stigma, style, stigmatic papillae and transmitting tissue of style (any available material)		(1P)
Comparison of mating types in species exhibiting heteromorphic self incompatibility*Hamelia patens/Pentas.*		(1P)
Microdissection of embryo with suspensor at different stages of development to unravel relationship between the two.		(1P)
Microdissection of endosperm with haustoria (cucurbit).		(1P)
<u>Learning Outcome</u>: At the end of the semester, the students will be able to:		

➢ Describe internal plant structures, reproductive structures through different tissues and embryological developmental stages. ➢ Explain mechanisms of pollination, seed dispersal and importance of propagation in higher plants.	
Suggested Readings 1. Bhojwani, S.S. and Bhatnagar, S.P. 2000. The Embryology of Angiosperms, 4h revised and enlarged edition. Vikas Publishing House, Delhi. 2. Carlquist, S. 1988. Comparative Wood Anatomy: Systematic, Ecologicar and Evolutionary Aspects of Dicotyledonous Wood. Springer-Verlag, Berlin. 3. Cronquist. A. 1968. The evolution and classification of flowering plants. Thomas Nelson (Printers) Ltd., London& Edinburgh. 4. Cutter, E.G. 1969. PartI. Cells and Tissues. Edward Arnold, London. 5. Cutter, E.G. 1971. Plant Anatomy: Experiment and Interpretation. Part II. Organs. Edward Arnold, London. 6. Delevoryas. Th. 1965. Plant Diversification. Modern Biology Series, Halt, Rinehart&Winston, New York. 7. Esau, K. 1977. Anatomy of Seed Plants, 'i.'d edition. John Wiley and Sons, New York. 8. Fahn, A. 1974. Plant Anatomy, 'i.'d edition. Pergamon Press, Oxford. 9. Foster, A.S. and Gifford, A.E.M., Jr. 1967. Comparative Morphology of Vascular Plants. Vakils, Peffer& Simons Pvt. Ltd. 10. Johri, B.M. 1984. Embryology of Angiosperms. Springer-Verlag, Berlin. 11. Mauseth, J.D. 1988. Plant Anatomy. The Benjamin/Cummings Publishing Company Inc., Menlo Park, California, USA. 12. Nair, M.N.B. 1998. Wood Anatomy and Major Uses of Wood. Faculty of Forestry, Universiti Putra Malaysia, 43400 Serdang, Selangor D. E., Malaysia. 13. Raghvan, V. 1997. Molecular Embryology of Flowering Plants. Cambr!dge University Press, N.Y. 14. Raghvan, V. 2000. Developmental Biology of Flowering Plants. Springer-Verlag, NY. 15. Sporne, K.R. 1977. The Morphology of Angiosperms. B.I. Publication, Bombay. 16. Steeves, T.A. and Sussex, I.M. 1989. Patterns in Plant Development, 2'd edition. CambridgeUniversityPress,Cambridge.	

PAPER XIV	**GENETICS, PLANT BREEDING & STATISTICAL MEHODS**	
	Course Objectives: 1. To acquire basic knowledge of Cytogenetics, Plant breeding and Statistical methods. 2. To understand the alterations in the genetic make up at genetic level, chromosome structure and number. 3. To understand the different methods of plant improvement. 4. To understand statistics through problem solving skills. 5. To develop skills of plant breeding such as emasculation and artificial pollination and its relevant applications in crop	

