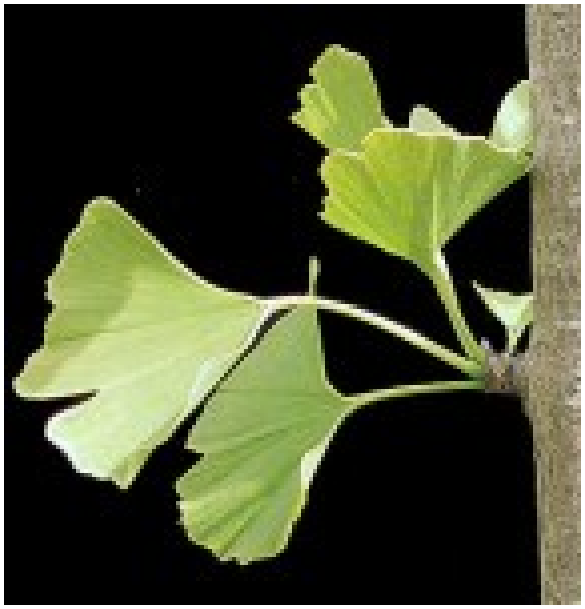
MASTER OF PHILOSOPHY

(M. PHIL)

DEGREE IN BOTANY



PROPOSED SYLLABUS AND SCHEME OF EXAMINATION

Department of Studies in Botany, University of Mysore

Manasagangotri, Mysore-570 006

MASTER OF PHILOSOPHY

(M. PHIL.)

DEGREE IN BOTANY

Preamble

Plants cover the earth and provide food and fuel that sustains most of the earth's biomass and life forms. The recently emerged new discipline plant molecular biology has provided the wealth of insights into how plants grow, reproduce, develop, respond to their environment, and defend themselves. In the second half of the 20th century the discovery of the structure of DNA and RNA, the steps in protein synthesis and other great discoveries of plant biology revolutionized the study of plants at all levels, from cells to ecosystems. Taxonomists, evolutionists, ecologists, physiologists, and developmental biologists are now using modern techniques of plant biology and are discovering responses and mechanisms that were not accessible in the past. It is now possible to identify with much more precision, the particular genes responsible for traits. With the techniques of modern biology, we can introduce or eliminate genes for specific traits. Using these plant biotechnological tools we may also alter the present taxonomy and phylogeny. In view of this, there is urgent need to incorporate and teach plant biology in different perspectives. Hence, it was propose to introduce M.Phil. Botany course for post M.Sc., students of botany/plant sciences under fully self financed scheme, as per existing regulations for M.Phil. Degree course of the University of Mysore-1998. Besides the UGC has also made M.Phil. Degree mandatory for the candidates applying for the teaching posts in under graduate colleges.

This one year M.Phil. Course is envisaged to fulfill the lacunae that exist among Botany / Plant Science postgraduate students. The course intends to mould and reorient students as future plant biologists who will fit in all the future expanding areas of plant science/plant biotechnology. The course provide the students with useful working knowledge of plant biology and how these principles are applied to elucidate the mechanisms underlying complex cellular and organisimal processes. The course exposes students to the exciting and expanding fields of advanced botany. Thus, students of botany/plant biology will have a fine understanding of biology of plants and underlying molecular mechanisms through which they functions.

The fee structure for M.Phil. Degree course in Botany is to be fixed by the competent authority of the University. All recognized guides in Botany are eligible to guide M.Phil. Students.

Eligibility: Candidates with M.Sc., Botany/M.Sc., Applied Botany/M.Sc., in Plant Science or equivalent degree of any other university are eligible for admission.

Duration: One year M.Phil. Degree course in Botany shall be for a period of 12 Months. The course comprises of Two Semesters. The first semester is devoted to course work and the second semester is devoted to project/research/dissertation work.

