

**Department of Botany**  
**Entrance Examination Syllabus**  
**(For M.Sc. in Botany Course)**

Diversity of Plants: Algae, Fungi, Lichen, Bryophytes, Pteridophyta & Gymnosperms (their salient features, classification, habit/habitat, life cycle, reproduction and physiological significances).

Angiosperms: Botanical nomenclature, natural and phylogenetic systems of classification, systematics and taxonomy of dicot- and monocot families with their economic importance; morphology, anatomy and reproductive biology of flowering plants.

Microbiology: Bacteria (general account, composition, structure, nutrition, reproduction, genetic recombination and their significance); Viruses (features, multiplication, bacteriophages, prions etc.); Diseases caused by different groups of microorganisms, symptoms and etiology.

Plant Physiology: Plant water relations; Plant nutrients and their deficiency; Photosynthesis (Photophosphorylation and carbon assimilation); Cellular respiration (breakdown of sugar and electron transport chain); Plant growth and phytohormones.

Elementary Biochemistry: structure and functions of simple and complex carbohydrates, lipids, amino acids and proteins, enzymes.

Ultrastructure of cell organelles and their function, cell division, cell interactions, structure of plasma membrane and cell wall, transport across membrane.

Mendel Law's of inheritance, gene interaction, linkage and crossing over, structural and numerical changes in chromosomes.

DNA replication, transcription, translation and regulation of gene expression; DNA damage and repair; Gene cloning and recombinant DNA technology.

Plant tissue culture and transgenics; Basics of plant breeding.

Environment and natural resources: Biodiversity: its significance and conservation, environmental pollution and climate change, their consequences.

Instrumentation: spectroscopy, microscopy, chromatography, staining techniques; molecular techniques viz. electrophoresis etc.

Basics of biostatistics and bioinformatics

## Question Paper Pattern

There will be 100 Multiple Choice Questions (MCQs), of which, 25 questions will be from general science, aptitude, reasoning, computer applications etc. (1); the rest of (i.e., 75 questions) will be from the subject botany, from within the syllabus prescribed herewith.

Sl. No.	Typology of Questions	Weightage (%)
1	Knowledge Based	25
2	Conceptual Understanding	25
3	Application Based & Interferential Type	25
4	Reasoning Based	15
5	Skill Based	10
Total		100%

# **Entrance Examinations Syllabus**

## **For Doctor of Philosophy (PhD) in Botany**

### **PART- I: Research Methodologies** (20 Questions, common for all science subjects)

**An overview of research methodology:** Research concept, steps involved, identification, selection and formulation of research problem, justification, hypothesis; literature collection- textual and digital resources (internet)

**Research design, data collection and interpretation:** Research design; sampling techniques, collection and documentation, presentation, analysis and interpretation of data

**Scientific writing:** Forms of scientific writing- Article, notes, reports, review article, monographs, dissertations, popular science articles, bibliographies,

**Formulation of scientific communication:** Outline preparation, drafting title, sub titles, tables, illustrations; Formatting tables- title, body footnotes; figures & graphs- structure, title and legends, Impact factor, citation indices, plagiarism

**Computer application:** MS office, excel, power point, graphics (Sigma plot), statistical software (SPSS)

**Biostatistics:** Statistical Methods: Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance;  $\chi^2$  test; Basic introduction to Multivariate statistics, etc.

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### **PART – II** (Subject specific 80 questions)

#### **Molecules and Their Interactions**

Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins); Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.); Bioenergetics, glycolysis, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers; Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes; Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds); Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).

Stability of proteins and nucleic acids; Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins.

#### **Cellular Organization**

Membrane structure and function (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes); Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility); Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons); Cell division and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

#### **Fundamental Processes**

DNA replication, repair and recombination (unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair

mechanisms, homologous and site-specific recombination); RNA synthesis and processing (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport); Protein synthesis and processing (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post- translational modification of proteins); Control of gene expression at transcription and translation level (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

Cell communication and cell signaling: Host parasite interaction, recognition and entry processes of different pathogens like bacteria, viruses into plant host cells, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in animals and plants, cell-cell fusion in both normal and abnormal cells (a), Cell signaling Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two component systems, light signaling in plants, bacterial chemotaxis and quorum sensing (b) Cellular communication Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation (c).

### **Developmental Biology**

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development

### **Plant Physiology**

Photosynthesis - Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO<sub>2</sub> fixation-C<sub>3</sub>, C<sub>4</sub> and CAM pathways.

