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UNIVERSITY OF MYSORE

Estd. 1916

VishwavidyanilayaKaryasoudha
Crawford Hall, Mysuru- 570 005

No.AC.2(S)/486/16-17 Dated: 20-06-2017

NOTIFICATION

Sub: Introduction of M.Phil Course in Botany from the academic year 2017-18.

Ref: 1. Decision of the Faculty of Science & Technology Meeting held on 03-03-2017.
2. Decision of the Academic Council meeting held on 30-03-2017.

*****

The Board of Studies in Botany (PG) which met on 28-12-2016 has resolved to introduce the M.Phil Course in Botany from the academic year 2017-18.

The Faculty of Science and Technology and the Academic Council have approved the above proposal at their Meetings held on 03-03-2017 and 30-03-2017 respectively and the Notification is issued herewith. The common regulations of M.Phil will be applicable to the above course and the syllabus for M.Phil in Botany is annexed herewith.

The concerned may download the syllabus in the University Website i.e., www.uni-mysore.ac.in.

Draft approved by the Registrar

Sd/-
Deputy Registrar (Academic)

To:

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DOS in Physics, MGM.
3. The Chairperson, BOS in Botany, DOS in Botany, Manasagangotri, Mysore.
4. The Chairman, DOS in Botany, Manasagangotri, Mysore.
5. The Director, College Development Council, Moulya Bhavan, Manasagangotri, Mysore.
6. The Deputy/Assistant Registrar/Superintendent, AB and EB, UOM, Mysore.
7. The P.A. to the Vice-Chancellor/Registrar/Registrar (Evaluation), UOM, Mysore.
8. Office file.

Annexure-II

MASTER OF PHILOSOPHY

(M. PHIL.)

DEGREE COURSE IN BOTANY

Proposed syllabus and scheme of examination for the Introduction of One Year Master of Philosophy (M.Phil.) Degree Programme in Botany to be Introduced from the Academic year 2017-2018 as per CBCS scheme

(As per the M.Phil. Guidelines Vide Order No. AC6/533/2011-12 Dated 20/06/2014)

Department of Studies in Botany

University of Mysore

MYSORE-570 006

Karnataka-India

MASTER OF PHILOSOPHY

(M. PHIL.)

DEGREE IN BOTANY

1) 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 possible to study in the recent past. It is now possible to identify with much more precision, the particular genes responsible for traits. With the techniques of modern biology, one can introduce or eliminate genes for specific traits. In view of all these, there is an urgent need to incorporate and teach plant biology in different perspectives. To bring the uniformity among the departments to run the course and also to adhere to UGC regulations in respect of research degrees, there is a necessity to have common regulations and to admit students to M. Phil. on the basis of entrance examination. Hence, it was proposed to introduce M. Phil. Botany course for post M.Sc., students of botany/plant sciences under fully self finance scheme, as per existing CBCS regulations of the University of Mysore. This one year M. Phil. Course is envisaged to fulfill the knowledge that is lacking among Botany / Plant Science PG students. The course intends to mould and reorient students as future plant biologists who will fit to all the future expanding areas of plant science/plant biotechnology/plant molecular biology. 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 also exposes students to the exciting and expanding fields of advanced botany in specific areas of plant sciences. Thus, students of botany/plant biology will have a fine understanding of biology of plants and underlying molecular mechanisms through which they functions.

2) Eligibility: All candidates who have passed M.Sc., Botany/M.Sc., Applied Botany/M.Sc., in Plant Science or equivalent degree of other university examination at least 55 % (50% for SC/ST/Cat-I) are eligible for admission to one year M.Phil. degree course. Admission guidelines for one year M.Phil. degree course in Botany are same as existing admission guidelines for PG courses of Mysore University.

3) Entrance Examination: There shall be an entrance examination for M.Phil. degree course.the entrance examination shall consist of 100 objective questions to be answered by the candiadts within a time duration of TWO hours. Candidates securing at least 55% in entrance examination are eligible for admission to M.Phil. degree course. The marks scored in the entrance examination shall only be considered for preparing the merit list for the purpose of admission.

4) Admission: The selections to one year M. Phil. Programme shall be made after preparing the merit list based on the scores of the candidates in the entrance examination and the seat matrix given by the University from time to time.

5) Duration: M. Phil. Degree programme in Botany shall be for a period of 12 months consisting of Two Semesters. During the first semester students have to study the prescribed three courses (papers) and during Second semester, they have to work for their dissertation topic.

6) Fee Structure: The fee structure for M.Phil. Degree course in Botany shall be fixed by the University from time to time.

7) Self Finance Scheme: M.Phil. degree course in Botany shall be fully self financed scheme.

8) Intake: Number students admitted to One year M. Phil. degree course shall be10 or as decided by the University of Mysore.

9) CBCS pattern: M.Phil. degree course in Botany shall be as per the continuous assessment of CBCS system. First semester comprises one compulsory Hard core paper on **Research Methodology** and two soft core papers in specialized areas of Botany in L:T:P (2:1:2) pattern with total 25 credits. The evaluation of the candidate shall be based on continuous assessment.

10) Assessment: Assessment and evaluation processes happen in a continuous mode. However, for reporting purposes, a semester is divided into 3 discrete components identified as C1, C2, and C3. The performance of a candidate in a course will be assessed for a maximum of 100 marks as explained below. The first component (C1), of assessment is for 15 marks. This will be based on test, assignment and seminar. During the first half of the semester, the first 50% of the syllabus will be completed. This shall be consolidated during the 8th week of the semester. Beyond 8th week, making changes in C1 is not permitted. The second component (C2), of assessment is for 15 marks. This will be based on test, assignment, and seminar. The continuous assessment and scores of second half of the semester will be consolidated during the 16th week of the semester. During the second half of the semester the remaining units in the course will be completed. The outline for continuous assessment activities for Component-I (C1) and Component-II (C2) will be proposed by the teacher(s) concerned before the commencement of the semester and will be discussed and decided in the respective Departmental Council. The students will be informed about the modalities well in advance. The evaluated courses/assignments during component I (C1) and component II (C2) of assessment are immediately returned to the candidates after obtaining acknowledgement in the register maintained by the concern teacher for this purpose. During the 18th -20th week of the semester, a semester-end examination of 3 hours duration shall be conducted for each course. Similarly, practical examination will be conducted for 70 marks. This forms the third/final component of assessment (C3) and the maximum marks for the final component will be 70. The details of course and assessment details are given in Table-1.

11) Attendance: Students shall have 75% attendance in lectures, tutorials and practicals. Students with less than 75% attendance are not eligible to take examination, and have to register for m. Phil. by taking admission afresh without entrance examination.

12) Setting questions papers and evaluation of answer scripts: Questions papers in three sets shall be set by the internal examiner for a course. Whenever there are no sufficient internal examiners, the Chairman of BoE shall get the questions papers set by external examiners.

i) The Board of Examiners shall scrutinize and approve the question papers and scheme of valuation. There shall be single valuation for all theory papers by internal examiners. In case, the number of internal examiners falls short, external examiners may be invited.

(ii) The examination for Practical work/ Field work/Dissertation work will be conducted jointly by the two internal examiners. However the BoE on its discretion can also invite external examiners if required.

13) Topic for Dissertation: The second semester shall be devoted for dissertation work. Research topic for the dissertation work shall be given by the assigned research guide. All recognized research guides in Botany are eligible to guide M.Phil. students for their dissertation work. The dissertation work and performance of the candidate shall be evaluated during Viva-Voce examination by the internal (research guide) and external examiners.

14) Dissertation Evaluation: Right from the initial stage of defining the problem, the candidate has to submit the progress reports periodically and also present his/her progress in the form of seminars in addition to the regular discussion with the guide. Components of evaluation are as follows. Component – I (C1): Periodic Progress and Progress Reports (15%). Component – II (C2): Results of Work and Draft Report (15%). Component– III (C3): Final Viva-voce and evaluation (70%). The report evaluation is for 40% and the Viva-voce examination is for 30%.

TABLE-1

COURSE STRUCTURE FOR ONE YEAR (TWO SEM.) M.PHIL. DEGREE

COURSE IN BOTANY (CBCS PATTERN)

FIRST SEMESTER		**Assessment in terms of Marks**								
Sl. No.	**Course Title**	**L:T:P**	**Credit Value**	**C1 Max.**	**C2 Max.**	**C1+ C2 Max.**	**C3 Max**	**Total Max. C1+C2+ C3**	**Minimum to be scored in C1+ C2+ C3**	**P: Percentage of marks scored in each paper**
1	HC-1.1:Research Methodology	2:1: 2	05	15	15	30	70	100	50	Marks scored out of 100

2	SC-1.1: Advanced Botany	2:1:2	05	15	15	30	70	100	50	Marks scored out of 100
3 Any one of the course will be selected by the student depending on the availability of the expertise in the specialized area of study	SC-1.2: Biodiversity and Bioprospecting	2:1: 2	05	15	15	30	70	100	50	Marks scored out of 100
	SC-1.3: Applied Mycology	2:1: 2	05	15	15	30	70	100	50	Marks scored out of 100
	SC-1.4: Plant - Microbe Interaction	2:1: 2	05	15	15	30	70	100	50	Marks scored out of 100
	SC-1.5: Molecular Plant Pathology	2:1: 2	05	15	15	30	70	100	50	Marks scored out of 100
	SC-1.6: Seed Pathology	2:1: 2	05	15	15	30	70	100	50	Marks scored out of 100
	SC-1.7: Plant Tissue Culture Technology	2:1: 2	05	15	15	30	70	100	50	Marks scored out of 100
	SC-1.8: Phytochemistry & Herbal Drug Technology	2:1: 2	05	15	15	30	70	100	50	Marks scored out of 100

SECOND SEMESTER		**Assessment in terms of Marks**								
Sl. No.	Course Title	L:T:P	Credit Value	C1 Max.	C2 Max.	C1+ C2 Max.	C3 Max	Total Max. C1+C2+C 3	Minimu m to be scored in C1+ C2+ C3	P: Percentage of marks scored in each paper
1	MPB:2.1 Dissertation	1:4:4	09	30	30	60	140	200	100	Marks scored out 200 divided by 2
2	MPB: 2.2: Viva-Voce	0:1:0	01	-	-	-	100	100	50	Marks scored out of 100
	Total of I and II Semester		25	600					300	

Syllabus

FIRST SEMESTER

Hard Core- 1.1: Research Methodology

Unit-1: Introduction to Research: What is Research? Essential steps in research. Need for literature collection and review, consulting source material; bibliography and literature citation. Formulating Objectives; Components of research report- thesis, dissertation, project work; Experimental Designs (Introduction, observation, Hypothesis and Null Hypothesis, Hypothesis Testing, Basic principles of Experiments. Experimental Units and sampling units, Dependent and independent variables, Experimental error, Discrimination, Replication, Generalization, Controls, Randomization) ; Data collection and analysis with statistical packages; Writing and publishing research papers in scientific journals; Journals standards – impact factor -citation and citation index; scientific editing tools, Research ethics.