First semester comprises two theory and two practical papers. Theory papers MPB-1.1 and 1.2 shall be of 64 hrs duration each and question paper shall be set by the external examiner and approved by the BOE. Practical papers MPB1.3 and 1.4 are of 96 hrs duration and the external and internal examiners shall conduct two separate practical examinations. The external and internal examiners shall value all the papers. Internal assessment (10+10=20) for theory papers is based on one test, one seminar in first semester. Practical records carry 10 marks as internal assessment for each practical record.

The second semester is fully devoted for project work. The research guide shall give research topic for the project work/Dissertation. The project work/dissertation shall be evaluated during Viva-Voce examination by the external and internal examiners.

COUSRE STRUCTURE FOR ONE YEAR M.PHIL. DEGREE IN BOTANY

FIRST SEMESTER						
Paper Code	**Title of the Paper**	**No. of Hours /Week**	**Total No. of Hours**	**IA**	**Theory/ Practical**	**Total Marks**
MPB 1.1	Theory:Research Methodology	04	64	20	80	100
MPB 1.2	Theory:Advanced Botany	04	64	20	80	100
MPB 1.3	Practical-I: Analytical Methods in Research	06	96	10	40	50
MPB 1.4	Practical-II: Methods in Plant Biology	06	96	10	40	50
Total Marks for First Semester						300
SECOND SEMESTER						
MPB 2.1	Project Work	Both internal and external examiners shall evaluate project work.				200
MPB 2.3	Viva-Voce	Research guide and external examiner shall conduct viva-voce examination.				100
Total Marks for Second Semester						300
I SEMESTER AND II SEMESTER		**GRAND TOTAL MARKS**				**600**

FIRST SEMESTER

MPB- 1.1: RESEARCH METHODOLOGY (04 X 16=64 Hrs)

1. **Introduction to Research:** Reflection, Science and Research. Basic and applied research. Essential steps in research. Literature collection- Need for review of literature, Review process and bibliography, Research reading, consulting source material. Literature citation. List of References. Citation-sequence system, Alphabet-Number system.
2. **Research Report:** Components of research report-title, authors and addresses, abstract, summary, synopsis, key words, introduction, Materials and methods, results, discussion, Acknowledgements, general introduction and general discussion, summary and conclusion, appendixes, references. Research Report-Tables-components. Research Figures- Components. Research Report-Formatting and typing.
3. **Experimental Designs and Principles and Applications of Biostatistics:** Introduction, observation, Hypothesis and Null Hypothesis. Basic principles of Experiments. Experimental Units and sampling units. Experimental error, Discrimination, Replication, Generalization, Controls, Randomization, Measurement. Classification of Data; Graphical representation of Biometric Data; Measures of central Tendency; Measures of Dispersion; Tests of Significance; Student T Test; The Chi-Square test; Probability; Correlation; Regression.
4. **Laboratory Rules and Laboratory Safety:** Laboratory rules and General Safety measures. Chemical Hazards. Physical Hazards. Biological Hazards. Spillage and Waste Disposal. Laboratory- acquired infections. First Aid. Safety measures. Safety in Genetic engineering. Safety of Laboratory animals.
5. **pH and pH Meter, Normal and Molar Solutions, Per cent solutions:** Introduction. pH, pH meter. Working of pH Meter. Physiological Solutions- Stock Solutions, Biological Buffers, Proteins, Enzymes and Antibiotics. Preparation of Solutions-Normal and Molar solutions. Per cent solutions.
6. **Centrifugation:** Introduction. Centripetal and Centrifugal Forces. Relative Centrifugal Force. Factors. Sedimentation Coefficient and Sedimentation Constant. Centrifuge. Gradient Media. Types of Centrifuges. Applications of Centrifugation- Preparative and Analytical Centrifugation.
7. **Chromatography:** Chromatographic Methods. Nature of Phases. Principles of Separation. Geo-metery and Stationary Phase. Mode of Operation. Retention Mechanism. Paper, Thin Layer, Column, Gas and Liquid Chromatography techniques and their Applications.
8. **Electrophoresis:** Principles, Components, Support Medium, Buffers, Types of Electrophoresis and their Applications. Horizontal and Vertical Gel Electrophoresis. Polyacrylamide Gel Electrophoresis, Two dimensional PAGE. Iso-electric Focusing.
9. **Colorimetery and Spectrophotometery:** Photometery, Colorimetery and Spectrophotometery. Single, Double and Split Beam Spectrophotometers. Biological