	improvement.	
Theory		
Alterations in the genetic make up -changes at genetic level: Spontaneous and induced mutations; mutagens -types and mode of action; transitions, transversions and frame-shift mutations; detection of mutations.		**(8L)**
Alterations in genetic make up -changes in chromosome structure: Origin, types and effects of duplications, deletions, inversions and translocations; meiosis in structural heterozygotes.		**(8L)**
Alterations in genetic make up-changes in chromosome number: Origin, types and effects of auto and allopolyploidy; origin and meiosis in nullisomics, monosomics and trisomics.		**(8L)**
Methods of plant improvement: Pure line and mass selection; techniques in hybridization; hybridization in self and cross-pollinated crops; introduction and acclimatization; hybrid vigour.		**(12L)**
Mutations and polyploidy as methods of plant improvement.		**(4L)**
Statistical methods: Sampling theories, data collection, processing and presentation; descriptive statistics (mean, median, mode, standard deviation, mean square value), correlation, regression, chi square, student's t- test.		**(10L)**
<u>Laboratory Exercises</u> (Genetics , Plant Breeding & Statistical Methods):		
Preparation of chromosome maps from 3-point test cross data.		**(1P)**
Correlation of floral structure with pollination system (e,g. *Salvia, Sesamum,* pea, rice, maize, *Ricinus).*		**(1P)**
Field exploration for detection of male sterile plants and estimation of their pollen fertility in locally grown crop plants (e.g. chilli)		**(2P)**
Estimation of pollen ovule ratio and its bearing on pollination system.		**(2P)**
Emasculation and bagging of flowers of Brassicaceae and Malvaceae pollinating them manually and estimating fruit and seed set.		**(2P)**
Analysis of data for mean, mode, median, standard deviation and standard error using suitable plant samples		**(2P)**
Determination of correlation and regression using examples		**(2P)**
Student 't' test and Chi square analysis		**(1P)**
Colchicine based polyploidy		(1P)
Colchicine based mutation (shoot/root/germination/chromosomes)		(1P)
Learning Outcome: At the end of the semester, the student will be able to: ➢ Explain about mutation, genetic makeup in chromosome**.** ➢ Describe different methods used in plant improvement **.** ➢ Perform techniques of sampling, data collection, processing and field experiments. ➢ Solve problems related to statistics.		
Suggested Readings 1. Atheri,Y, A.G., Girton, J. R. and McDonald. 1999. The Science of Genetics. Saunders College Publishing Co., FortWorth, USA. 2. Gardener, J., Simmons, H.J. and Snustad, D.P. 1991. Principles of Genetics (5th		

Edition). John Wiley & Sons, NewYork.
3. Gupta, P.K. 1994. Genetics. Rastogi Publications. Shivaji Road, Meerut.
4. Gupta, P .K. 1995. Cytogenetics. Rastogi Publications, Meerut.
5. Hartl, D.L. and Jones, E. W. 1998. Genetics: Principles and Analysis (4th Edition).
6. Jones &Bartlett Publishers, Massachusetts, USA.
7. Poehlmann, J. M. and Sleeper, D. R. 1995. Breeding Field Crops. Panima Publishing House, New Delhi.
8. Russel, P.J. 1998. Genetics (5th Edition). The Benjamin/Cummings Publishing Co., Inc., USA.
9. Simmonds, N.W. 1979. Principles of Crop Improvement. Longman, London and New York.
10. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2'd Edition). John Wil)ey& Sons, Inc., USA.
11. Sharma, J.R.1994. Principles and Practice of Plant Breeding. Tata McGraw-Hill Publishing
Co. Ltd., New Delhi.

PAPER XV.	**MICROBIOLOGY AND PLANT PATHOLOGY**	
	Course Objectives: 1. To acquire knowledge on basic and advanced concepts of microbiology and plant pathology. 2. To understand the occurrence and economic value of various microbes; their interactions with the environment and impact on living organisms. 3. To understand plant defense mechanisms, disease management, resistance and Plant disease epidemiology 4. To develop basic skills in isolation and handling of microorganisms and its relevant applications.	
Theory		
A. <u>Microbiology</u>:		
Discovery of microorganisms; Systematics of microorganisms in biological world; Classification of microorganisms (Bergey's manual) (and characteristic features of different groups.		**(2L)**
Methods in microbiology: Staining, sterilization methods; culture media and pure culture methods; methods for population estimation, growth determination.		**(4L)**
Ultrastructure of microorganisms: Viruses: properties and classification; Characteristics of host-virus interaction; Mycoplasma, Prions, Viroids; bacteriophage T4 and TMV. **P**rokaryotic microorganisms; bacteria; Actinomycetes; fine structure of prokaryotic cell; Eukaryotic microorganisms; yeasts.		**(10L)**
Geneticrecombination in Prokaryotes: Conjugation, transformation and transduction; Plasmids		**(1L)**
Role of microorganisms in biogeochemical cycling : Nitrogen, Phosphorus and Carbon,Biological N_2 fixation; Symbiotic and asymbiotic; Mycorrhizae and their role in agriculture and forestry		**(4L)**