Unit-2: Biochemical Techniques: Laboratory safety rules. pH, Normal and Molar Solutions, Per cent solutions. Buffers solutions; Principles and Application of Centrifugation, Chromatography and Electrophoresis. Principles and applications of Transmission and Scanning Electron Microscopy; Fluorescence Microscopy. Histology-Collection, fixation and processing plant materials; Freeze drying and Freeze substitution, Embedding, Microtomy, Staining, Double staining and Photomicrography. General Principles and applications of Radioimmunoassay (RIA). Enzyme Linked Immunosorebent Assay (ELISA). Fluorescent Immunoassay (FIA). Avidin-Biotin-mediated Immunoassay,

Unit-3: Techniques in Cell and Molecular Biology: Cell and tissue culture techniques and their applications; Isolation of Nucleic acids (DNA/RNA) and plasmids. Restriction analysis; Principles of gene cloning technique; Analysis of recombinants; Blotting methods and PCR Techniques; Nucleotide sequencing**;** Immunochemical techniques- immunohisto/cytochemistry; Immunoassays; Affinity and Avidity; Spectroscopic Techniques- Atomic spectroscopy; Infrared and Raman spectroscopy; Electron spin resonance spectroscopy; Nuclear maganetic resonance spectroscopy(NMR); MALDI imaging mass spectrometry (MALDI-IMS**);** Radioisotope techniques and its applications in biological sciences.

Unit-4: Biostatistics- 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. **Bioinformatics-** Databases (NCBI, EMBL, DDBJ); Data bases of proteins and nucleic acids; Data storage and mining technologies; Molecular modeling and prediction of structure; Gene expression analysis; Genome Analysis and methods; Microarrays-Technologies and Applications; Web based tools for sequence search and analysis. Phylogenetic analysis. **Intellectual property rights (IPR) and Patent Law**; copy right, royalty, reproduction of material-Plagiarism, Citation and acknowledgement.

Practicals:

1) Research citation-a practical exercise.
2) Study of pH and preparation of different buffer solutions, stock solutions, working solutions, Buffer solutions and milli molar solutions.
3) Separation of proteins/Nucleic acids in gradient solutions using centrifugation.
4) Determination of Sugars/Amino acids by Thin layer chromatography techniques.
5) SDS Separation of proteins by vertical gel electrophoresis.
6) Isolation of genomic and plasmid DNA and separation by agarose gel electrophoresis.
7) Cloning/Construction of Chimeric DNA, Preparation of competent cells and transformation and recovery of plasmid clones.
8) DNA amplification by PCR.
9) Analysis of DNA and RNA and Protein by Southern and Northern and Western blotting.
10) Biological and chemical database-Sequences, enzymes, Data Bank-GenBank, PDB.DATA mining and Data curation.
11) Molecular Sequence Analysis- Gene Finding-GENSCAN, GRAIL, PairWise Alignment–BLAST, PSI-BLAST, FASTA.
12) Pair Wise Sequence Alignment ALIGN, Multiple Sequence Alignment-ClustalW.
13) Proteomics Analysis ,ExPASy.
14) Bioinformatics organization-NCBI, EBI and TIGR.

Further Reading

1) Anthony, M. Graziano, A.M. and Raulin, M.L. 2009. Research methods: A process of Inquiry, Allyn and Becon.
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3) Gurumani, N. 2006. Research Methodology for Biological Sciences , MJP Publishers, First Edition, 2006, Chennai.
4) Jan A Pechenik, 1987. A Short Guide to Writing about Biology, Little, Brown and Company, ISBN-0-316-69642-0, Boston/Toronto.
5) Janathan Anderson, Berry H. Durston and Millicent Poole, 1970. Thesis and Assignment Writing, First Edition, Wiley Eastern University Edition, Eighth Wiley Eastern Reprints.
6) Jane Roskams and Linda Rodgers, 2004. Lab Ref-A Handbook of Recipes, Reagents and other Reference Tools for use at the Bench First Indian Print, 2004, I.K. International Pvt. Ltd., ISBN-81-88237-05-1, New Delhi.
7) John W. Best, 1983. Research in Education, Fourth Edition, Prantice Hall of India Pvt. Ltd., New Delhi.
8) Joseph Gibaldi and Walter S. Achtert 1989. MLA Handbook for Writers of Research Papers , Third Edition, ISBN -81-224-0188-0, First Wiley Eastern Reprint, May 1989, Wiley Eastern Limited, New Delhi.
9) Krishnswamy, K.N. Shivkumar, A.I and Mathirajan, M 2006. Management research Methodology; Integration, Methods and Techniques, Pearson Education, New Delhi.
10) Montgomery, Douglas C. and Runger, George C. 2007. Design and Analysis of Experiments, Wiley India publication.
11) Paul Stapleton, 1987. Writing Research Papers. The Australian Centre for International Research, (ACIAR) Canberra.
12) Robert A. Day, 1990. How to Write and Publish a Scientific Paper , Cambridge University press, Cambridge.
13) Satguru Prasad, 1992. Fundamentals of Biostatistics (Biometry), First Published, Reprint, EMKAY Publications, New Delhi.
14) Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications, Universal Law publishing.

Soft Core -1.1: Advanced Botany (Compulsory)

Unit-1: Biodiversity and Conservation- Levels of Biodiversity; (Genetic, Species Population, community, Ecosystem and Habitat); Biodiversity profile in India. Mega diversity Zones and Hot Spots; Uses of Biodiversity; Threat to Biodiversity; IUCN threat categories, Red Data book; Conservation of Biodiversity**. Ecology and Conservation Biology**- Natural Resources, Climate change 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.

Unit-2: Molecular Taxonomy- Molecular taxonomy and phylogeny; Processing molecular data and Phylogenetic inference using different Method; Use of Chloroplast, Nuclear and Mitochondrial DNA sequences in Plant systematics; **Plant Reproductive Biology-** Induction of flowering; Genetic and molecular analysis of flower development. Genetics of apomixes; Techniques to screen apomicts; Practical importance of apomixes. **Crop Physiology**- Recent developments in Photosynthesis, Respiration and Photorespiration; Signal transduction- receptors- phytochrome, 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, abiotic stresses, water stress, freezing stress.

Unit-3: Cell Biology-Plant Cell Compartments, Membrane transport mechanisms, Protein Sorting and Vesicle Traffic. Cell division regulation -Recent developments in cell cycle research. **Plant Molecular Biology-** Plants as genetic tools in molecular biology; 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*; **Plant Biotechnology**-Plasticity and totipotency; In-vitro culture techniques and their applications in plant breeding, Horticulture and Forestry; *Agrobacterium*-mediated plant transformations. Edible plant Vaccine (EPV) technology; Molecular Farming/pharming-metabolic engineering of plants.

Unit-4: Applied Mycology- Fungi in biotechnology; Fungi in Genetic Research; Endophytic fungi and their importance; Fungal interactions and practical exploitation; Mycorrhizas (VAM) and significance. **Molecular Plant Pathology-**Molecular biology of Plant-Microbe interaction; Genetic engineering and crop protection: Engineering resistance to viral, bacterial, fungal and insect diseases of crop plants. Gene silencing and control of viral diseases. **Medicinal Plants and Phytochemistry-** Floristic diversity and medicinal plant research scenario in India; 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).

Practicals

1) Assessment of plant and microbial biodiversity by different methods and calculating species richness, species evenness and species abundance.
2) Study of biodiversity maps of India and Karnataka; Plant and Microbial Diversity; Mega diversity Zones of the world.
3) Processing morphological and molecular date and construction of a Phylogenetic tree using different Methods (Parsimony, Maximum Likelihood, Bayesian). Phylogenetic trees and their construction.
4) Testing hypersensitivity reaction on Nicotiana tabaccum against TMV.
5) Estimation of lypoxygenease in diseased and healthy plants.
6) Studying systemic acquired resistance in crop plants and genetic testing of disease resistance in plants.
7) Isolation and study of endophytic fungi.
8) Effect of Mycorrhizas (VAM) on plant growth and crop yield.
9) Study of Arabidopsis thaliana as model plant.
10) Study of Biology and Genetics of Agrobacterium tumefaciens.
11) Analysis of phenols, alkaloids, seponins, volatile oils, hydrocarbons, flavonoids, sugars.
12) Mapping the distribution of habitat types in the region as types of landscape elements with the help of satellite imagery along with field surveys.
13) Compile and assess biodiversity data for region and mapping of forest types, protected areas and natural forest using GIS.
14) Assessing the threats to different species as a result of ongoing landscape changes and other causes like commercial harvest.

