Indira Gandhi National Tribal University
Amarkantak (M.P.)

SYLLABI

(Based on CBCS Pattern)

Department of Botany
Faculty of Science

Ph.D. Programme in Botany

(Effective from 2015-2016)

ABOUT THE PROGRAM

The PhD course work course comprises common courses (05 credits; **A**), discipline-specific courses (05 credits; **B**) and research theme-specific courses (05 credits; **C**). Since PhD students come from different educational backgrounds, relevant courses will be chosen in consultation with the concerned DRC/RAC to compliment the previous education, improve specific skills required for thesis and subsequent career. The *Common Courses (SCC)*, for all PhD scholars registered in life science related disciplines with the Faculty of Science; IGNTU, and *Discipline-Specific Cources* designed for individual life science disciplines e.g., Botany (BOTD), and is compulsory for all students registered in the Department of Botany. Wheras, a research scholar will select elective courses (i.e., *Research Theme-Specific Cources,* BOTR) as suggested by the concerned DRC/RAC. Further, the ability of a registered scholar to write a research proposal (on the Research Theme-Specific paper s/he has chosen), review of literature and presentation shall also be evaluated by the concerned DRC/RAC. The detailed course layput is given below.

COURSE LAYOUT

A) Common Courses (05 credits)

Course Code	Title	Nature	Credits
SCC-01	Research Methodology & Computer Applications	Compulsory	**04**
SCC-02	Lab. work based on SCC-01	Compulsory	**01**

B) Discipline-Specific Courses (05 credits)

Course Code	Title	Nature	Credits
BOTD-01	Instrumentation & Techniques in Plant Science	Compulsory	**04**
BOTD-02	Lab. work based on BOTD-01	Compulsory	**01**

C) **Research Theme-Specific Courses (05 credits)**

Course Code	Title	Nature	Credits
Any one of the following -		Elective	**03**
BOTR-01	Plant-Microbial Interaction & Soil Microbiology		
BOTR-02	Biodiversity & Conservation		
BOTR-03	Applied Cyanobacteriology		
BOTR-04	Phytochemistry & Herbal Biotechnology		
BOTR-05	Stress Biology		
BOTR-06	Biomass Utilization for Production of Agriculturally Important Bioactive Compounds		
BOTR-07	Plant Pathology		
BOTC-01	A test on writing Review of Literature, preparation and presentation of research plan proposal (in form of a seminar before the	Compulsory	**02**

	concerned DRC)		
Total credit (A+B+C)			**15**
Duration of the entire course		06 Months (i.e., one semester)	

DETAILED COURSE CONTENTS

SCC-01: Research Methodologies & Computer Applications
(Credits- 04; contact hour- 60h; maximum marks – 100)

Unit I: An Overview of Research Methodology (10h)
Research concept, steps involved, identification, selection and formulation of research problem, justification, hypothesis; literature collection- textual and digital resources (internet).

Unit II: Research Design, Data Collection & Interpretation (8h)
Research design; sampling techniques, collection and documentation, presentation, analysis and interpretation of data.

Unit III: Scientific Writing (10h)
Forms of scientific writing- Article, notes, reports, review article, monographs, dissertations, popular science articles, bibliographies,

Unit IV: Formulation of Scientific Communication (10h)
Outline preparation, drafting title, sub titles, tables, illustrations; Formatting tables- title, body footnotes; figures & graphs- structure, title and legends, Impact factor, citation indices, plagiarism

Unit V: Elementary Biostatistics (10h)
Standard deviation/error; Correlation coefficient, types of correlation, regression equation, biological significance of correlation and regression; Test of significance, chi-square test, analysis of variance.

Unit VI: Computer Applications (10h)
MS office, excel, power point, graphics (Sigma plot), statistical software (SPSS).