Applications of UV-Visible Spectrophotometers. Mass spectrometry and Infrared Spectroscopy. Turbidometry and Nephelometery.

10. **Immunochemical Techniques:** General Principles. Antigen and Antibody Interaction. Antibody Production. Immuno-diffusion. Radioimmunoassay (RIA). Enzyme Linked Immuno-sorbent Assay (ELISA). Fluorescent Immunoassay (FIA). Avidin-Biotin-mediated Immunoassay. Labeled antibody techniques for detecting antigens.
11. **Techniques in Molecular Biology:** Isolation of Nucleic acids (DNA/RNA) and plasmids. Restriction Digestion. Separation of Nucleic acids by Agarose Gel Electrophoresis. Construction of cloning vector. Transformation. Transfection. Gene expression. Analysis of recombinants. Blotting and PCR Technique. Nucleic acid sequencing.
12. **Techniques in Cell Biology:** Transmission Electron Microscopy –Thin specimens, Ultramicrotomes, Shadow casting, Negative staining, and Tracers, Image reconstruction from Electrom Micrograph, Scanning Electron Microscopy, Fluorescence Microscopy-Autofluorescence and Fluorochrome Dyes, Flow-Sorting Cytometery.
13. **Plant Histology:** Collection, fixation and processing plant materials; Freeze drying and Freeze substitution, Embedding, Microtomy, Staining, Double staining, Microscopy and observation, Photomicrography, Camera Lucida drawings.
14. **Bioinformatics:** Introduction to Bioinformatics; Databases; Applications of Bioinformatics; Bioinformatics business areas; Techniques in bioinformatics; Searching for genes; Bioinformatic Tools; Career and Training in Bioinformatics; Bioinformatics centers in India.
15. **Intellectual Property Rights:** Protection of IPR in India. Terminology Associated with IPR- Patent-Copyright-Trademark-Design-Geographical Indication-Plant Variety and Farmers' Rights Protection-Trade Secrets.

MPB-1.2: ADVANCED BOTANY (04 X 16=64 Hrs)

1. **Biodiversity and Conservation:** Concepts, significance and magnitude; Levels of Biodiversity; (Genetic, Species Population, community, Ecosystem and Habitat); Biodiversity profile in India and Karnataka; Plant and Microbial Diversity; Mega diversity Zones and Hot Spots; Uses of Biodiversity; Threat to Biodiversity; IUCN threat categories, Red Data book; Conservation of Biodiversity.
2. **Molecular Taxonomy:** Scope; Methods in Molecular taxonomy and Systematics; Processing molecular data and Phylogenetic inference using different Methods (Parsimony, Maximum Likelihood, Bayesian); Use of Chloroplast, Nuclear and Mitochondrial DNA sequences in Plant systematics; Phylogenetic trees and concepts; Applications of molecular Phylogenetics.
3. **Plant Reproductive Biology:** Recent developments in plant embryology; Induction of flowering; Genetic and molecular analysis of flower development. Genes and formation of gametes. Apomixes and its significance, Genetics of apomixes; Techniques to screen apomicts; Practical importance of apomixes; Embryology in relation to taxonomy; Palynology in Taxonomy; Experimental and Applied Embryology.
4. **Crop Physiology:** Recent developments in Photosynthesis, Respiration and Photorespiration- an overview; Signal transduction- receptors- phtochrome, ABA G proteins and Phosphate signaling Cyclic nucleotides. Calcium, Protein kinases.