Further Reading

1) B.B.Buchanan, W.Gruissem and R.L.Jones, (2000). Biochemistry and Molecular Biology of Plants Ed. ASPP Press, USA
2) T A Brown, (2000). Essential of Molecular Biology, Vol-I and 2 Edn. Oxford University Press, Oxford.

3) I. Potrykus and G.Spangenberg, (1995).Gene Transfer to plants (eds). Springer, Berlin. Heidelberg
4) James D Watson, Tania A Baker, Stephen P Bell, Alexander Gannm, Michael Levine, (2004). Molecular Biology of the Gene. 5th Edition, Pearson Education .
5) Philip M Gilmartin and Chris Bowler, (2002).Molecular Biology of Plants. Vol-I & 2, Edited by Oxford University Press, Oxford.
6) S.J.Karchar. .(19995). Molecular Biology. A Project approach. Academic Press, New York.
7) Adrian Slater, Nigel Scott and Mark Flower, (2000). Plant Biotechnology -The Genetic Manipulation of Plants, Oxford University Press, Oxford.
8) P.J.Lea and R.C.Leegood. (1999). Plant Biochemistry & Molecular Biology: John Wiley and Sons.New York.
9) J. Draper et.al. (1988). Plant Genetic Transformation and Gene Expression by (eds) Blackwell Scientific Publications, Oxford.
10) R.W. Old, S.B.Primrose, (2004). Principles of Gene Manipulation. An Introduction to Genetic Engineering. 5th edn. Blackwell Science Publications.
11) P.J.Lea and R.C.Leegood (1993). Plant Biochemistry and Molecular Biology by John Wiley and Sons.

12) Pal Maliga (1995). Methods in Plant Molecular Biology. A Laboratory Course Manual by (Ed) Cold Spring Harbour-Laboratory Press.

Soft Core- 1.2: Biodiversity and Bioprospecting

Unit -1: Biodiversity: Scope and applications: Introduction to the concept and terminologies; Types of biodiversity: species, genetic and ecological diversities; Biogeographic regions; Biodiversity Hotspots and their significance; Threat categories to biodiversity-extinct, rare, threatened, vulnerable, endangered; Red data book; Conservation and Management of biodiversity; Role of international conventions, agencies and boards in preserving biodiversity-CBD, IUCN, WWF, UNEP, CITES, CI, National Biodiversity Authority, State Biodiversity Boards.

Unit-2: Microbial diversity: Definition; Microbial tree of life; Assessment of diversity - alpha, beta, gamma; Sampling methods; Estimation of diversity – Relative abundance, species richness; Diversity indices – Simpson, Shannon, Fisher's alpha; Microbial diversity in plant species, soil and extreme environments and their significance; Isolation methods; Techniques to identify microorganisms- Cultural, morphological, biochemical and molecular; Polyphasic taxonomy and phylogeny; Genetic Databases and their applications.

Unit-3: Plant Diversity: Introduction to land plants; Biogeography and speciation; Timescale of plant diversification; Evolution of vascular plants; Bryophyte, lycophyte and gymnosperm diversity; Native, invasive and carnivorous plant diversity; Angiosperm diversity and phylogeny; Medicinal plant diversity in India; Measurement and estimation of plant diversity indices; Scope and applications.

Unit-4: Bio-prospecting: Scope and applications: Definition and concept; Processes for bio-prospecting; Isolation and characterization of bioactive molecules from natural products and their applications as therapeutic agents;Product development and commercialization; International laws governing bio-prospecting; Intellectual Property Framework: TRIPS, WIPO, CBD; ethics and benefit sharing.

Practicals

1) Biodiversity concept and types.
2) Biogeographic regions of India.
3) Biodiversity hotspots and their significance.
4) Sampling, isolation and estimation of microbial diversity (fungi/bacteria/actinobacteria) in soil samples.
5) Identification of microbial taxa by cultural, biochemical and molecular methods.
6) Isolation and identification of microbial endophytes from plant species of pharmaceutical importance
7) Calculation of species diversity indices by rarefaction curves and species richness
8) Molecular characterization of microbial taxa: Isolation of microbial DNA and quantification by Spectophotometry.
9) Amplification of ribosomal RNA gene (16S/23S) from bacteria / fungi by PCR using universal primers
10) DNA sequencing and analysis; Identification of taxa, Genbank submission of sequences
11) Sequence alignment and construction of phylogenetic tree using online software- CLUSTAL- W, MEGA, PHYLLIP.
12) Microbial fermentation and extraction of secondary metabolites
13) Screening of crude microbial/ plant extracts for pharmaceutical or pharmacological potentials.
14) Bioactive guided fractionation of secondary metabolites by chromatographic techniques
15) Identification of bioactive compounds by GC-MS, NMR and IR spectroscopy.

Further Reading

1) Chao, A. 2004. Species richness estimation. In: N. Balakrishnan, C. B. Read, and B. Vidakovic, (eds.), Encyclopedia of Statistical Sciences. New York: Wiley. Magurran, A. E. 2004. Measuring Biological Diversity. Oxford: Blackwell Publishing. Rosenzweig, M. 1995. Species Diversity in Space and Time. New York: Cambridge University Press.
2) Wilson, E. O., and F. M. Peter, eds. 1988. Biodiversity. Washington, DC: National Academy Press.
3) Kate, K. and Laird, S.A. 1999. The commercial use of biodiversity: Access to genetic resources and benefit-sharing. Prepared for the European Commission. Kew Royal Botanical Garden.
4) Krishnamurthy, K.V. 2008. An Advanced Text book on Biodiversity: Principles and Practice. Science Publishers, Inc., New Hampshire, USA.
5) Reddy, G.V. et al. 2016. Recovering Biodiversity in Indian Forests. Briefs in Ecology, Springer Science +Business Media, Singapore.
6) Chhazllani, V.K. 2010. Biodiversity and Conservation: International Perspectives, Manglam Publications.
7) M.P. Nayar and R.V. Varma (eds.) 2012. Biodiversity : Utilization Threats and Cultural Linkages, Narendra Publishing House, ISBN : 9789380428949.
8) Kumar K. 2005. Biodiversity : Extinction and Conservation, Aavishkar Publications, ISBN: 8179101029.
9) Pullaiah, T and Reddy, K.J. 2013. Biodiversity in India. Astral publishers, Vol. 6., ISBN: 9788189233846.
10) Willey, J., Sherwood, L and Wolverton, C. 2014. Prescott's Microbiology, 9th edition, McGrawHill education, ISBN: 9780073402406.
11) Gibson, J.P and Gibson, T.R. 2007. Plant Diversity: the green trends. Infobase publishing, ISBN:9781438107011
12) Henry, R.J. 2007. Plant Diversity and Evolution: Genotypic and Phenotypic Variation in Higher Plants. ISBN:978-0851999043.

13) Ingrouille, M. and Eddie, W. 2006. Plants: Diversity and Evolution, Cambridge University Press, UK.
14) Mutke, J. *et al*., 2011. Vascular Plant Diversity in a Changing World: Global Centres and Biome-Specific Patterns. In: F.E. Zachos and J.C. Habel (eds.), Biodiversity Hotspots, DOI 10.1007/978-3-642-20992-5_5, # Springer-Verlag Berlin Heidelberg 201

Soft Core-1.3: Applied Mycology

Unit-1: Fungi and Their Allies; Preparation, Preservation and Use of Fungal Specimens in Herbaria; Preservation and Distribution of Fungal Cultures; Electronic Information Resources; Recommended protocols for Sampling Particular Groups of Fungi; Direct Collecting; Isolation Protocols for Macrofungi and Micro Fungi; Fungus related websites. Fungal germplasm and databases.

Unit-2: Evolution and Phylogeny of Fungi; Fungal Genomics; Genome Sequencing, assembly and Gene Prediction in Fungi; Meiotic Recombination in Fungi; Molecular genetics of Circadian Rhythms in *Neurospora crassa*; Fungal Transposable Elements; Fungal Mitochondrial Genomes, Plasmids and Introns; Fungal Pathogenicity Genes; Genetic Improvement of Baker's Yeast.

Unit-3: Anamorphic Fungi; Nematophagous Fungi: Aquatic Hyphomycetes; aero-aquatic Fungi; Basidiomycetes yeasts; Bioremediation of coal waste through VAM fungi. Fungi as Symbionts of Photobionts, Plants and Insects; Applications of Molecular Biology in Fungal Biotechnology; Sex hormones in fungi; Fungal Senescence.

Unit-4: Profiling of Lignin degrading Fungi for the discovery of Novel Enzymes; Emerging issues in Mycology. Endophytic Fungi: Mutualism, Bioactive Metabolites and Bio-prospecting. Marine Fungi and Novel Metabolites and Future prospects; Agricultural Applications of Mycorrihiza; Mushroom Cultivation in India. Ecology, Economic Importance and fungal Biotechnology.

Practicals:

1) Preparation and preservation of fungal cultures/herbaria.

2) Study of Meiotic Recombination in Fungi (*Neurospora crassa*).

3) Study of different strains of Baker's yeast.

4) Study of Nematophagous Fungi/aero-aquatic Fungi;

5) Study of Lichens.

6) Studying fungal senescence.

7) Study of Insect pathogenic fungi.

8) Studying the production of sex hormones in fungi.

9) Evaluation of lignin degrading fungi isolated from woods.

10) Isolation of endophytic fungi from plants and analysis of bioactive principle.

11) Isolation of marine fungi.

12) Fungal metabolite production, extraction and analysis.

13) Evaluation of VA mycorrhiza on the growth and yield of French bean.

14) Cultivation of paddy straw mushroom and assessing the yield.

