THE AMERICAN COLLEGE
DEPARTMENT OF BOTANY
M.PHIL PROGRAM
BOARD OF STUDIES
27TH MAY 2019

CURRICULUM FOR M.Phil PROGRAM IN BOTANY

Semester	Course Code	Subject	Hrs/ Week	Total Hours	Credit	Marks
I	MPB6601	Research Methodology	6	90	6	120
I	MPB6603	Trends In Botany	6	90	6	120
I	MPB6605	SPECIAL PAPER (Any ne)	6	90	6	120
I	MPB6600	Project	12	-	12	240
II	MPB6600	Dissertation Studies	30			
		Viva - voce				

Special Paper 1. Plant Tissue Culture
Special Paper 2. Bioprocess Engineering
Special Paper 3. Mycology
Special Paper 4. Plant Pathology

M Phil in BOTANY

Department of Botany had it long felt dream of upgrade fulfilled in the academic year 2018-19 and in the forthcoming 2019-20. The department is elated in commencing its first ever M Phil course with scope for about 6 scholars joining the department. Offering a holistic and meaningful courses in plant sciences all these years, the Department had carved out its MPhil program in for two semester with total of 30 credits assigned for 3 theory papers (2 must do papers and the third optional one, from one of the four specialization areas in which the given student will be pursuing his/ here research.

MPB6601 RESEARCH METHODOLOGY 6Hrs/Week

Learning objectives

- Defending the use of Research Methodology
- Judging the reliability and validity of experiments
- Being able to perform exploratory data analysis
- Using parametric and non-parametric hypothesis tests (and interpreting their results).
- Being able to draw conclusions from categorical data
- Using computer-intensive methods for data analysis
- Drawing conclusions from statistical test results
- Being able to compare statistical models
- Being able to argue when to use Bayesian vs Frequentist statistics

These objectives will be achieved by means of lectures, discussions in the lectures, assignments and blogs.

UNIT: 1 HOW DOES RESEARCH WORK?

Concept of research- the role of research, research process overview-importance of research- types of research- sources- attitude of a researcher- selection of research problem- evaluation of the problem- defining the problem.

UNIT: 2 METHODS OF RESEARCH

Science and its functions, What is theory?, and The meaning of methodology Experimental- Historical- Case study- Survey- Focus Group Discussion- Ethanography- Participatory Rural Apprasial- Methods of literary research- Econometric methods**.**

UNIT: 3 RESEARCH DESIGN

Understanding Concepts, Constructs, Variables, and Definitions- components of research- hypothesis and its value- Sampling- the nature of sampling, Probability sampling design, Nonprobability sampling design, Determination of sample size.

UNIT: 4 DATA INTERPRETATION

1. ***COLLECTION OF DATA***- Source (primary and secondary, electronic, library, note cards)- techniques in data collection (observation- interview- questionare- schedule- scales)
2. ***QUANTIFICATION OF DATA***- Classification of data- tabulation- diagrams- one dimensional- two dimensional- pictogram- cartogram- graphs- charts.
3. ***DATA ANALYSIS***- Statistics-Summarizing and describing a collection of data - Univariate and bivariate analysis- Mean, mode and standard deviation- Percentages and Ratios- Histograms- Identifying randomness and- uncertainty in data.

UNIT: 5 REPORT WRITING

Guidelines- stages- preliminaries- main body- reference material- foot notes- abbreviation- bibliography- Publication. Structure and Content, Presentation, Referencing and Appendices

References

- Adèr, H. J., & Mellenbergh, G. J. (Eds.). (1999). *Research Methodology in the Social, Behavioural and Life Sciences: Designs, Models and Methods*. Sage.
- Sahu, P. K. (2013). *Research methodology: A guide for researchers in agricultural science, social science and other related fields* (p. 432). New Delhi: Springer.
- Laake, P., Benestad, H. B., & Olsen, B. R. (Eds.). (2007). *Research methodology in the medical and biological sciences*. Academic Press.
- Walliman, N. (2017). *Research methods: The basics*. Routledge.
- Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.
- O'Leary, Z. (2017). *The essential guide to doing your research project*. Sage.