Senescence and Programmed Cell Death. PCD in life cycles of plants. Genes responding to hormones, phytochrome, abiotic stresses, water stress, freezing stress.

5. **Advanced Cell Biology:** Plant Cell Compartments, Membrane Structure and Membranous Organelles, Membrane transport mechanisms, Protein Sorting and Vesicle Traffic. Cell division regulation -Recent developments in cell cycle research. Mechanism of cell cycle regulation. Cell cycle regulation in multi-cellular organisms; Cell cycle regulation and plant cell growth.
6. **Plant Molecular Biology:** Plants as genetic tools in molecular biology (*Zea, Rice, Nicotiana, Antirrhinum and Arabidopsis*); Organization of plant nuclear genes, plastid genes and mitochondrial genes; Genes for structure, function and development. Molecular mechanism of leaf and flower development in *Arabidopsis* and *Antirrhinum.* Regulation of genes involved in Photosynthesis and nitrogen fixation. Biology and Genetics of *Agrobacterium tumefaciens*.
7. **Plant Biotechnology:** In-vitro culture techniques; Plasticity and totipotency, Culture types – callus, cell suspension culture, Protoplast, Root culture, Shoot tip and Meristem culture, Embryo culture, Microspore culture. Plant regeneration - Somatic embryogenesis, Organogenesis; Applications of tissue culture in plant breeding, Horticultre and Forestry; Industrial Applications of Tissue culture for secondary metabolite production; *Agrobacterium*-mediated plant transformations. Edible plant Vaccine (EPV) technology; Molecular Farming/pharming-metabolic engineering of plants.
8. **Mycology and Molecular Plant Pathology:** Fungal biodiversity; Fungi in biotechnology; Fungi in Genetic Research; Endophytic fungi and their importance; Fungal interactions and practical exploitation; Major groups of plant pathogenic fungi. Host specialized necrotrophic pathogens; Mycorrhizae (VAM) and significance. Plant disease diagnosis and diagnostics; Molecular biology of Plant-Microbe interaction; R-genes and R gene mediated disease resistance; Genetic engineering and crop protection: Engineering resistance to viral, bacterial, fungal and insect diseases of crop plants. Potential of Plant derived genes in the genetic manipulation of crops for insect resistance. Gene silencing and control of viral diseases.
9. **Medicinal Plants and Phyto-chemistry:** Floristic diversity and medicinal plant research scenario in India; Diagnostic features, bioactive molecules and therapeutic value of some common medicinal plants; Standardization of herbal drugs; Commercial cultivation of medicinal plants; Neutraceuticals and medicinal food; Bio-prospecting, bio-piracy and protection of traditional medicinal knowledge (IPR). Methods of Plant Analysis; Phenolic compounds; The terpenoids; Organic acids, lipids and related compounds; Nitrogen Compounds; Sugars and their derivatives; Macromolecules.
10. **Ecology and Conservation Biology:** Scope of ecology; Community organization-concept of habitat, functional role and niche, key stone species, dominant species, ecotone, edge effect. Natural Resources, Global warming and catastrophic threat to global biological diversity; Degradation and Restoration of Natural Ecosystems; Remote Sensing and its applications; Resource Policies, Conflict Management, Environmental Planning, International Environmental Policies and organizations and conventions.

MPB-1.3: ANALYTICAL METHODS IN RESEARCH 96 Hrs

(Teaching concepts and demonstrating relevant practical)