Further Reading

1) Alexopoulos, C. J., Mims, C. W., and Blakwell, M. 2007. Introductory Mycology 4th edn., Wiley India Edition, New Delhi.
2) Arora, D. K. and Khachatourians (2003). Applied Mycology and Biotechnology (Fungal Genomics).Elsevier, New York.
3) Carlile, M.J. Watkinson,S.C. and Gooday, G.W. 2001.The Fungi, 2nd edn. Academic Press, USA.
4) Deacon, J. W. 1997. Modern Mycology 3rd Edition, Blackwell Science publishers, London.
5) Mehrotra, R.S. and Aneja, K.R. (2008). An intriduction to Mycology. New Age international Publishers, New Delhi.
6) Mueller, G M; Bills, GF and Foster, M.S. 2004. Biodiversity of Fungi, Elsevier Academic Press, New York.
7) Munshi, M. and Soporay, S. K. (2004). Biotechnology: Applications and Careers. Viva Books Private Limited, New Delhi.
8) Rai, M. and Bridge, P.D. 2009. Applied Mycology, CABI International, UK.
9) Ray S. and Ray A.K. (2006). Biodiversity and Biotechnology. New Central book Agency (P) Ltd. Kolkata.
10) Sridhar, K.R. (2009). Fronntiers in Fungal ecology, Diversity and Metabolites. Ed. I. K. International, New Delhi.
11) Vashishta, B.R. and Sinha, A.K. (2014). Botany for Degree Students-Fungi. S. Chand and Company Ltd. Ram Nagar, New Delhi.

Soft Core- 1.4: Plant- Microbe Interactions

Unit- 1: Introduction of plant- microbe interaction; importance of microbes in plant world, influence of microbes in Plant growth and metabolism, categorization of microbes based on their activities (friends & foes), microbes in Agriculture- interaction of microbes- rhizosphere and phylloplane, Plant growth promoting fungi (PGPF), Plant growth promoting Rhizobacteria (PGPR), phosphate solubilizing bacteria, significance and applications.

Unit-2: Significance of plant diseases, types of plant diseases, basic procedures of plant disease diagnosis, parasitism and pathogenecity, disease development in plants, disease cycle, infection cycle and plant disease triangle. Major groups of plant pathogens in fungi and bacteria; Effects of microbes on plant physiology, photosynthesis, nutrient uptake, respiration, membrane permeability, transcription and translation, plant growth and reproduction.

Unit-3: General concepts on plant immunity, Pathogen associated molecular patterns (PAMP)- Triggered Immunity (PTI) and effector- triggered immunity (ETI), Outer member vesicles (OMVs) and their

involvement in Plant immunity. Genetics of plant disease, variability in pathogens, stages of variation, types of plant resistance to pathogens, genetics of virulence in pathogens and resistance in plants, mechanism of disease resistance- (pre- formed compounds and induced compounds and phytoalexins); pathogenesis related (PR) proteins, pathogenicity genes, resistance genes, in plants, signal transduction and disease development.

Unit 4: Biology of plant- microbe interactions-Plant Pathogenesis, process of pathogen attack, chemical weapons- enzymes, toxins, growth regulators in plant disease; Plant defense mechanisms-pre-existing, and induced structural, role of elicitors, receptors, suppressors in disease development, Hypersensitive reaction (HR), systemic acquired resistance (SAR), Induced resistance (IR), various levels of defense mechanisms- cellular, biochemical and molecular mechanism, various biochemical and molecular pathways, programmed cell death (PCD), gene- for gene interaction, 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.

Practicals:

(1) Study on nectrotrophic and biotrophic pathogens
(2) Study of beneficial microbes- PGPF, PGPR, and AM fungi
(3) Study of plant- microbe interactions at cellular level
(4) Study of plant- microbe interaction at biochemical level
(5) Study of plant- microbe interaction at molecular level
(6) Study of Polyphenols in diseased and healthy plants
(7) Study on hypersensitive response (HR) during plant- microbe interaction
(8) Studies on the defense related enzymes
(9) Studying systemic acquired resistance (SAR) in crop plants
(10) Studying gene expression in diseased and healthy plants

Further Reading

1) Mukherji, S. and A.K. Ghosh. 2005. Plant Physiology. 1st Edn. Central Edn. New Central Book Agency (P) Ltd. India.
2) Mehrotra, R.S. and A. Aggarwal. 2003. Plant Pathology. 2nd Edn. Tata McGraw-Hill Publishing Company Ltd. New Delhi, India.
3) Ignacimuthu, S.J. 1996. Applied Plant Biotechnology. Tata McGraw-Hill Publishing Company Ltd. New Delhi, India.
4) Smith, J.E. 1996. Biotechnology. 3rd Edn.Cambridge University Press, USA.
5) Khan, A.A. and S. Singh. 2008. Abiotic Stress and Plant Responses. I.K International Publishing House Pvt. Ltd. New Delhi, India.
6) Gatehouse, A.M.R., Hilder, V.A. and D. Boulter. 1994. Plant Genetic Manipulation for Crop Protection. 2nd Edn. CAB International, UK.
7) Murray, D.R. 1991. Advanced Methods in Plant Breeding and Biotechnology. CAB International, UK.
8) Walker, J.M. and E.B. Gingold. 1993. Molecular Biology and Biotecchnology. 1st Edn. Royal Society of Chemistry, England.

9) Leong, S.A., Allen, C. and E.W. Triplett. 2002. Biology of the Plant Microbe Interactions. Vol. 3. International Society for Molecular Plant Microbe Interactions, USA.
10) Freifelder, D. 2006. Molecular Biology. 2nd Edn.Narosa Publishing House, New Delhi, India.
11) Lugtenberg, B. 2015. Principles of Plant-Microbe Interactions-Microbes for Sustainable Agriculture. Springer.
12) Martin, F. and S.Kamoun. 2011. Effectors in Plant-Microbe Interactions. John Wiley & Sons Inc. UK.
13) Stacey, G. and N.T. Keen. 1996. Plant Microbe Interaction. Vol. 1. Chapman & Hall, New York.

Soft Core- 1.5: Molecular Plant Pathology

Unit-1: Modern Plant Pathology: Disease causing organisms. Crop disease diagnosis. Crop disease assessment. Assessment of disease progress. Forecasting models. Molecular biology of Plant-Microbe interaction: Response to plant pathogens. Genetic basis of plant-pathogen interaction. R-genes and R gene mediated disease resistance. Necrogenic plant pathogenic bacteria with emphasis on hrp and avr genes and virulence factors. Pesticide resistance in phytopathogens.

Unit-2: Genetics of Plant Diseases: Genes and Diseases, Mechanism of variability, Physiological specialization among plant pathogens. Stages of variation in pathogens. Types of plant resistance to pathogens. Genetics of virulence in pathogens and of resistance in host plants. **Molecular Basis of Defense Mechanism in Plants:** Signal Transduction, Recognition of the pathogen by the host, transmission of the alarm signal to the host defense providers. Molecular basis of induced biochemical reaction, Local and systemic acquired resistance.

Unit-3: Genetic engineering and crop protection: Engineered resistance to viral, bacterial, fungal and insect diseases of crop plants. Genetically engineered plants for herbicide resistance. Isolation of a plant R gene by transposon tagging. Engineering of insect resistant plants with *Bacillus thuringiensis* crystal protein genes. Potential of plant derived genes in the genetic manipulation of crops for insect resistance. **Crop Disease management:** Breeding for disease resistance-conventional breeding, biotechnological approach including genetic engineering.

Unit-4: Genetics of *Agrobacterium:* Biology and genetics of *Agrobacterium tumefaciens.* The Ti-Plasmid. Vir genes and expression. The mechanism of T-DNA transfer and integration. Basic features of vectors for plant transformation. **Genetic engineering of virus resistance:** Cross Protection. Gene Silencing and disease control- Mechanism of gene silencing and control of viral diseases. Promoting crop protection by genetic engineering and conventional plant breeding: Problems and perspectives.

Practicals

1) Isolation of plant Pathogens.
2) Demonstration of Koch's postulates.
3) Extraction of pectolytic enzymes from a pathogen.
4) Assaying of polygalacturonase.
5) Testing hypersensitivity reaction on *Nicotiana*.
6) Estimation of lypoxygenease activity in diseased and healthy plants.
7) Estimation of polyphenols in diseased and healthy plants.

8) Induction of systemic acquired resistance in crop plants.
9) Genetic testing of disease resistance in plants.
10) Screening antagonism.
11) Induction and extraction of pathogenesis related proteins.
12) Separation of PRPs by Polyacrylamide gel electrophoresis.
13) Expression of foreign genes in plant cells through *Agrobacterium tumefaciens.*
14) Production of tobacco transgenic plants and assay for the introduced transgene.
15) Co-cultivation of Tobacco and *Agrobactrium tumefaciens.*

Further Reading

1) Agrios G N –1994 -Plant Pathology 2nd Edn. Academic Press NY
2) Mehrotra R S –1983-Plant Pathology Tata Mc. Graw Hill Pub. Co. Ltd., New Delhi.
3) Gatehouse AMR; Hilder AA; and Boulter D (1992) Plant Genetic manipulation for crop Protection. (Ed.)Biotechnology in Agriculrure No.7. CAB International, UK.
4) David R Murray (1991) Advanced methods in Plant Breeding in Biotechnology .(Ed.) Biotechnology in Agriculrture No 4. CAB International, UK.
5) Biochemistry and Molecular Biology of Plants Ed. B.B.Buchanan, W.Gruissem and R.L.Jones ASPP Press, USA (2000).
6) Plant Biotechnology -The Genetic Manipulation of Plants, Adrian Slater, Nigel Scott and Mark Flower, Oxford University Press, (2000).
7) Rangaswamy G and Mahadevan (2002) Diseases of Crop plants in India. Prentice Hall of India Private Limited New Delhi.
8) Vidhyasekaran P 2004. Encylopedia of Plant Pathology.Viva Books Pvt.Ltd. New Delhi.