Suggested Readings:

1. Research Methodology - Methods & Techniques, CR Kothri CR (1990), Vishva Prakashan, New Delhi.
2. Research Methodology & Statistical Techniques, S Gupta (1999) Deep & Deep Publications, New Delhi.
3. Research Methodology for Biological Sciences, N Gurumani (2007), MJP Publishers, Chennai.
4. Introduction to Biostatistics, L Forthofer (1995), Academic Press, New York.
5. Biostatistical Analysis, JH Zar (2006), Prentice-Hall.
6. Research Design: Qualitative, Quantitative & Mixed Method Approaches, John W. Creswell (2009), Sage Publication, USA.
7. Experimental Design & Data Analysis for Biologists. PQ Gerry & JK Michael (2002), Cambridge University Press.
8. Choosing & Using Statistics: A Biologists Guide, D Calvin (2003), Blackwell Publisher.

SCC-02: Tutorial based on SCC-01 **(Credits- 01; contact hours- 15h; maximum marks - 50)**

BOTD-01: Instrumentation & Techniques in Plant Sciences
(Credits- 04; contact hour- 60h; maximum marks – 100)

Unit I: Microscopy (10h)
Principles and applications of phase contrast, differential image control, fluorescence, confocal, scanning and transmission electron microscopes

Unit II: Spectrophotometry (10h)
Principles and applications of UV-Visible, atomic absorption and fluorescence spectrophotometers, NMR spectroscopy
Measurement of radioisotopes and their applications in biological systems

Unit III (10h)
Centrifugation: Principle and types of centrifuges, ultracentrifugation, density gradient centrifugation and continous centrifugation
Chromatography: Principle and application of TLC, Gas chromatrograph, HPLC, FPLC.

Unit IV (10h)
Microbial culture techniques: Sterilization, culture media, types of cultures- batch and continuous, culture preservation
Tissue culture techniques: Media preparation, sterilization, *in vitro* regeneration

Unit V (20h)
Proteomics: Gel electrophoresis (native, SDS and 2-D), isoelectric focusing, MALDI-TOF, LC-MS, Gel documentation system
Genomics: Isolation of genomic and plasmid DNA, PCR, RT-PCR, Ribotyping, AFLP, RFLP, FISH, blotting techniques, sequencing, EST, Microarray
Bioinformatics: Basic concepts and applications

Suggested Readings:

1. Chromatography - Concepts & Contrasts, JM Miller (2005), John Wiley & Sons, New Jersey, USA.
2. Modern Practice of Gas Chromatography, RL Grab & EF Barry (2004), fourth edition, John Wiley & Sons, New Jersey, USA.
3. High Performance Liquid Chromatography- Fundamental Principles and Practices, WJ Ough & IW Wainer (1995), Blackie Academic & Professional, Glasgow, Scotland.
4. Gel Electrophoresis of Protein- A Practical Approach, BD Hames (2002), Oxford University Press Inc., New York, USA.
5. Principles and Techniques of Biochemistry and Molecular Biology, K Wilson & J Walker (2010), 7th edition, Cambridge University Press.
6. Applications of Infrared, Raman and Resonance Raman Spectroscopy in Biochemistry, FS Parker (1983), Plenum Press, New York, USA.
7. Centrifugal Seperation in Biotechnology, Woon-Fong Leung (2007), Elsevier.
8. Biotechnology: A Laboratory Course, JM Becker, GA Caldwell, EA Zachgo (1996), second edition, Academic Press, California.
9. Phytochemical Methods - A Guide to Modern Techniques of Plant Analysis, JB Harborne (1998), Chapman & Hall, London, UK.
10. Biochemical Methods, S Sadasivam & A Manickam (2005), New Age International Private Ltd, New Delhi.
11. Analytical Techniques for Atmospheric Measurements, D Heard (2006), Blackwell Publishing Ltd, UK.

12. Plant Proteomics- Technologies, Strategies and Application, GK Agrawal & R Rakwal (2008), John Wiley & Sons, New York, USA.

BOTD-02: Lab work based on BOTD-01
(**Credit- 01; contact hours -15h; maximum marks 50)**

BOTR-01: Plant Microbial Interaction & Soil Microbiology

(Credits- 03; contact hour- 45h; maximum marks – 100)

Unit I (10h)

Introduction to the key concepts, terms, and challenges; Major types of organisms found in soils Traditional and advance methods used to examine soil microbial diversity.