1) Data collection, review of literature and preparation of research report. Citation of references. How to write a research paper?
2) Study of experimental designs, different sampling techniques. Experimental error, Replication, Controls, Measurement.
3) Applications of biostatistics- Data; Measures of central Tendency; Measures of Dispersion; Tests of Significance; Student T Test; The Chi-Square test; Probability; Correlation; Regression.
4) Study of pH meter and preparation of different pH solutions.
5) Preparation of different stock solutions, working solutions, Buffer solutions and milli molar solutions.
6) Separation of proteins/Nucleic acids in gradient solutions using centrifugation.
7) Determination of Sugars, Amino acids by Thin layer chromatography techniques.
8) Separation of proteins by vertical gel electrophoresis.
9) Separation of Alkaloids by column chromatography.
10) Isolation of Nucleic acid from plant tissues by CTAB method.
11) Isolation of genomic and plasmid DNA from bacteria and purification by agarose gel electrophoresis.
12) Restriction analysis of DNA. Construction of Chimeric DNA. DNA
13) Ligation. Preparation of competent *E. coli* cells. Bacterial transformation and recovery of plasmid clones.
14) DNA amplification by PCR.
15) Analysis of DNA and RNA and Protein by Southern and Northern and Western blotting.
16) Demonstration of use of Transmission Electron Microscopy and Scanning Electron Microscopy.
17) Fluorescence Microscopy-Autofluorescence.
18) Collection, fixation and processing plant materials, Embedding, Microtomy, Staining, Double staining.
19) Photomicrography, Camera Lucida drawings.
20) Windows and net working essentials. Internet and Linux operating system. Biological and chemical database-Sequences, enzymes, Data Bank-GenBank, PDB.DATA mining and Data curation
21) Molecular Sequence Analysis- Gene Finding-GENSCAN, GRAIL, PairWise Alignment–BLAST, PSI-BLAST, FASTA.
22) Pair Wise Sequence Alignment ALIGN, Multiple Sequence Alignment-ClustalW.
23) Proteomics Analysis ,ExPASy.
24) Bioinformatics organization-NCBI, EBI and TIGR.

MPB -1.4: METHODS IN PLANT BIOLOGY 96 Hrs

(Teaching theoretical concepts and demonstrating relevant practical)

1) Assessment of plant and microbial biodiversity by different methods**.** Biodiversity maps of India and Karnataka; Plant and Microbial Diversity; Mega diversity Zones of the world.
2) Processing morphological and molecular date and construction of a Phylogenetic tree using different Methods (Parsimony, Maximum Likelihood, Bayesian). Phylogenetic trees and their construction.
3) Study of apomictic plants. Examples of applications of embryology in relation to taxonomy; Palynology in Taxonomy.
4) Testing hypersensitivity reaction on *Nicotiana*. Estimation of lypoxygenease in diseased and healthy plants.
5) Estimation of polyphenols in diseased and healthy plants.
6) Studying gene expression in diseased and healthy plants.
7) Studying systemic acquired resistance in crop plants and genetic testing of disease resistance in plants.
8) Isolation and study of endophytic fungi.
9) Study of interactions among fungi and their practical exploitation.
10) Study of major groups of plant pathogenic fungi.
11) Study of Mycorrhizas (VAM). Chemical control of fungal growth.
12) Study of *Arabidopsis thaliana.*
13) Estimation of DNA by DPA method.
14) Estimation of RNA by orcinol method.
15) Estimation of concentration of DNA.
16) Separation of genomic DNA on agarose gel electrophoresis.
17) Study of Biology and Genetics of *Agrobacterium tumefaciens*.
18) Plant tissue culture-preparation of MS medium. Shoot differentiation in tobacco.
19) Agrobacterium-mediated transformation of tobacco,
20) In-vitro mass production of secondary metabolites.
21) Analysis of phenols, alkaloids, seponins, volatile oils, hydrocarbons, flavonoids, sugars.
22) Mapping the distribution of habitat types in the region as types of landscape elements with the help of satellite imagery along wit field surveys.
23) Compile and assess biodiversity data for region and mapping of forest types, protected areas and natural forest using GIS.
24) Assessing the threats to different species as a result of ongoing landscape changes and other causes like commercial harvest.

SECOND SEMESTER

MPB -2.1: PROJECT WORK/DISSERTATION

The second semester is fully devoted for course work. The research guide shall give research topic for the project work/Dissertation. The project work shall be evaluated for 200 marks during Viva-Voce examination by external and internal examiners.