Soft Core-1.6: Seed Pathology

Unit-1: Seed Pathology- Introduction, Historical Development, Development of Seed Health Testing, Significance. Reduction in Crop Yields Loss in due to seed-borne diseases. Seedborne Pathogens **(**Fungi, Bacteria, Mycoplasmalike Organisms, fastidious Vascular Bacteria, Spiroplasmas, Viruses, Viroids, Nematodes). Location of Seed-borne Inoculums, Histopathology of Some Seed-borne Pathogens; Seed Infection, Mechanism of Seed Infection, Seed Infestation or Contamination; Factors Affecting Seed Infection, Longevity of Seed-borne Pathogens.

Unit-2: Seed Transmission and Inoculation, Factors Affecting Seed Transmission, Cultural Practices, Epidemiology and Inoculum thresholds of Seed-borne Pathogens; Classification of Seed-borne , Role of Seed-borne Inoculum in Disease Development, Economic Loss Due to Seed-borne Pathogens; Certification Program, Seed Processing Procedures Seed Health Tests, Non-parasitic Seed Disorders, Deterioration of Grains by Storage Fungi, Field and Storage Fungi. Invasion by Storage Fungi, effects of seed deterioration.

Unit-3: Detection of Seed-borne Diseases; Examination of Dry Seeds, Isolation of Fungi, Bright-Field Microscopic Examination, Observation under UV Light, Measurement of Gases, Determination of FAV, Moldy Smell, Collection of Seed Exudates, Immunoassays, Ergosterol Estimation, Scanning Electron Microscopy, Avoiding Damage to Seeds During Harvesting,, Processing, Threshing, Storage Conditions, Reducing Seed Moisture to Safe Limits, Seed Treatment, Resistance.

Unit-4: Mycotoxins- Fungi Known to Produce Mycotoxins, Factors Affecting Mycotoxin Production, Effects of Mycotoxins, Control of Mycotoxins- Storage Conditions, Sorting of Grains, Cultural Operations, Chemical Treatment, Biological Control, Detoxification, Regulatory Measures, Use of Resistant Cultivars; Control of Seed-borne Pathogens, Selection of Seed Production Areas, Crop Management, Crop Rotation, Isolation Distances, Roguing, Biological Control, Chemical Method, Mechanical Method, Physical Methods; **Certification**-Setting Certification Standards, Plant Quarantine, National and International Regulations.

Practicals:

1-5) Detection of seed-borne fungi and their identification.

6) Detection of Seed-borne bacteria.

6) Detection of seed-borne viruses.

7) Detection of seed-borne insects by egg-plug staining.

8) Detection seed-borne nematodes.

9)Effect of deterioration of grains by Storage Fungi.

10) Detection of seed-borne fungi by PCR.

11) Estimation of ergosterol by UV-visible Spectrophotometer.

12) Detection of mycotoxins by thin Layer chromatography.

Further Reading

1) Agarwal, V.K. and Sinclair, J.B. 1996. Principles of Seed Pathology, Second Edition, CRC Press, Tayler and Francis, USA.

2) Neergaard, P. 1977. Seed Pathology. Vol. I..Macmillan Press, Cornell University, USA.

3) Agrios G N –1994 -Plant Pathology 2nd Edn. Academic Press NY

4) Mehrotra R S –1983-Plant Pathology Tata Mc. Graw Hill Pub. Co. Ltd., New Delhi.

5) Rangaswamy G and Mahadevan (2002) Diseases of Crop plants in India. Prentice Hall of India Private Limited New Delhi.

6) Agarawal, P. K. 2005. Principles of Seed Technology.2nd edn. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.

7) Basra, A. S. 2006. Handbook of Seed Science and Technology, The Haworth Press, USA

8) Copeland, L.A. 1995. Principles of Seed Science and Technology- Kluwer Academic Publishers, The Netherlands.

9) Vanangamudi, K., Natarajan, K., Saravanan, T., Natarajan, N., Umarani, R., Bharathi, A. and Srimathi, P. 2006. Advances in Seed Science and Technology: Vol: III: Forest Tree Seed Technology and Management, Agrobios, New Delhi.

Soft Core- 1.7: Plant Cell and Tissue Culture

Un**it-1: Introduction to Plant tissue culture**: Scope and Importance of plant tissue culture, concept of totipotency, factors affecting totipotency, Media composition and types, aseptic technique, sterilization of media and tissue, hormones and growth regulators, explants for organogenesis, cell culture- isolation and culture of single cells, applications of cell culture, production of haploid plants and techniques, anther and microspore culture applications of haploids.

Unit -2: **Micropropagation and Somaclonal variations:** Techniques and factors affecting micro-propagation, methods of micro-propagation-Multiplication by axillary buds and apical shoots- meristem and shoot tip culture, bud culture ,single node culture axillary bud culture, direct and indirect organogenesis, somatic embryogenesis- direct and indirect, Photoautotrophic micro-propagation , applications of micro-propagation , synthetic seeds and somaclonal variations and their applications .

Unit-3:Protoplast culture , regeneration and Somatic hybridization- importance of protoplast culture, purification and isolation of protoplast, methods of protoplast culture and regeneration of protoplast, protoplast viability testing, protoplast fusion, techniques- chemical fusion, electro fusion ,selection of fused protoplasts, uses of protoplast culture, cybrids, genetic modification of protoplast.

Unit-4: Cell suspension culture and secondary metabolite production: Types- batch and continuous cultures, range and source of secondary metabolites, strategies to optimize production, elicitation-biotic and abiotic agents, , secondary metabolite production through suspension culture, hairy root culture, Immobilization of plant cells, bioreactors for secondary metabolite production: techniques, characteristics and , factors affecting immobilization, biotransformation, Important secondary metabolites produced in tissue culture.

Practicals

1) Preparation of plant tissue culture medium- MS medium, B5 medium, L2 medium, Woody plant medium.
2) Organ cultures- shoot tip, leaf, nodal, anther, and embryo culture
3) Micro-propagation techniques in medicinal herbs and tree species**.**
4) Induction of callus in medicinal herbs and trees species**.**
5) Establishment of cell suspension cultures for secondary metabolite production**.**
6) Encapsulation of somatic embryos and Production of synthetic seeds**.**
7) Estimation of secondary metabolites by Colorimetry and TLC methods

Further Reading

1) M.M Yeoman Ed. Plant cell culture technology. 1986. Blackwell Scientific Publications Oxford, London
2) S.S Bhojwani (Ed.) 2012. Plant tissue culture Applications and limitations. 2nd edition, Elsevier, Amsterdam
3) Indra K. Vasil and Trevor A. Thrope (Ed.) 1994. Plant cell and tissue culture. Kluever, Academic publishers, London

4) Robert H. Smith 1994. Plant Tissue Culture-Techniques and experiments 3rd edition
5) John H Dodds and LorinW Roberts 3rd ed. 1995. Experiments in Plant Tissue culture .J Jeslopp-Harrison
6) M.K Razdan 2003. An Introduction to plant Tissue Culture .Scientific Publishers Inc. Enfield (NH) ,USA
7) Timir Baran Jha and Biswajit Ghosh 2005. Plant Tissue culture: Basics and Applied University press,
8) Michael A Dirr and Charles W Henserja. 2006 The reference manual of woody plant propagation from seed to Tissue culture 2nd Ed.
9) Harinder P.S , Makkar and P. Sidhuraju .2007. Plant secondary metabolites (Methods in Molecular biology)
10) Prathiba Chaturvedi, Pushpa Khanna and Abhay Choudhary 2012 . Invitro production of secondary metabolites of Medicinal plants -A biotechnological approach
11) I. K. Vasil. 1984. Cell culture and somatic cell genetics of plants Vol.1 Laboratory procedures and their applications. Academic Press. INC Orlando, Florida
12) P.K Gupta, 2015. Plant Biotechnology 2nd ed. Rastogi Publications, Meerut
13) S.S Purohit. Biotechnology: Fundamentals and Applications 3rd ed. 2004. Agrobios (India)

Soft Core-1.8: Phytochemistry and Herbal Drug Technology

Unit-1: History, scope and importance of medicinal plants. A brief account of Indigenous medicinal sciences-Ayurveda, Siddha and Unani. Documentation of traditional knowledge. WHO guidelines for assessment of quality of herbal medicines.Brief account of herbal formulations and preparations.

Unit-2:Extraction Techniques-Aqueous extraction, Solvent extraction, Successive solvent extraction, Soxhlet apparatus, maceration, Infusion, Digestion, decoction, percolation, counter current extraction, sonication, microwave assisted extraction, Super critical fluid extraction, Steam distillation, Partitional extraction, Sepboxes, Head space technique and selection of suitable extraction process.**Phytochemicals screening methods**: Primary and secondary metabolites-Alkaloids, Flavonoids, Steroids, Terpenoids, Tannins, Glycoside, Monosaccharides and Reducing sugar, Phenolic compounds, Resinous substances.

Unit-3: Screening Methods for Herbal Drugs:Bio-prospecting, Activityguided assays, antibacterial, antifungal, antiviral, antiprotozoal, Antihelmintheic, antiallergic and anti-inflammatory, antioxidant, anti-diabetic, anticancer, and antimitoticand antinematicidal activity cytotoxicity, Bioacutograpgy, MIC IC50 and LD50 values. **Isolation and characterization of Bio active principles:** Principles, Instrumentation, processes, and applications of chromatography, TLC, HPLC, counter current extraction, Gas liquid chromatography, gas chromatography, affinity chromatography, column chromatography, UV and visible spectrophotometer, Turbidometry, Spectroscopic analysis-IR, NMR, mass and X ray diffraction and Differential scanning calorimeter.