Unit II (8h)

Factors affecting microbial activities in soils; Role of microbes in the transformation of the soil carbon, nitrogen, sulfur and phosphorous cycles.

Unit III (10h)

Plant microbe interactions: Types of interactions, rhizosphere and rhizoplane, phylloshere and phylloplane, mycorrhizae; Impact of interactions on agricultural ecosystems, and nitrogen fixation

Unit IV (17h)

Processes such as - host detection, colonization, infection and maintenance of infection, virulence, nodulation, or systemic spread of a microbe in or on a plants; Molecular mechanisms of plant-microbe interactions, especially plants perception of microbial signals, signal transduction pathways and associated defense mechanisms; The tripartite interaction between pathogen, insect vector and host plant.

Suggested Readings:

1. Modern Soil Microbiology (2006), JD van Elsas, JK Jansson, JT Trevors (eds), Second Edition, CRC Press, USA
2. Soil Microbiology, Ecology and Biochemistry (2014), EA Paul, 4th Edition, Associate Press.
3. Principles of Plant-Microbe Interactions: Microbes for Sustainable Agriculture (2015), Ben Lugtenberg (ed.), Springer.

BOTR-02: Biodiversity & Conservation
(Credits- 03; contact hour- 45h; maximum marks – 100)

Unit I (15h)
Biodiversity: the concept and levels of biodiversity: Genetic, species, community and ecosystem
Magnitude and distribution: Diversity gradients and related hypotheses, methods for biodiversity monitoring, megadiversity zones and hot spots

Unit II (10h)
Biodiversity and ecosystem functions: Concepts and models
Biodiversity and ecosystem services: Provisioning, regulating, supporting and cultural

Unit III (10h)
Threats to biodiversity: Causes of biodiversity loss, species extinction, vulnerability of species to extinction, IUCN threat categories, Red data book

Unit IV (10h)
Strategies for biodiversity conservation: Principles of biodiversity conservation, *in-situ* and *ex-situ* conservation strategies; Biodiversity act of India, International convention on biodiversity.

Suggested Readings:

1. Global Biodiversity Assessment, VH Heywood & RT Watson (1995), UNEP, Cambridge University Press.
2. Handbook of Biodiversity Methods: Survey, Evaluation and Monitoring, D Hill, M Fasham & P Shaw (2005), Cambridge University Press.
3. Ecological Diversity and Its Measurement, AE Magurran (1988), Princeton University Press, Princeton, New Jersey.
4. Conservation Biology: Foundations, Concepts, Applications, Van Dyke Fred (2008), 2nd edition, McGraw Hill, New York, USA
5. Biodiversity and Conservation, Peter J. Bryant (2009), University of California, Irvine, USA

BOTR-03: Applied Cyanobacteriology
(Credits- 03; contact hour- 45h; maximum marks – 100)

Unit I (12h)
Commercial potential of cyanobacteria; Use of cyanobacteria for the treatment of wastewaters and for the production of useful biomass and energy; hydrogen production by cyanobacteria; immobilized and inactivated cyanobacterial biomass for metal and nutrient removal

Unit II (10h)
Mass cultivation of cyanoabcteria under outdoor and indoor conditions;
Paddy field cyanobacteria: Qualitative and quantitative assessment of their biodiversity using molecular tools, their use as biofertilizer, reclamation of Usar lands.

Unit III (8h)
Cyaobacteria as a source of fine chemicals, polysaccharides, bioactive molecules, pigments, antioxidants, lipids and polyunsaturated fatty acids.

Unit IV (15h)
A brief account of cyanobacterial genomics and proteomics;
Mode of gene transfer in cyanobacteria with special reference to conjugation, transformation, electroporation, spontaneous and induced mutagenesis, transposon mutagenesis, expression of foreign gene(s) in cyanobacteria and its consequences.