Industrial application of microorganisms: Secondary metabolites;Organic acids, bread, wine, alcohol, food processing, milk products, antibiotics, biofertilizers; Mushroom cultivation.	**(5L)**
B. Plant Pathology:	
General account of Plant Pathogens: General account of diseases caused by plant pathogens; Symptomatology.	**(2L)**
Pathogen attack and defense mechanisms: Stages of disease establishment; Physical, physiological, biochemical and molecular aspects.	**(5L)**
Plant disease epidemiology: Transmission and spread of plant pathogens; disease cycles, epidemics; modeling and disease forecasting.	**(3L)**
Plant disease management: Cultural, Chemical, biological; IPM systems; development of transgenics; biopesticides; Plant disease clinics.	**(4L)**
Genetics of resistance and susceptibility: Genes for virulence and avirulence, their application in resistance and susceptibility; induced resistance (immunization).	**(3L)**
Molecular Plant Pathology: Molecular diagnosis; identification of genes and specific molecules in disease development; molecular manipulation of disease resistance.	**(4L)**
Application of Information Technology in Pl. Pathology: Simulation of epidemics; programmes for diagnosis; remote sensing and image analysis for ecosystem level effects; prediction of disease control decisions	**(3L)**
Laboratory Exercises: **Microbiology:**	
Determination of dimensions of microorganisms (suggested model organisms: yeast, lactobacilli, Cyanobacteria).	**(1P)**
Sterilization; preparation of agar medium for Bacteria and PDA solid medium and CzapeckDox liquid medium for fungi	**(2P)**
Isolation of microorganisms: streaking on agar plates/pour plate method	**(2P)**
Turbidimetric determination of growth of a microorganism using spectrophotometer (model organism: *E. coli* / yeast)	**(1P)**
Determination of microbial population size (model organism: yeast; use of haemocytometer, serial dilution technique, relationship between dilution and cell count, determination of standard error, reliability in cell counts)	**(1P)**
Mycorrhizal preparation using tryphan blue / cotton blue. Demonstration **ecto- and endomycorrhizae**; wet-sieving and decanting method for isolation of arbuscularmycorrhizae	(**2P)**
Isolation and inoculation of bacterial and fungal pathogens.	**(2P)**
Anatomical observations of fungal infected plants (rust, blight, rots)	**(1P)**
Plant Pathology:	
Study of symtomotology, **morphology and anatomy** of important locally available plant diseases symptoms and host-parasite relationship **(One viral, bacterial and fungal**)	**(1P)**
Isolation and culture of plant pathogens (e.g. ***Colletotrichum/Fusarium/Alternaria)*** and establishment of Koch's postulates and their pathogenicity	**(2P)**
Learning Outcome: At the end of the semester, the students will be able to: ➢ Define different terms related to microbes	

➢ Describe various plant disease symptoms and their causes by different causal agents. ➢ Demonstrate various standard safety lab procedures with hands on practice of sterilization methods.	
Suggested Readings 1. Agrios, G.N. 1997. Plant Pathology. Academic Press, London. 2. Albajes, R., Gullino, M.L., van Lenteren, J.C. and Elad, Y. 2000. Integrated Pest and Disease Management in Greenhouse Crops. Kluwer Academic Publishers. 3. Bridge, P. et al. 1998. Molecular Variability of Fungal Pathogens. CAB International, UK. 4. Bridge, P. et al. 1999. Application of PCR in Mycology. CAB International, UK. 5. Bridge, P., Moore, D.R. and Scott, P.R. 1998. Informationa.i Technology, Plant Pathology and Biodiversity. CAB International, UK. 6. Persley, G.J. 1996. Biotechnologies and Integrated Pest Management. CAB International, UK. 7. Skerritt, J.H. and Apples, R. 1995. New Diagnostics in Crop Sciences. CAB International, UK. 8. Sullia, S.B. 2001. General Microbiology, Oxford Publishers, New Delhi 9. Tauro, P.T. 1988. Introductory Microbiology. 10. Vaidya, J.C. 2000. Biology of Fungi. 11. And any other latest books on the subject **Suggested Readings (for laboratory exercises):** 1. Eklund, C. and Lankford, C.WE. 1967. Laboratory Manual for General Microbiology. Prentice-Hall, Inc., Engle-wood Cliffs, N.J. 2. Gunasekaran, P. 1995. Laboratory Manual in Microbiology. New Age International Pvt Ltd. 3. Pawsey, R.K. 1974. Techniques with Bacteria- A Guidebook for Teachers. Hutchinson Educational. 4. Pelezor, M.J. and Chan, E.C.S. 1972. Laboratory Exercises in Microbiology. McGraw Hill Book Co. 5. Meyneil, E. and Meynell, G.G. 1970. Theory and Practice in Experimental Bacteriology. University Press, Cambridge. 6. Wistreich, G.A. and Lechtman, M.D. 1973. Laboratory Exercises in Microbiology. Glencoe Press, New York, Beverly Hills, Collier Macmillan Publishers, London. 7. Aneja, K. R. 1993. Experiments in Microbiology, Plant Pathology and Tissue Culture. Wishwa Publication, New Delhi. 8. Mahadevan, A. and Sridhar, R. 1986. Methods in Physiological Plant Pathology. Sivakami Publication, Madras. 9. Schaad, N. W. 1988. Plant Pathogenic Bacteria: Laboratory Guide for Identification of Plant Pathogenic Bacteria. Academic Press. **Journals/Series** 6. Methods in Microbiology ; Methods in Enzymology ; Methods in Biochemistry	