Unit-4: Standardization of herbal drugs: Importance of standardization and problems involved in the standardization of herbs. Standardisation in single drug and compound formulations. WHO Guidelines for quality standardised herbal formulations. Estimation of parameter limits used for standardization. IPR issues.

Practicals

1) Extraction methods: Cold extraction method, Soxhlet extraction and successive solvent extraction,
2) Preparation of NA, NB, PDA and PDB, sterilization, pouring, inoculation and culturing of bacteria and fungi
3) Antibacterial activity assay by well and disc diffusion methods
4) Antifungal activity assay by well and disc diffusion methods
5) Antifungal activity by poisoned food technique
6) Determination of MIC (Minimal Inhibition Concentration) by Micro dilution method
7) Antioxidant assay by DPPH and ORAC methods
8) Antioxidant assay by FRAP and ABTS methods
9) Phytochemical screening of plant extracts: Detection of Alkaloids, Flavonoids, Steroids, Terpenoids, Tannins,
10) Phytochemical screening of plant extracts: Detection of Glycoside, Saponins, Monosaccharides Reducing sugar, Phenolic compounds and Resins
11) Isolation of active principle by TLC method
12) Bioautography technique

Further Reading

1) Harborne, J. B. 1984. Phytochemical Methods (2^{nd}ed.). Chapman and Hall, London
2) Kemp, W. 1993. Organic Spectroscopy (3^{rd}ed.) ELBS, Hong Kong
3) Mann J., Davidson, R. S. Hobbs J. B. Banthorpe. D. V. and Harborne J. B. 1994. Natural Products. Longman S cientific and Technical Essex
4) Silverstein, R. M. Bassler, G.C. and Morrill, T. C. 1981. Spectroscopic Identification of Organic Compounds (4^{th}ed.). John Wiley, New York.
5) Trivedi, P. C. (2006). Medicinal Plants: Ethno-botanical Approach, Agrobios, India.
6) John R. Dean. (2010). Extraction Techniques in Analytical Sciences John Wiley and Sons, Ltd. UK.
7) Schwalbe, R., Moore, L.S. and Goodwin, A. C. (2007). Antimicrobial susceptibility testing protocols. CRC Press, Taylor and Francis Group, Boca Raton, London, New York.
8) Central council for Ayurvedic formulations (1987). Pharmacopeial stands for Ayurvedic formulations.
9) Agarwal, S. S. and Paridhavi, M. 2007. Herbal drug technology, University Press Pvt. Ltd.
10) Willow J. H. 2011. Traditional Herbal medicine research methods, Identification, Analysis, Bioassay and Pharmaceutical and Clinical Studies, A John Wiley and Sons, Inc., publications
11) Mangathayaru, K. 2013. Pharmacognosy an Indian Perspective. Dorling Kindersley (India) Pvt. Ltd
12) Rastogi R. P. and Mahrotra, B. N. 1998. Compendium of Indian Medicinal Plants, Vol 1-5, Central drug research institute Lucknow and National Institute of Science Communication New Delhi
13) Chattergee, A, Pakrashi, S. C. 1997. The Treatise on India medicinal plants, V0l 1-5National institute of science communication, New Delhi

14) Rao, C. K. 2000. Material for the database of medicinal plants, Karnataka state council for the science and technology for the department of forests, Environment and ecology Government of Karnataka
15) Bone K., Mills, S. 2013. Principles and practice of Phototherapy modern herbal medicine, 2nd Edi., Chrchill Living stone eksevier
16) Raaman, N. 2006. Phytochemical techniques. New India Publishing Agency, New Delhi
17) Roy, A. 2012. Herbal Drug Industry. Oxford book company, Jaipur, New Delhi
18) Parmar, N. S. and Prakash S. 2013. Screening methods in Pharmacology, Narosa, New Delhi.

SCHEME OF EXAMINATION FOR M.PHIL. BOTANY (CBCS)

FIRST SEMESTER

Scheme of Examination (Theory)

Time-03 Hours **Max. Marks: 70**

Q.1: 10 questions of 1 mark each, 10 to be answered. 10x01=10

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. 03x12=36

Scheme of Examination (Practical)

Time-03 Hours **Max. Marks =70**

Q1. Conduct the experiment 'A', record data, analyse and draw inferences. 15 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 & I. 5X3=15 Marks

Q5. Viva-voce examination. 10 Marks

Q6. Practical Records 10 Marks

SECOND SEMESTER

Dissertation and Viva-Voce Examination

The research guide (internal examiner) and external examiner shall evaluate the dissertation for 300 marks. Dissertation will be evaluated for (C3) 140 marks. The candidate shall defend his dissertation work by way of power point presentation during viva-voce examination for 100 marks. Both the internal (research supervisor) and external examiners shall conduct evaluation.

Sd/-
Prof. G. R. JANARDHANA
Chairman, Board of Studies in Botany

SYLLABUS FOR M. PHIL. BOTANY ENTRANCE EXAMINATION

Unit 1: Virology- Classification of viruses-ICTV and Baltimore System. Genome diversity in viruses. Mechanism of replication of DNA and RNA viruses. Viroids - Structure and multiplication; Prions - Structure and multiplication and Prion diseases, Phytoplasma. **Bacteriology**-Bergey's Manual of

Determinative and Sytematic Bacteriology; C R Woese Three domain classification of Bacteria. Archeabacteria and Eubacteria - Diversity and Evolution; Nutritional types of bacteria (Autotrophs, Heterotrophs and Symbionts); Growth of bacteria. Recombination in bacteria (Transformation, Transduction and Conjugation). Economic importance of bacteria. General characters of Actinomycetes and their economic importance. Structure and multiplication of Mycoplasma. **Mycology**- Classification of fungi. Thallus structure, spore producing organs. Nutrition in fungi- Saprotrophs, Biotrophs, Necrotrophs; Symbiotrophs. Methods of reproduction in fungi - Asexual, Sexual methods. Evolution of sex in fungi, Heterothallism and Parasexuality in fungi. **Plant Pathology**- Classification of plant diseases; Parasitism and Disease Development, Defense Mechanisms in Plants. Plant Disease Epidemics and Plant Disease forecasting. Methods of Plant disease management. Plant Diseases- Sandal Spike, Citrus canker, Bacterial Blight of Paddy, Late Blight of Potato, Downy Mildew of Bajra, , Tikka disease of ground nut, Grain smut of Sorghum. Phloem Necrosis of Coffee, Root Knot Disease of Mulberry.

Unit 2: Diversity and distribution of algae: Unicellular, colonial, filamentous, heterotrichous, parenchymatous, pseudoparenchymatous, siphonous forms in algal classes, General characteristics and phylogeny: **Pigmentation in algal groups:** Role of photosynthetic and accessory pigments, **Life cycles in algae:** Haplontic, diplontic, isomorphic, heteromorphic; Economic importance of algae. **Bryophytes:** Introduction, General characteristics, classification and phylogeny of Bryophytes; Distribution, habitat, External and Internal morphology and Reproduction; Comparative account of gametophytes and sporophytes of Bryophytes, Economic importance of Byrophytes. **Pteridophytes:** Introduction, Classification and phylogeny; Morphology, Anatomy Reproductive Biology and phylogeny: Psilophytes, Lycophytes, Sphenophytes, Filicophyta;Evolution of Sorus, Evolution of Sporangium; Gemetophyte development- Homosporous and Heterosporous ferns; Heterospory and seed habit; Stelar evolution in Pteridophytes; Ecology of Pteridophytes; Economic importance. **Gymnosperms:** Introduction, Distribution, classification and phylogeny of Gymnosperms, Range in Morphology, Anatomy, Reproduction and interrelationships of- Cycadales, Ginkgoales, Conifereales, Gnetales, Economic importance of Gymnosperms.

Unit 3: Taxonomy of Angiosperms: Carolus Linnaeus and his contributions to Taxonomy; Concept of family, genus and species; Concept of primitive flower and evolutionary tendencies; Principles and Aims of ICBN. Experimental Taxonomy: Anatomy, Embryology, Palynology, Cytology, Phytochemistry, Molecular Biology, Numerical Taxonomy; Botanical Garden; Methods of preparation, maintenance and significance of Herbarium. Bentham and Hooker's, Engler and Prantl's, Hutchinson's system, Takhtajan's, Cronquist's system of classification. The Classfication of Angiosperm Phylogenetic Group (APG)-III System. Salient features, morphological peculiarities, systematic position and affinities of the following families-

Dicotyledons- Magnoliaceae, Nymphaeaceace, Papaveraceae, Urticacecae, Casuarinaceae, Nyctaginaceae, Malvaceae, Passifloraceae, Euphorbiaceae, Amaranthaceae, Droseraceae, Podostemaceae, Balanophoraceae, Loranthaceae, Meliaceae, Sapindaceae, Linaceae, Scrophulariaceae, Bignoniaceae, Acanthaceae, Rubiaceae and Asteraceae; **Monocotyledons-** Alismataceae, Araceae, Cyperaceae, Commelinaceae, Zingiberaceae, Liliaceae, Dioscoreaceae, and Orchidaceae. **Economic Botany:** Cereals and Millets, Legumes, Sugar yielding plants, Spices and condiments, Fibre yielding plants, Timber yielding plants, Dyes; Rubber yielding plant, Gums and Resins, Oil yielding plants; Medicinal plants; Ethnobotany and IPR.