MPB6603 **TRENDS IN PLANT SCIENCES** **6**Hrs/Week

Preamble

This common course for all scholars focuses on providing a glimpse of the ongoing research at least in certain selected frontiers of botanical sciences. Topics and concepts touched here are by no means claimed complete. The intent is to inform learners about the trends in the domains where the research supervisors suggest candidates the topics for investigation. Besides the general glimpse on how botanical enquiries have progressed over time, ideas on metabolic and developmental regulation, methods in molecular biology, nanobiology, system biology and ideas on the intricacies of plants in environment are covered.

UNIT 1: Introduction

Facets of Botanical investigations: exploration; experimentation: expansive and intrusive approaches and interdisciplinary initiatives. Biophysical and chemical narratives, computational and statistical approaches - Metabolic & Developmental Integration**:** Principal events and plant circuitry; symplastic and apoplastic connectivity; hormonal coordination: signal perception & transduction- Calmodulin and protein kinases - Initiation and regulation of reproductive development (florogenesis, fertilization, seed and fruit formation).

UNIT 2: Molecular biology and Genetic engineering

Fine structure and organization of chromatin network – DNA as a hereditary element – Gene concept: exons, introns, cistrons – lac and Trp operons. Post transcriptional and translational modifications – Molecular cloning- vectors- gene transfer methods - rDNA technology and transgenics - protein expression- fusion proteins- site directed mutagenesis- gene knockout- nucleic acid sequencing- molecular markers- protein sequencing - hybridoma technology- detection of molecules.

UNIT 3: Nanobiology

Designs and templates from nature- self assembly- molecular references of bioprocesses: Biomimetics - nucleic acids, amino acids, proteins, lipids & polysaccharides as inputs in modern biomaterials- Bionanomachines: ATP synthetase, Actin and Myosin, Antibodies and Collagen- Quantum dots, quantum well, nanotubes, nanowires - Nanotechnology in agriculture: plant nutrition and crop protection, Designer proteins, Peptide nucleic acids, Nanomedicine; Drug delivery, DNA computing, Molecular design using biological selection, Biosensors - Future directions.

UNIT 4: Systems biology

Post *Omics* realization: *sum of parts is not whole*- reductionism vs Holism – biological big data - Networks concepts : gene and gene regulatory network - Metabolomics: Interconnection of

pathways; enzymes in metabolic regulation; Molecular modeling tools: Modelling process - Graphic visualization; structure and functional prediction; Protein folding prediction; homology modeling, Docking simulation and Computer assisted molecular design- Translating biochemical networks into linear algebra - system biology softwares and platforms.

UNIT 5: Plant and Environment

Spatial and temporal components of plant life- Response to plant pathogens- Plant defence systems - response to abiotic stresses- water deficit, osmotic adjustment, drought, oxidative and heat stress- molecular physiology of mineral nutrient acquisition & utilization- climate change and plant productivity.

References:

- Systems Biology: Definitions and perspectives by L.Alberghina H.V.westerhoff, 2005, Springer.
- Computational systems biology by A.Kriete, R.Eils, 2005, Academic press.
- Systems Biology in practice: Concepts, Implementation and applications by E.Klipp. R.Herwig, A.Kowlad, C.Wierling and H.Lehrach, 2005, Wiley InterScience.
- Niemeyer.C.M. Mirkin C. A "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley – VCH, 2004.
- Buchanan, Bob B., Wilhelm Gruissem, and Russell L. Jones, eds. *Biochemistry and molecular biology of plants*. John Wiley & Sons, 2015.

MPB 6605 PLANT TISSUE CULTURE 6Hrs/Week

PREAMBLE:

The idea of this special paper is to help the researcher to a get glimpse of the genesis and historical account of this discipline and review the fundamentals of the in vitro methodology harping on its academic and applied avenues. Despite the omission of certain topics of industrial implications, intricacies of cell, tissue and organ culture and opportunities vested with manipulations of soma and the generative organs of the flower, and basics of secondary metabolite production finds special mention**.**

UNIT 1: The concept and idea of Plant Tissue culture

Introduction to plant tissue culture- cellular totipotency, cytological, cytochemical and vascular differentiations- terms and definitions, historical background, scope- applications-laboratory organization, tools and techniques, aseptic conditions – labelling and data collections.

UNIT 2: Media and Culture Preparation

Role of micro and macro nutrients, vitamins and carbon source - media preparations- pH, temperature, solidifying agents, slant preparations, plant growth regulators and mode of action, effects on *in vitro* culture and regeneration; molecular basis of plant organ differentiation, maintenance of cultures, environmental conditions, explants characteristics. culture techniques-explants selection, methods of sterilization and inoculation; economics of micropropagation projects.