7. Indian Journal of Mycology & Plant Pathology, Jodhpur 8. Mycorrhiza News Letter, TERI, New Delhi 9. Indian Journal of Microbiology.	

PAPER XVI	**ECONOMIC AND APPLIED BOTANY**	
	Course Objectives: 1. To acquire knowledge about ethnobotany, major crops and medicinal plants of India 2. To understand the concepts and scope of floriculture, Horticulture, Sericulture, Apiculture and Forestry. 3. To develop skills in identification of crop plants in India and vegetative propagation techniques. 4. To develop skills for to analyse different oils and fibres.	
Theory		
Ethnobotany: Introduction to indigenous knowledge and ethnobotany; ethnobotanical knowledge in bioprospecting		(2L)
Agroclimatic regions and major crops of India: Major features and crops. Botanical names, part used, climatic requirements and popular cultivars if any of the following: Cereals and millets: wheat, rice, maize, sorghum, bajra, finger millet. Pulses: Chickpea (Bengal gram), red gram (arhar), black gram, green gram Vegetable oil sources: Mustard, groundnut, sunflower, sesame and coconut Tuber crops: Yams, Tapioca, Potato, Sweet potato Fruits: Mango, Banana, Jack fruit, Papaya, Pine apple, Apple, Oranges. grapes. Vegetable: Brinjal, Okhra, Ridge gourd, tomato, onion, Amaranth, radish Spices and condiments: Capsicum, Cinnamon, Black pepper, turmeric, ginger Cash crops: Tea, coffee, rubber, cashew, cocoa, sugarcane Plant fibres: Cotton, jute, sisal and coir. Timber plants of Goa: *Matti, Kindal, Sailo, Ponas, sisam,* bamboo Miscellaneous: Dye - *Bixa;* essential oil - *Eucalyptus*; insecticidal - neem; fodder - subabul		(25L)
Medicinal plants: A brief account of plant drugs and their chief constituents used in indigenous and allopathic systems of medicine with regard to *Rauwolfia serpentina, Hemidesmus indicus, Garcinia indica, Holorrhena antidysentrica, Andrographis paniculalta, Catharanthus roseus, Aloe vera, Tinospora cordifolia, Adhatoda vasica, Boerhaavia diffusa*		(4L)
Floriculture: Scope and present status in India; basic aspects of cultivation of Orchids, Anthuriums, Gerbera, Crossandra, Carnation, Jasminum.		(3L)
Horticulture: Concept & application, Landscape gardening, Kitchen gardening, Rock gardening, Lawn making, Bonsai, Horticultural crops of Goa		(6L)
Vegetative Propagation		(4L)
Concepts & Applications of Sericulture & Apiculture		(2L)
Forestry:Silviculture, Agroforestry & Social Forestry		(4L)
<u>Laboratory Exercises</u>:		
Identification (botanical name and family), description and utilization of plants and/or plant parts studied in theory, under each group, including flouriculture plants		(8P)
Chemical tests for oil: Sesame/**groundnut** T.S. of Eucalyptus leaf to study oil glands		(1P)