Unit 4: Reproductive Biology of Angiosperms: Development of embryology in India; Microsporogenesis- Male gametophyte development; anther wall layers and functions; Tapetum- types, Concept of male germ unit; Pollen morphological features; Unusual features: pollen development in Cyperaceae, pollen embryosac; Scope of palynology. Megasporogenesis- Female gametophyte development; Ovular structure & types; Development of monosporic, bisporic, tetrasporic & special types of embryo sacs; Ultrastructure & nutrition of female gametophyte; Fertilization- double fertilization; single fertilization; heterofertilization & polyspermy; Pollen incompatibility reactions; Endosperm- Types; haustorial variations; ruminate & composite endosperm; Embryo- Structure; development of monocot, dicot & grass embryo; significance of embryonal suspensor; Experimental Embryology. **Plant Morphogenesis:** Shoot apical meristems, root meristems Cell fate/ fate maps, gradients, stem cells in plants and their significance in development, polarity, symmetry, totipotency of cell types, pleuripotency, plasticity, differentiation, redifferentiation, dedifferentiation and regeneration in *Acetabularia, Arabidopsis,* Photoreceptors & photo morphogenesis. Totipotency, factors affecting totipotency, Micropropagation and its applications, techniques and applications of Meristem culture, Embryo culture, Endosperm culture and Somatic embryogenesis including synthetic seeds production. Androgenesis and Microspore culture, Significance of Haploids, Diploidization and bulbosum technique. Isolation, culture methods and regeneration of protoplasts, somatic hybridization, fusogens, fusion techniques and its applications, Somaclonal variations. **Techniques of Suspension Culture.** Plant germplasm storage by cryopreservation and its advantages.

Unit 5: Primary vegetative body of the plant: Anatomical features of leaf, stem and root- dicot, monocot, fern and gymnosperm. Kranz anatomy. Ultrastructure and chemistry of the cell wall, Structure and differentiation of xylem and phloem tissues. Secondary growth- Vascular cambium, secondary xylem of gymnosperms and dicots and secondary phloem of gymnosperms and dicots. Periderm and Bark, Anomalous secondary growth in monocots and climbers. Floral anatomy: flower parts, floral meristem, vascular system. Structure, Composition of biomolecules, membrane structure and Functions. Plant

propagation: S**eed Propagation** techniques Vegetative Propagation: **Cuttings, Buddings, Micro propagation** techniques. Applications in forestry and horticulture. Propagation methods of some selected plants – Citrus, grape, mango, mulberry, hibiscus, rose, croton, Eucalyptus. Cell and cellular components. **Plant Physiology:** Transport of solutes across the membranes Transmembrane proteins, Transport of ions, solutes and macro-molecules, Mechanism of translocations in phloem; Plant hormones: Discovery, Biosynthesis, Metabolism, transport and Physiological effects of plant hormones and their applications; Phytochrome: Photochemical and Biochemical propecties of phytochrone. Role played in signal transduction pathway stomatal physiology; Phytosynthesis in higher plants (i) Photophosphorylation (ii) Calvin cycle (iii) Photorespiration (iv) C_4 – Pathway (Cycle); (v) CAM in plants; Oxidative Phosphorylations; (i) Glycolysis (ii) TCA – Cycle (iii) ET – Chain. (ii) Biosynthesis of amino acids (iii) Assimilation of nitrate & ammonium; Lipid metabolism: Fats and Oils biosynthesis and oxidation of lipids; Physiology of Seed Germination and Flowering.

Unit 6: Cell Biology: Biomolecules – Structure, Composition of biomolecules and their stabilizing Interactions (Carbohydrates, Lipids, Proteins and Nucleic acids). Unit membrane structure and Functions. Mechanism of protein sorting and intracellular transport including apoplast to symplast transport. Electrical properties of membranes. **Functions of intracellular Organelles:** Cell wall, Membranes, Nucleus, Mitochondria, Golgi bodies, Lysosomes, Spherosomes, Peroxisomes, Ribosomes, Endoplasmic Reticulum, Plastids, Chloroplast, Vacuoles and Cytoskeleton. Cell Cycle and mechanism of cell cycle regulations. A brief account of cell signaling, Receptors, Second messengers. General mechanism of Signal TransductionPathway, Programmed cell death in life cycles of plants. **Chromosomal theory of inheritance, classical and modern Mendelian principles,** C**oncept of the gene, Gene mapping methods-** linkage maps, tetrad analysis, Recombination in bacteria, mapping genes in bacteria by interrupted mating technique, fine structure mapping, transduction and transformation mapping, mapping genes in bacteriophages**, sex determination and dosage compensation**- Chromosomal and genetic basis of sex determination, mechanism of sex determination in melandrium, *C. elegans*, drosophila and humans, dosage compensation mechanisms in humans, Drosophila and *C. elegans*. **DNA replication**- patterns, Messelson and Stahl and Taylor's experiment, enzymes of replication, mechanism of DNA replication in prokaryotes and Eukaryotes, proof reading and error correction mechanisms. **Plants as genetic tools in Biology:** *Arabidopsis, Oryza, Zea, and Saccharomyces.* Genome organization. **Organization of chromosomes and genes in prokaryotes and eukaryotes**- operon, interrupted genes, gene families, unique and repetitive DNA. Plant genes and regulation, Nucleus and chromatin organization, DNA packaging, organization and types of DNA sequences, organization of plant nuclear genes, plastid genes and mictochondrial genes. Genes responding to hormones, phytochrome, responses to abiotic stresses. Genes involved in photosynthesis and nitrogen fixation and their regulation; Genetic and molecular analysis of flower development. Genes involved in Fertilization, seed development,

Embryo development. Genetics of *Agrobacterium.* Proteomics, Genomics and Bioinformatics Bio-informatics- tools of bioinformatics, data bases and data base management, Bioinformatics in taxonomy, biodiversity, agriculture. Bioinformatics in drug design and drug discovery.

Unit 7: Molecular Biology, mechanism of mutation, repair and recombination:- Nature of genetic material: nucleic acids as genetic material, nucleic acid primary and secondary structure and types, **Organization of chromosomes and genes in prokaryotes and eukaryotes**- operon, interrupted genes, gene families, unique and repetitive DNA, heterochromatin, euchromatin, transposons, mitochondrial and chloroplast genome organization, Transposable elements in prokaryotes and eukaryotes, genetic and evolutionary significance, **DNA replication**- patterns, Messelson and Stahl and Taylor's experiment, enzymes of replication, mechanism of DNA replication in prokaryotes and Eukaryotes, proof reading and error correction mechanisms; **Mutation-**DNA damage by spontaneous mutations, physical and chemical mutagens and their molecular mechanisms, **Repair mechanisms**- direct reversal of damage, base and excision repair, recombinational repair, SOS repair, translation repair synthesis, transcription coupled repair, **Recombination**- homologous recombination, models of recombination, mechanisms, protein machinery of homologous recombination, genetic consequence of homologous recombination, gene conversion, site specific recombination, mechanism and biological significance, non homologous recombination- transposition, molecular mechanisms of transposition- conservative, replicative and retrotransposition. **RNA synthesis, processing and translation:** transcription activators and repressors, promoters, RNA polymerases and transcription factors, mechanism of transcription in prokaryotes and eukaryotes, **RNA processing**- capping, polyadenylation, splicing, alternative splicing, RNA editing, exon shuffling and RNA transport, **Translation and processing**- ribosomes, tRNA aminoacylation, aminoacyl tRNA synthetase, genetic code, wobble hypothesis, deciphering of the code, translation mechanism , translation proof reading, translation inhibitors and post translation modifications. **Regulation of gene expression in Prokarytes:** Operon concept, regulation at transcription initiation- lac and trp operon control, regulation of lytic and lysogenic cycles in lambda phage, regulation beyond transcription initiation-premature termination- trp operon, ribosomal proteins as translational repressors, ribo switches, **Regulation of gene expression in eukaryotes**-transcription activators and repressors, regulation after transcription initiation- alternative splicing, translational control in ferretin and tranferrin mRNA, RNA interference, role of chromatin in regulation of gene expression and gene silencing.

Unit 8: Breeding Methods: Plant introduction and Acclimatization, Domestication and agriculture, pure line, clonal, mass and progeny selections, recurrent selection, Pedigree, bulk and back cross methods, Heterosis, breeding synthetic and composite varieties. **Breeding Techniques :** Mutation breeding, Polyploidy, Hybridization, Tissue culture techniques in crop improvement , protoplast

fusion, electroporation, electro fusion, biolistics, somatic hybridization, Transgenic plants (GMO's), The role of Gene technology in plant breeding. **Breeding for Specific Purposes :** Breeding for disease resistance, insect resistance, drought and salinity, quality trait, multiple cropping systems, Idiotype breeding, breeding for Adaptation. **Crop breeding and seed production :** Breeding field crops, seed production techniques, release of new varieties, intellectual property rights, computer application in plant breeding, Crop breeding Institutes/ centers. Genetic Resources and Germplasm conservation. **Scientific Plant breeding** Green revolution, The elite crop (Golden rice), **Modern Plant breeders:** M.S. Swaminathan, Norman E. Borlaug, N.I. Vavilov.