UNIT 3: Cell, Tissue and Organ Culture

Micropropagation – bud cultures: shoot tips and nodal buds- Tissues as explants and organs for culture -- formation of callus, shoots and roots using various explants, production of virus free plants by meristem and shoot-tip culture. Hardening and planting in field. Factors affecting morphogenesis and proliferation rate; Technical problems in micropropagation.

UNIT 4: Somatic Embryogenesis and Genetic Enhancement in cultures

Process of somatic embryogenesis, structure, stages of embryo development, factors affecting embryogenesis; production of artificial seeds; Embryo rescue and wide hybridization; Protoplast culture: protoplast fusion, cybrids, asymmetric hybrids- somaclonal variations- Cryopreservation of plant germplasm - Invitro Fertilization - Techniques and significance of androgensis and gynogenesis (ovary, ovule, egg, synergids culture)

UNIT 5: Application of Cell Culture Systems in Metabolic Engineering

Cell suspension cultures: Batch & Continuous cultures; cell, tissue and organ culture as source of secondary metabolites; hairy root cultures; screening of high yielding cell lines; procedures

for extraction of high value industrial products, fractionation, bioassays; growth and production kinetics of cell cultures; scale-up procedures in bioreactors, types of bioreactors for plant cell cultures; Manipulation in production profile by biotic and abiotic elicitation; biotransformation.

References:

- Anis, M., & Ahmad, N. (Eds.). (2016). ***Plant Tissue Culture: Propagation, Conservation and Crop Improvement.*** Singapore: Springer.
- Bhojwani S.S., Razdan M. K (2005) ***Plant tissue culture: Theory and Practice, Studies in Plant Science*** 5,North Holland, Elsevier, New Delhi
- George, E. F., Hall, M. A., & De Klerk, G. J. (Eds.). (2007**). *Plant propagation by tissue culture**: volume 1. the background***(Vol. 1). Springer Science & Business Media.
- Gupta, S. D., & Ibaraki, Y. (Eds.). (2006). ***Plant Tissue Culture Engineering*** (Vol. 6). Springer Science & Business Media.
- Neumann, K. H., Kumar, A., & Imani, J. (2009). ***Plant Cell and Tissue Culture-A tool in Biotechnology: Basics and Application.*** Springer Science & Business Media.
- Smith R.H (2000) ***Plant Tissue Culture: Techniques and Experiments***, Second edition, Academic Press, USA
- Taji, A., Kumar, P. P., & Lakshmanan, P. (2002). ***In vitro Plant Breeding***. food products Press.

MPB 6605 Bioprocess Engineering 6Hrs/Week

Preamble:

In this course the scholar(s) would be able to define, understand the integration of physicochemical processes of cells and tissues and grow them in contamination free environment in bioprocess and develop concepts to scale-up bioprocess, analyze and formulate mechanisms for enzymatic reactions, Analyze metabolic network and metabolic flux and design bioreactors for the production of various products. Specify required technologies to effectively utilize genetically engineered microorganisms for bioprocessing.

UNIT: 1 Introduction : Interaction between chemical engineering, Microbiology and Biochemistry. History of fermentation, fermentation processes, microbial culture selection, media formulation, sterilization processes - Richard's rapid methods and process optimization. Stoichiometry of cell growth. Monod's Growth kinetics, fermentation classification - Gaden's, design and operation of fermenters, Basic concepts for selection of a reactor and types of fermentors, scale up of bioreactor.

Unit 2 : Down Stream processing: Recovery of particulate matter, product isolation, distillation, centrifugation, whole broth processing, filtration, aqueous two-phase separation, solvent extraction, chromatography and electrophoresis. Product synthesis kinetics, Instrumentation and control. Bioprocess economics, regulation and fermentation economics.

Unit 3 : Bioprocess: Regulatory constraints, steps in bioprocess development, major products of biological processing, bioprocess control methodologies and problems on scale-up methods. Role of diffusion in Bioprocessing, Convective mass transfer, Gas-liquid mass transfer, Oxygen uptake in cell cultures.

Unit 4: Modelling and simulation of bioprocesses : Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

Unit 5: Recombinant cell cultivation : Different host vector system for recombinant cell cultivation strategies and advantages. *E.coli*, *yeast*, *Pichia pastoris*/ *Saccharomyces cereviseae*, Animal cell cultivation, plant cell cultivation, process strategies, reactor considerations in the above system.