MPB -2.1: VIVA-VOCE

The performance of the research candidate is assessed during viva voce examination for 100 marks by the both the internal and external examiners.

SCHEME OF EXAMINATION FOR M.PHIL. BOTANY

FIRST SEMESTER

Scheme of Examination (Theory)

Time-03 Hours	Max. Marks: 80
Q.1: 12 questions of 2 mark each, 10 to be answered.	10x02=20
Q.2: 6 questions of 6 mark each, 4 to be answered.	04x06=24
Q.3: 3 questions of 12 mark each with internal choice.	03x03=36

Scheme of Examination (Practical)

Time-04 Hours	Max. Marks =40
Q1. Conduct the experiment 'A', record data, analyse and draw inferences.	12 Marks
Q2. Conduct the experiment 'B', analyse the data and draw inferences.	10 Marks
Q3. Comment on C & D.	2X5=10 Marks
Q4. Identify giving reasons F, F, G &H.	4X2=08 Marks

SECOND SEMESTER

The candidate shall defend his research work/dissertation work by way of power point presentation. The research guide (internal examiner) and external examiner shall evaluate the project work/dissertation of the candidate during viva-voce examination and award the marks.

REFERENCES

Gurumani, N. (2006) Research methodology for biological sciences. MJP Publishers. Chennai. Wilson, K and Walker J (1995) Practical Biochemistry. Cambridge University Press. Cambridge. Plummer D T (1992), An Introduction to Practical Biochemistry. Third Edition. Tata McGraw-Hill Publishing Co Ltd. Satguru Prasad (1995).Fundamentals of Biostatistics (Biometry). Emkay Publications, New Delhi. Bailey Norman T.J. (1995). Statistical methods in Biology. 3rd Edn. Cambridge University Press, Cambridge. UK. Harborne J B (1998). Phytochemical Methods- A guide to modern techniques of Plant analysis.3rd Edn. Chapman and Hall Publication, London. An advanced textbook on Biodiversity- Principles and Practice (2004). By K.V. Krishnamurthy, Oxford and IBH Publishing Co. Pvt. Ltd. New Dehi. Biodiversity and Biotechnology (2006) By Samit Ray and Arun K Ray; New Central Book Agency (P) Ltd. Kolkata, India.Biochemistry and Molecular Biology of Plants Ed. B.B.Buchanan, W.Gruissem and R.L.Jones ASPP Press, USA (2000). Essential of Molecular Biology, Vol-I and 2 Editeed by T A Brown, Oxford University Press, (2000). Gene Transfer to plants Edited by I.Potrykus and G.Spangenberg, Springer, Berlin. Heidelberg (1995).Molecular Biology of the Gene. 5th Edition, James D Watson, Tania A Baker, Stephen P Bell, Alexander Gannm, Michael Levine, Pearson Education (2004). Molecular Biology of Plants. Vol-I & 2, Edited by Philip M Gilmartin and Chris Bowler, Oxford University Press, (2002). Molecular Biology. A Project approach. S.J.Karchar. Academic Press, New York.(19995).Plant Biotechnology -The Genetic Manipulation of Plants, Adrian Slater, Nigel Scott and Mark Flower, Oxford University Press, (2000). Plant Biochemistry & Molecular Biology: P.J.Lea & R.C.Leegood. John Wiley and Sons.New York. (1999). Plant Genetic Transformation and Gene Expression by (eds) J.Draper *et.al*. Blackwell Scientific Publications, Oxford (1988).Principles of Gene Manipulation. An Introduction to Genetic Engineering. R.W. Old, S.B.Primrose Fifth Edition, Blackwell Science Publications (2004). Plant Biochemistry & Molecular Biology by P.J.Lea & R.C.Leegood (1993) John Wiley and Sons. Plants, Genes and Agriculture by M.J.Chrispeels and D.F.Sadava (1994)., Jones and Bartlett. Molecular Cloning - A Laboratory Manual by J.Sambrook, E.F.Fritsch and T.Maniatis (1989). Plant Molecular Biology Manual by S.B.Gelvin, R.A.Schilperoort and D.P.S.Verma (Eds) Kluwer Academic Publishers, Dordrect (Current Edition). Methods in Plant Molecular Biology. A Laboratory Course Manual by (Ed) Pal Maliga (1995) Cold Spring Harbour-Laboratory Press. Gene Transfer to plants Edited by I.Potrykus and G.Spangenberg, Springer, Berlin. Heidelberg (1995). Gene Biotechnology (2006). By S.N. Jogdand, Himalaya Publishing House, New Delhi. Agrios G N –1994 -Plant Pathology 2nd Edn. Academic Press NY; Mehrotra R S –1983-Plant Pathology Tata Mc. Graw Hill Pub. Co. Ltd., New Delhi. Rangaswamy G and Mahadevan (2002) Diseases of Crop plants in India. Prentice Hall of India Private Limited New Delhi. Vidhyasekaran P 2004. Encylopedia of Plant Pathology.Viva Books Pvt.Ltd. New Delhi.Gatehouse AMR; Hilder AA; and Boulter D (1992) Plant Genetic manipulation for crop Protection. (Ed.)Biotechnology in Agriculrure No.7. CAB International, UK. Biochemistry and Molecular Biology of Plants Ed. B.B.Buchanan, W.Gruissem and R.L.Jones ASPP Press, USA (2000). Plant Biotechnology -The Genetic Manipulation of Plants, Adrian Slater, Nigel Scott and Mark Flower, Oxford University Press, (2000).D.D.Ryu and S.Furusaki : Advances in Plant Biotechnology.1994. Elsevier Amesterdam – Newyork – London - Tokyo. Y.P.S.Bajaj :Biotechnology in Agriculture and Forestery 1. Trees 1. Springer – Verlag. 1986. Hultan and Yang Honguan : Haploids of higher plants in vitro. 1986. China Academic Publishers Beijing. Wagner, H., Hirosi Hikino and Norman R.Fransworth : Economic and Medicinal plant research. Volume 2. 1988. Academic Press :Harcourt Brace Jovanovich Publishers.Razdan,M.K.: An introductory to plant Tissue Culture.1993. Oxford and IBH Publishing Co. Private Ltd. New Delhi. I.K.Vasil.: Cell culture and Somatic Cell Genetics of plants. Volume 1. Laboratory procedures and their applications. 1984. Academic Press, INC.Orlando, Fiorida. Shain-dow Kung Ray Wu : Transgenic plants.Volume 2: present status and social and economic impacts.1993. Acdemic Press. Inc. California. Hand Book Of Plant Cell Culture by Evans, Sharp, Ammirato, Yamada.1983.Mac millan Publishing Company.Volume 2.Crop species.1984.Volume 3 Crop species.1984. Volume 4. Evans, Sharp and Ammirato.1986. Techniques and Applications.J. L. Chapman and M. J. Reiss (1995) Ecology-Principles and Application (1st ed.). Cambridge University Press, UK. Eugene P. Odum (1996) Fundamentals of Ecology (3rd ed.) W. B. Saunders Company. USA. Groom, M.J., Meffe, G.K. and Carroll, C.R. (2006) Principles of Conservation Biology (3rd ed.). Sinauer Associates,Sunderland, MA. Norse, Elliott A. and Larry B. Crowder. (2006) Marine Conservation Biology: The science of maintaining the sea's biodiversity. Island Press, Washington, D.C. Primack, Richard B. (2004) A Primer of Conservation Biology. Sinauer Associates, Sunderland, MA. Primack, Richard B. (2006) Essentials of Conservation Biology. Sinauer Associates, Sunderland, MA.