Unit 9: Ecology- Plants and the environment- plant adaptation, ecotypes**;** Life Cycles and Life History- Life span, Plant growth, Frequency of reproduction, Life history strategies; Habitat Ecology- Fresh Water and Marine water ecology (ecosystems), Wetlands and their Characteristics; Plant Communities and Ecosystems- Species diversity, Community structure, Ecosystem function; Interactions among Plants- Competition, Commensalism and Parasitism, Mutualisms, Herbivory. **Habitat ecology & Environment -** The distribution of biomes, Major Terrestrial Biomes; Forests-Tropical Forests, Temperate Forests, Taiga, Grasslands, Savanna, Temperate Grasslands/Prairies, Tundra, Desert, Chaparral, Management of terrestrial, aquatic and mangrove vegetation; The Changing Ecosystem- Characteristics of disturbances; Fire, Succession and Agriculture practices; Pollution, Protecting habitats and species; Environmental Education Programmes- WWF, UNEP, IUCN, MAB. **Biodiversity & Conservation Biology-** Science in the Service of Biodiversity. Biodiversity and its value. Biodiversity issues, Concerns, Management. Biodiversity Hot spots. Biodiversity- Creation and Destruction, Threats & current status of biodiversity. Invasive alien species as threat to biodiversity. Conservation Strategies, Past, Present, and Future- Attitudes about Conservation, Conservation Movements; Endangered Species Act. 2002 (GOI) National Biodiversity Conservation Strategy; Geologic and Biogeographic Forces, Selecting Reserves- Biogeography, Representation, Tools for Inventory and Evaluation; Protected area Network of India- History, size and scale & management. **Phytogeography-** Physical features of the world, India & Karnataka. Climatic zones, tectonics, continental movements; Types of plant distribution – discontinuous distribution - land bridge theory, continental drift, polar oscillation, shifting of poles, glaciation: continuous distribution- cosmopolitan, circumpolar, circumboreal, circumaustral, pantropial. Distribution of plants – coastal regions, Rivers & Lakes of India & Karnataka; Distribution of plants – Islands; Distribution of crop plants Natural & artificial social environments; Floristic regions of the world, India; Floristic Ecological plant geography; Ecological crop geography; Plant dispersal, migrations & isolation - endemic plants of Western Ghats; Origin, Distribution and acclimatization of coffee, cardamom, sugarcane, cashew, ragi, maize, wheat, rice & cotton; Remote sensing, study of vegetation by GIS. **Management of Plant Biodiversity:** Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication. **Biodiversity and Biotechnology:** Role in assessment of biodiversity

and bio-resources, Utilization of biodiversity, Conservation of biodiversity, Adverse impacts of biotechnology on biodiversity.

Unit 10: Proteins: Classification, Structure- primary, secondary, tertiary and quaternary structure; properties of proteins; **Enzymes**: Nomenclature, nature and properties of enzymes, active sites, co-enzymes, kinetics of enzyme action, Catalysis, specificity and inhibition, Allosteric enzymes, Ribozyme and Abzyme. **Biomolecules-** A brief account of carbohydrates, proteins, lipids and nucleic acids**; Principles and applications of Chromatography**- Basic principle, Partition Coefficient, Survey of chromatographic procedures, techniques of chromatography, types of chromatography and their applications; **Spectroscopy**- Basic principle, Electromagnetic spectrum, the Laws of Absorption, Absorption Spectrum, Instrumentation for UV, Vis. and Infrared spectroscopy, NMR, and applications; **Electrophoresis**-Basic principle, Migration of an ion in electric field, Factors affecting electrophoretic mobility, types of electrophoresis- micro electrophoresis, moving boundary electrophoresis and Zone electrophoresis and their applications; **Centrifugation-** Basic principle- Relative Centrifugal Force, Instrumentation- Desktop, High speed and Ultra centrifuge, Preparative Centrifugation-(i) Differential centrifugation (ii) Density Gradient Centrifugation –(a) rate zonal (b) iso-pycinic, Analytical Centrifugation and applications. **Biofertilizers:** Preparation and applications of biofertilizers such as Rhizobium, Azotobacter, Blue Green Algae and VAM. Single Cell proteins (SCP): Health benefits and advantages of single cell proteins- *Spirulina.* Biofuels: Ethanol and Biofuel production from plants. Mushroom cultivation and its advantages. Bioremediation: Phytoremediation; Biodegradation, Xenobiotics. Biotechnology of medicinal and aromatic plants for human welfare.

Unit 11. Seed Technology Seed Science and Technology and its goal at national and international level. Seed Biology, Seed structure and functions. Seed programmes and organizations. Principles of seed production in self and cross pollinated and vegetatively propagated crops; Hybrid seed production; Maintenance of inbred lines and breeders seeds; Synthetic and composite seeds; Improved seed and their identification. Germplasm Banks, Seed Processing: Harvesting- seed drying, seed cleaning and gracing; Equipment needed; Seed Storage- types of storage structure; seed factors affecting storage life; effect of storage on relative humidity; temperature and moisture; Seed deterioration of commerce, Seed treatment. Seed quality Testing: Devices and tools used in seed testing. ISTA and its role in seed testing. Seed Sampling: Physical purity and heterogeneity test. Seed moisture content: importance and determination and methods, Viability and Vigour Testing, Genetic purity testing : objective and criteria for genetic purity testing, Seed health Testing: field and seed standards ; designated diseases, objectionable weeds - significance of seed borne diseases, Seed health testing and detection methods for seed borne fungi, bacteria, viruses and nematodes. Testing of GM seeds and trait purity. Preparation and

dispatch of seed testing reports; storage of guard samples; application and use of seed standards and tolerances. Seed Certification: Principles and Philosophy of Seed Certification, purpose and Procedures, National Seed Programme: National Seed Corporation- agencies responsible for achieving self reliance in seed production and supply of quality of seeds (State Seeds Corporation; National Seed Development Council- Central Seed Committee; Seed market surveys, seed industry in relation to global market , concept of WTO, GATT, IPR, Plant Variety Protection and its significance; UPOV and its role.

Unit 12: Plant Recombinant DNA Technology. Tools in Genetic Engineering: Restriction endonucleases-types and action, All DNA modifying enzymes. Cloning vectors: Plasmids isolation and purification- Ti Plasmid, pBR322, pUC –series. Phage vectors-M13 phage vectors, Cosmids-Types,Phasmids or Phagemids, Shuttle vectors-types. YAC and BAC vectors, Lambda phage vectors, Lamda phage DNA as a vectors. Cloning vectors and expression vectors. Vectors for Plant cells, Vectors for animal cells, Baculovirus vectors- adenoviruses Retroviruses, Transposons as vectors. Synthetic construction of vectors. **Binary vectors for plant transformation:** Introduction, Desirable features of any plasmid vector, Development of plant transformation vector, Basic features of vectors for plant transformation, Optimization, Clean gene technology. **Techniques for plant Transformation:** Integration of plant tissue culture in to plant transformation protocols. **The genetic manipulation of herbicide resistance:** The use of herbicide in modern agriculture, Strategies for engineering herbicide resistance, The environmental impact of herbicide-resistant crops. **The genetic manipulation of pest resistance**: GM strategies for insect resistance The *Bacillus thuringiensis* approach to insect resistance, The Copy Nature Strategy, Insect resistant crops and food safety. **The genetic resistance to plant disease resistance:** Plant pathogen interaction, Natural disease resistance pathways-Overlap between pests and diseases, Biotechnological resistance to disease resistance. Transgenic approaches to viral disease resistance. **Engineering stress tolerance, the improvement of crop yield and quality:** The genetic manipulation of fruit ripening, engineering plant protein composition for improved nutrition, The genetic manipulation of crop yield by enhancement of photosynthesis. **Molecular Farming/Pharming:** Metabolic engineering of plants. Carbohydates and lipids, Molecular farming of proteins, Economic consideration of molecular farming. **Future prospects for GM crops:** The current state of transgenic crops, Concerns about GM crops, the regulations of GM crops and products.

Unit 13: Biological control of Pests, Pathogens and weeds: Bio-control agents and Biopesticides; Biological control of crop pests; Biological control of Pathogens and weeds. Mycoherbicides. **Gene Therapy:** Gene therapy methods and applications. **Fermentation Technology:** Industrial production of economically important products-acids, enzymes, amino acids, bevergares, biopolymers, antibiotics. **Biofertilizers:** Preparation and applications of biofertilizers such as Rhizobium, Azotobacter,

Azospirillium, Blue Green Algae, VAM and Azolla. **Single cell proteins (SCP**): Health benefits and advantages of single cell proteins- Spirulina, Chlorella, Scenedesmus; Yeast as SCP. **Biofuels:** Biofuels production; Ethanol, Biogas, Hydrogen and their applications. **Mushroom cultivation:** Important edible mushrooms, Nutritive and medicinal value of edible mushrooms; Cultivation and Advantages. **Biological waste treatment and reuse of wastes:** Waste treatment, Steps, Reuse of wastes; Conversion of wastes in biogas; Ethanol and compost. **Bioremediation:** Cleaning environment; Insitu bioremediation. **Biodegradation:** Xenobiotics; Biodegrading agents; Treatment of Toxic pollutants, Advantages of Biodegradation. **Biomining:** Bioleaching, microbes involved in bioleaching; Advantages of Biomining.

Unit 14: Theories of Evolution of life, Earth and Universe, condition of the early earth, Emergence of the first living cell, origin of Prokaryotic and Eukaryotic cells, life in the Paleozoic, Mesozoic and coenozoic era. **Development of Evolutionary thoughts ,** Ecological context, Before Darwin, Darwinsim, Darwins evolutionary theory. **Fossil evidence of Ancient life,** fossilization, Evidences from comparative, morphology, Patterns of Development, Comparative Physiology and Biochemistry, Biogeography, Paleontology, Taxonomy, Anatomy and Embryology, plant and animal breeding, Evidence from changing earth and sea. Extinctions. Evolutionary ecology. **Speciation and origin of higher categories:** Natural Selection- Selective forces, Types of Natural Selection, Selection models, Sexual Selection, Selection and nonadaptive characters. **Isolating Mechanism and Species formation:** Mendelian Genetics, Isolation and Subspeciation; Premating and Postmating Mechanisms; Chromosomal Rearrangement as Isolating mechanisms. **Polyploidy:** Autotetraploidy in plant evolution, Allotetraploidy in experiment and in nature, Polyploidy in the Animal kingdom. **Evolutionary mathematics:** Hardy-Weinberg law, Selection Pressure and Rate of Evolution, Mutation Pressure and Genetic Equilibrium, Genetic Drift. **Molecular basis of evolution,** Neo-Darwinism and modern synthesis.

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Prof. G. R. JANARDHANA
Chairman, Board of Studies in Botany