References :

- Biely, J.E. and Ollis D.F. Bio Chemical Engineering Fundamentals (1986) Megraw Hills. Rehm, H.J. and Reed G (ed), Biotechnology, Vol 1-2, Verlag chemie.

- Stanbury, P.E. and Whitaker A., Principles of Fermentation Technology (1984) Pergamon Press.
- Pirt, S.J. Principles of Microbial and Cell Cultivation. Blackwell Scientific Publication, London.
- Moo-young M. Comprehensive Biotechnology Vol. 1-4 Pergamon Press Oxford.
- Principles Of Fermentation Technology Paperback – 2008 by P F Stanbury Dr. A Whitaker (Author) Elsevier; 2 edition (2008)
- Bioprocess Engineering Principles Paperback – 2009 by Pauli. M (Author) Elsevier (2009)
- Bioprocess Engineering Principles Paperback – 2012 by Doran (Author) Elsevier; Second edition
- Pauline Doran,2010.Bioprocess Engineering Principles, Elsevier, UK.
- John Villadsen, Jens Nielsen, Gunnar Lidén. (2011) Bioreaction Engineering Principles, 3rd Edition. Springer Science & Business Media.
- Jens Nielson, John Villadsen and Gunnar Liden, "Bioreaction engineering principles", 2nd Edition, Kulwer Academic, 2002

MPB 6605 Mycology 6Hrs/Week

Preamble

This course will provide scientific knowledge on fungi and related organisms. Scholars will learn the unique biological characteristics that distinguish Fungi from other organisms, with the knowledge gained he/she will be able to comprehensively view the diversity of fungi and evaluate its ecological and academic significances. They will be able to screen the fungal resource for commercial value and potential molecules to be used as drug.

UNIT 1. Unique attributes of kingdom Fungi:

Historical perspective in mycology – characteristics of fungi — cell wall components and architecture – Nutrient requirements: carbon, energy sources, mineral nutrients – metabolic profile – mechanism of apical growth - optimum growth conditions - overview of energy yielding pathways – secondary metabolism – storage products – contemporary trends in Indian mycology.

UNIT 2. Fungal Diversity and Systematics:

Fungal diversity – fungal classification: conventional and modern approaches; molecular and phylogenetic system – nomenclature – occurrence, general characters and lifecycle of Myxomycetes, Oomycetes, Zygomycetes, Ascomycetes and Basidiomycetes – form class concept of Deuteromycetes - macrofungal diversity.

UNIT 3. Fungal Reproduction and Genetics

Reproductive biology – lifecycle patterns - heterokaryosis and parasexulaity – sex hormones - Origin and evolution of sex in fungi including hormonal control - genetics – genome sequences – spore germination – evolution and phylogeny.

UNIT 4. Fungal Ecology and Interactions

Fungi as saprotrophs and parasites - decomposers and nutrient cycling - symbiotic relationships: mycorrhizae: types, host range and ecological significance. Lichens : mycobiont, types, ecology and significance. Endophytic association: types, fungal endophytes, importance to host. Fungus - insects associations - necrotrophic and biotrophic plant pathogens - wood rot fungi.

UNIT 5. Applied and Industrial Mycology

Fungi in human welfare - food borne fungi – mycotoxins - pharmaceuticals – edible fungi - fungal metabolites - enzyme production – Fermentation industry: alcoholic production, bakery and cheese production – Agriculture: mycorrhizae, biological control agents.

References:

- Alexopolous, C.J., Mims, C. W. and Blackwell, M. 2002. Introductory Mycology (4th Ed.), John
- Wiley & Sons, Inc., New York, USA. ISBN: 9814-12-612-8
- Deacon,J.2006. Fungal Biology. (4th Ed.). Blackwell Publishing House, United Kingdom.
- ISBN 978-1-4051-6953-0
- Kavanagh K. 2006. Fungi: Biology and Applications. John Wiley and Sons, Ltd. UK. ISBN: 0-
- 470-86701-9
- Mueller G. M., Bills G.F., Foster M. S. 2004. Biodiversity of Fungi. Inventory and
- Monitoring Methods. Elsevier Academic Press, New York. ISBN 0-12-509551-1
- Webster J, Weber R.W.S. 2007. Introduction to Fungi. Cambridge University Press.
- ISBN-13 978-0-521-01483-0

MPB 6605 Plant Pathology 6Hrs/Week

Preamble:

This course is designed to inculcate the students to have a panoramic view on plant diseases, at all levels of biological organization from molecular to populations, and plants pathogenic and related agents. It focuses on how hosts, pathogens and environment interact to cause plant diseases and on understanding finds ways to control it. Exploring a plant pathogen, their disease etiology, disease cycles, economic impact, resistance, and management of plant diseases will be dealt. Averting a plant, free from pathogens is a key component of sustainable management strategies against plant pests and diseases.