Properties of plant fibres: Cotton, Jute and coir.	(1P)
Study of plants (live or from herbarium specimens) used as sources of drugs: (*Rauvolfiaserpentina, Adhatodavasica, Tinosporacordifolia, Terminaliabellirica, Holorrhena antidisentrica, Garcinia indica, Andrographis paniculata, Catharanthus rosesus, Hemidesmus indicus, Boerrhavia diffusa* and *Aloe vera.*	(3P)
Extraction of plant pigments in water, ethanol and n-hexane of any two: e.g. *Curcuma longa* (turmeric), *Bixaorellana* (annato), *Lawsonia inermis* (mehndi), Garciniaindica (Kokum).	(1P)
Vegetative propagation techniques	(1P)
Preparation of a list of trees and shrubs used as ornamentals along with their popular and scientific names. Seasons of flowering and brief description. Calendar of seasonals grown as bed plants, potted plants, houseplants, and flowers used for worship or ornamentation. This may be illustrated and presented as a term paper at the time of examination.	
Learning Outcome: At the end of the semester, the students will be able to: ➢ Categorize major crops of India with reference to their Botanical names, parts used, climatic requirements and popular cultivars. ➢ Explain about Ethnobotany, medicinal plants, floriculture, horticulture, vegetative propagation, sericulture, apiculture and different units of forestry. ➢ Identify the major crops of India, crops of floriculture, medicinal plants.	
Suggested Readings 1. Carlquist, S. 1988. Comparative Wood Anatomy: Systematic, Ecological and Evolutionary Aspects of Dicotyledonous Wood. Springer-Verlag, Berlin. 2. Fuller, K.W. and Gallon, J.A. 1985. Plant Products and New Technology. Clarendon Press, Oxford, New York. 3. Hilll Economic Botany 4. Kocchar, S.L. 1998. Economic Botany in Tropics, 'i.'d edition. Macmillan India Ltd., New Delhi. 5. Nair, M.N.B. 1998. Wood Anatomy and Major Uses of Wood. Faculty of Forestry, Universiti Putra Malaysia, 43400 Serdang, Selangor D. E., Malaysia. 6. Sambamurthy, A.V.S.S. and Subramanyam, N.S. 1989. A Textbook of Economic Botany. Wiley Eastern Ltd., New Delhi. 7. Sharma, O.P. 1996. Hill's Economic Botany. Tata McGraw Hill Publishing Company Ltd., New Delhi. 8. Simpson, B.B. and Conner-Ogorzaly, M. 1986. Economic Botany- Plants in Our World. McGraw Hill, New York. 9. Thomas, P. 2000. Trees: Their Natural History. CambridgeUniversity Press, Cambridge. 10. Tippo, O. and Stern, W.L. 1977. Humanistic Botany. W.W. Norton, New York. Vishnu Swarup 1997. Ornamental Horticulture. Macmillan India Ltd., New Delhi.	

FIELD WORK

In addition to the requisite number of lectures and practicals, a student of Botany at F.Y./ S. Y./ T. Y. B. Sc. course is required to undertake field work / study tour to acquaint with the practical aspects of the subject as well as learn the recent developments in the subject by visiting research institutes / Universities under the guidance of a teacher as per the details shown below:

Course	**Field trips / study tours**
F.Y. B. Sc. (Semester I & II together)	Two local field trips (one in each semester)
S.Y. B. Sc. (Semester III & IV together)	Two local field trips in **semester III** short tour of not less than four days outside Goa in **semester IV**.
T.Y. B.Sc. (Semester V & VI)	Three local field trips **in semester V** and one long study tour outside the state of Goa of not less than 10 days**in semester VI**.

Note 1: Total duration of each local field trip should not be less than eight hours.

2: The teacher student ratio for the purpose of field trip / study tour be same as that for practicals.

3. The students are required to maintain a field record to be submitted at the time of practical examination.

4. Field trips / study tours should be to the places other than the ones mentioned in the practicals.

5. As per the circular No. GU/V/Gen. Appt./30/97/3754 dated 26.6.1997 following will be the work load for field work/study tour in Botany.

F.Y. B.Sc. - One period/week/batch
S. Y. B.Sc. - Two periods/week/batch
T.Y. B.Sc. - Five periods/week/batch

The syllabus to be implemented in phased manner from 2011-12
Approved by B.O.S. in Botany dated 19th April 2011

Chairman, BOS in Botany
Goa University