Suggested Readings:

1. The Biology of Cyanobacteria, NG Car & BA Whitton (1982), Blackwell.
2. Microalgal Biotechnology, MA Borowitzka & LJ Borowitzka (1988), Cambridge University Press, New York, USA
3. Algae and Cyanobacteria in Extreme Environment, J Seckbach (2007), Springer.
4. Protocols on Algal and Cyanobacterial Research, SN Bagchi, D Kleiner, P Mohanty, (2010), Narosa.
5. Algae and their Biotechnological Potential, Chen Feng & Y Jiang, (2001), Kluwer.
6. The Molecular Biology of Cyanobacteria, DA Bryant (1994), Kluwer Academic Publishers
7. The Ecology of Cyanobacteria. Their Diversity in Time and Space, BA Whitton & Malcolm Potts (2000). Kluwer Academic Publishers.
8. Cyanobacteria: An Economical Perspective, NK Sharma, AK Rai, LJ Stal (2013), Wiley & Sons, UK.

BOTR - 04: Phytochemistry & Herbal Biotechnology

(Credits- 03; contact hour- 45h; maximum marks – 100)

Unit I (15h)

Introduction to Phytochemistry; Fundamental and practical aspects of plant material handling; types of phytochemicals; Application of phytochemicals in industry and healthcare; Current scenarios (local, regional & global) of herbal & phytochemical products.

Unit II (10h)

Steps, solvents & equipments used for phytochemical analyses; Techniques used for extraction, seperation, purification and *in vitro* and *in vivo* analyses of phytochemicals; Herbal extract preparations and storage methods, product quality assessment.

Unit III (10h)

Methods of drug evaluation (morphological, microscopic, physical & chemical); Material balance on herbal & phytochemical processing.

Unit IV (10h)

Methods to identify adulterants in herbal medicines, drug adulteration - Types of adulterants; Chemical and molecular methods of analysis and detection of adulterants in herbal medicines (RAPD, SSR, SCAR and RFLP).

Suggested Readings:

1. Pharmacognosy, CK Kokate, AP Purohit, SB. Gokhale (1996), Nirali Prakashan, 4th Ed.
2. Natural Products in Medicine: A Biosynthetic approach (1997), Wiley, UK
3. Cultivation & Processing of MedicinalPlants, L Hornok (ed.) (1992), John Wiley & Sons, Chichister, UK.
4. Herbal Biotechnology & Pharmocognosy, V Kumaresan (2015), Saras Publication.

BOTR-05: Stress Biology
(Credits- 03; contact hour- 45h; maximum marks – 100)

Unit I (10h)
Stress- biotic and abiotic stress; Introduction to oxidative, osmotic, water, temperature, salinity stresses; Affect of stress on plant and its productivity; General adaptations.

Unit II (15h)
Stress physiology: Stress conception in plants; Plants response to drought, temperature and salinity; Pathways – Jasmonic acid, Salicylic acid, ABA dependent and independent.
Immunity; Innate and Aquired; Chemical and morphological defence in plants; Elicitors, Receptors; Basal resistance and innate biochemical host defenses; Basic ROS cycle and adaptation during stress.

Unit III (10h)
Plant Secondary metabolites – Classification and structural characterization; Outlines of major Biosynthetic pathways of secondary metabolites; Isolation – Methodology and functional characterization.

Unit IV (10h)
Basic principles of a crop improvement programme under stress; Development of transgenic plants- disease resistance, insect resistance, oxidative and osmotic stress tolerance; Manipulation of plant metabolism to enhance the nutritional quality of plants and crop yield.

Suggested Readings:

1. Plant Tissue Culture: Theory and Practice, SS Bhojwani, MK Razdan (1996), a revised edition, Elsevier Science Publishers, New York, USA.
2. Biotechnology: Fundamentals and Applications, SS Purohit (2000), Agrobios, New Delhi.
3. Plant Propagation by Tissue Culture, Volume 1, EF George, MA Hall, G-J De Klerk, (2008), The background (3rd ed.), Dordrecht: Springer.
4. Plant Physiology, L Taiz, E Zeiger (2010), fifth edition, Sinurer Associates

BOTR-06: Biomass Utilization for Production of Agriculturally Important Bioactive Compounds

(Credits- 03; contact hour- 45h; maximum marks – 100)

Unit I (10h)

Renewable and non-renewable sources of energy; Bioactive compounds and their role in sustainable agriculture; Role of plant growth promoting rhizobacteria in agriculture.