Respiration and photorespiration – Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

Nitrogen metabolism - Nitrate and ammonium assimilation; amino acid biosynthesis.

Plant hormones – Biosynthesis, storage, breakdown and transport; physiological effects and mechanisms of action.

Sensory photobiology - Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism and biological clocks.

Solute transport and photoassimilate translocation – uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photo-assimilates.

Secondary metabolites - Biosynthesis of terpenes, phenols and nitrogenous compounds and their roles. Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

### **Inheritance Biology**

Mendelian principles: Dominance, segregation, independent assortment.

Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests

Extensions of Mendelian Principles: Codominance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy, linkage and crossing over, sex linkage, sex limited and sex influenced characters.

Gene mapping methods: Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids, development of mapping population in plants.

Extra chromosomal inheritance: Inheritance of Mitochondrial and chloroplast genes, maternal inheritance. Microbial genetics: Methods of genetic transfers – transformation, conjugation, transduction and sexduction, mapping genes by interrupted mating, fine structure analysis of genes.

Quantitative genetics: Polygenic inheritance, heritability and its measurements, QTL mapping.

Mutation: Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal versus somatic mutants, insertional mutagenesis.

Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.

Recombination: Homologous and non-homologous recombination including transposition.

### **Plant Systematics**

Principles & methods of taxonomy: Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of plants, animals and microorganisms.

Comparative anatomy, adaptive radiation, adaptive modifications.

Outline classification of plants; Evolutionary relationships among taxa.

### **Ecological Principles**

Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.

Population Ecology: Characteristics of a population; population growth curves; population regulation; life history strategies (r and K selection); concept of metapopulation – demes and dispersal, interdemic extinctions, age structured populations.

Species Interactions: Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.

Community Ecology: Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.

Ecological Succession: Types; mechanisms; changes involved in succession; concept of climax.

Ecosystem Ecology: Ecosystem structure; ecosystem function; energy flow and mineral cycling (C, N, P); primary production and decomposition.

Biogeography: Major terrestrial biomes; theory of island biogeography; biogeographical zones of India. Applied Ecology: Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches. Conservation Biology: Principles of conservation, major approaches to management.

### **Techniques in Plant Science**

Molecular Biology and Recombinant DNA methods: Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial and plant vectors. Isolation of specific nucleic acid sequences Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. *In vitro* mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms. Protein sequencing methods,

detection of post translation modification of proteins. DNA sequencing methods, strategies for genome sequencing. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD and AFLP techniques Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, fluocytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ* localization by techniques such as FISH and GISH.

Biophysical Method: Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.

Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

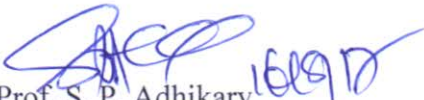
Microscopic techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and staining techniques for EM, freeze-etch and freeze-fracture methods for EM, image processing methods in microscopy.


Electrophysiological methods: Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT .

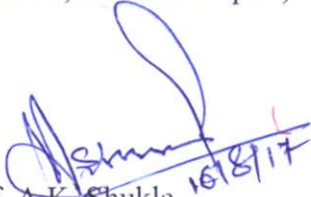
Methods in field biology: Methods of estimating population density of animals and plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization: ground and remote sensing methods.

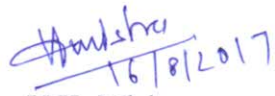
The syllabi of following programs are hereby approved in a meeting of the Board of Studies for Botany, Department of Botany, IGNTU, Amarkantak (M.P.) on this date of August 16<sup>th</sup>, 2017, Wednesday.

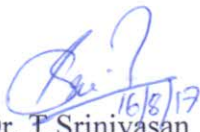
1. Syllabi for MSc (Botany) & PhD (Botany) entrance examinations
2. Syllabi for PhD Course work
3. Syllabi for MSc (Botany)
3. Syllabi for BSc (Hon's) in Botany


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

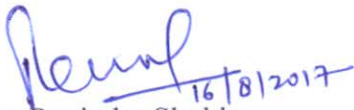
  
Prof. R. P. Sinha  
(Member, External Expert)

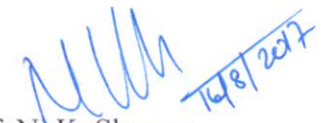
  
Prof. A.K. Shukla  
(Member)

  
Dr. V.K. Mishra  
(Member)

  
Dr. P. Srinivasan  
(Member)

  
Dr. Prashant K. Singh  
(Member)

  
Dr. Ravindra Shukla  
(Member)

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