UNIT I: Fundamentals of Plant Diseases: History – classification – diagnosis and identification – Koch's postulates – gene for gene hypothesis – disease tetrahedron – pathogenesis (disease initiation, development and establishment) – Disease development and influence of factors – inoculum and inoculum potential – hypersensitivity – pathogenic impacts on host physiology – host defense mechanisms - innate and induced – morphological and anatomical defenses – biochemical (phenols, phenolic glycosides, phytoalexins) – Pathogenesis Related Proteins (PR) – Systemic acquired and Induced systemic resistance (SAR and ISR) - parasitism (role of enzymes, toxins and growth regulators).

UNIT II: Diseases and Disease Cycle: Study of the following diseases with reference to their incidents – symptom manifestation and control measures – fungal (rust of wheat, blast of rice, Tikka of groundnut, Red rot of Sugar cane) – bacterial (Bacterial blight, Citrus canker) – mycoplasmal (Little leaf of brinjal, *phyllody of* sesamum – viral (Yellow vein mosaic disease) – nematode (Root knot of potato) – non- parasitic diseases (*Cuscuta, Striga).*

UNIT III: Disease Management: Principles of plant disease management by cultural, physical, biological, chemical, organic amendments and botanicals methods of plant disease control, integrated control measures of plant diseases. Disease resistance and molecular approach for disease management. Foliage, seed and soil application of chemicals, spreaders and other adjuvants, health vis-a-vis environmental hazards, residual effects and safety measures. History of fungicides, bactericides, antibiotics, concepts of pathogen, immobilization, chemical protection and chemotherapy, nature, properties and mode of action of antifungal, antibacterial and antiviral chemicals.

UNIT IV: Post-Harvest Diseases: Concept of post-harvest diseases, definitions, importance with reference to environment and health, principles of plant disease management as preharvest and post-harvest - Factors governing post harvest problems (biotic and abiotic), role of physical

environment, agro-ecosystem leading to infection, operational mechanisms and cultural practices - pathogens antagonist relationship - merits and demerits of chemical ,biological / phytoextracts in controlling post-harvest diseases - improving the shelf life of produce - application and monitoring for any health hazard.

UNIT V: Biocontrol agents in plant diseases and Integrated Disease Management: Concept of biological control – importance – principles of plant disease management with bioagents – history, merits and demerits –Types of biological interactions– operational mechanisms and cultural practices in biological control of pathogens – biocontrol agents – control of soil-borne and foliar diseases– compatibility of different bioagents –commercial production of antagonists, their delivery systems, application and monitoring. Integrated Disease Management (IDM) – concept and tools of disease management – development of IDM, basic principles – IPM and organic farming system– biopesticides available in market– quality control system of biocontrol agents.

References:

- Agrios GN. 2005. Plant Pathology. 5th Ed. Academic Press, New York.
- Ainsworth GC, Sparrow FK & Susman HS. 1973. The Fungi ñ An Advanced Treatise. Vol. IV (A & B). Academic Press, New York.
- Alexopoulos CJ, Mims CW & Blackwell M.2000. Introductory Mycology. 5th Ed. John Wiley & Sons, New York.
- Bindra OS & Singh H. 1977. Pesticides - An Application Equipment. Oxford & IBH, New Delhi.
- Campbell R. 1989. Biological Control of Microbial Plant Pathogens. Cambridge Univ. Press, Cambridge.
- Fokkemma MJ. 1986. Microbiology of the Phyllosphere. Cambridge Univ. Press, Cambridge.
- Gibbs A & Harrison B. 1976. Plant Virology - The Principles. Edward Arnold, London.
- Gnanamanickam SS (Eds). 2002. Biological Control of Crop Diseases. CRC Press, Florida.

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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. :

Semester I.

1. Pre VIVA 50 Marks

Semester II.

1. Oral presentation 50 Marks
2. Dissertation 50 Marks
3. Viva – Voce 50 Marks