Unit II (10h)

Carbohydrate biomass and their utilization by microorganisms - Cellulose, chitin, chitosan and their global turnover, cellulose and chitin-degrading microorganisms and diversity.

Unit III (10h)

Hydrolytic enzymes and their role in polymeric chitin, chitosan and cellulose degradation; chitinases, chitosanases and their classification, cloning and heterologous expression of chitin-degrading genes, mechanism of catalysis, enzyme kinetics, auxiliary chitin and chitosan binding proteins.

Unit IV (15h)

Chitooligosaccharides (COS) - Preparation, structure and function, Detection and separation by TLC and HPLC; Mass spectrometric (MS) analysis of COS; Application of COS for crop protection; perception mechanisms of COS by plants – Elicitation, priming, chitin receptors, LysM domain containing proteins and signal transduction; Future prospective.

Suggested Readings:

1. Biochemistry and Molecular Biology of Plants, B Buchanan, W Gruissem, RL Jones (2004) Amer. Soc. Plant Physiol.
2. Plant Biochemistry and Molecular Biology, H Heldt (1997), Oxford Univ Press.
3. Lehningers Principles of Biochemistry, DL Nelson, MM Cox (2008), fifth edition, W. H. Freeman & Co, New York, USA
4. Benson J (1990) Microbiological applications (A laboratory manual in general microbiology). 5th Edition.
5. Berger and Reynolds (1988). *Methods in Enzymology* 161:140-142

BOTR07: Plant Pathology
(Credits- 03; contact hour- 45h; maximum marks – 100)

Unit I (10h)
Major epidemics and their social impacts; Growth, reproduction, survival and dispersal of plant pathogens; Factors influencing infection

Unit II **(15h)**
Properties of bacteria, viruses and fungi; Molecular mechanisms of pathogenesis and resistance; Bacterial genetics and variability; Conventional and biotechnological techniques used in detection and diagnosis; Innate and acquired immunity of plants.

Unit III (10h)
Role of environment and meteorological factors in the development of plant disease epidemics; Prediction and forecasting of diseases; Diseases due to unfavourable environment and nutritional deficiencies.

Unit IV **(10h)**
Genetic basis of disease resistance and pathogenicity; Concept of QTL mapping; Breeding for disease resistance, Integrated disease management; Plant growth promoting Rhizobacteria

Suggested Readings:

1. Plant Pathology, GN Agrios (2006), fifth Edn, Elsevier Academic Press.
2. Diseases of Crop Plants in India, Rangaswamy & Mahadevan.
3. Introductory Mycology, CJ Alexopoulos, CW Mims, M Blackwell (1996), JohnWiley & Sons.

……

BOTC-01: Review of literature, preparation of research proposal and presentation of a seminar required (**Credits – 02; maximum marks -50)**

The syllabi of following programs are hereby approved in a meeting of the Board of Studies for Botany, Department of Botany, IGNTU, Amarkantak (M.P.) on this date of August 16th, 2017, Wednesday.

1. Syllabi for MSc (Botany) & PhD (Botany) entrance examinations
2. Syllabi for PhD Course work
3. Syllabi for MSc (Botany)
3. Syllabi for BSc (Hon's) in Botany

Prof. S. P. Adhikary
(Member, External Expert)

Prof. R. P. Sinha
(Member, External Expert)

Prof. A.K. Shukla
(Member)

Dr. V.K. Mishra
(Member)

Dr. T.Srinivasan
(Member)

Dr. Prashant K. Singh
(Member)

Dr. Ravindra Shukla
(Member)

Prof. N. K. Sharma
(Chairman & Convener)