



**St. Joseph's Research Institute**

**St. Joseph's University**

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## **Syllabus for Ph.D. Entrance Exam**

### **Botany**

#### **Unit I: Diversity of Bacteria, Viruses and Mycoplasma,**

Bacteria: Distribution in soil, air and water, Diversity in structure, organization and reproduction. Role of bacteria in organic matter decomposition, production of methane and xenobiotics.

Viruses - General characteristics, nomenclature and classification, structure, transmission and replication, viroid and prions

Mycoplasma: General characteristics, ultrastructure and reproduction.

#### **Unit II: Fungi and Plant Pathology**

Fungi: Distribution, Structure and reproduction. Fungi as saprophytes, parasites, predators, symbionts, biopesticides, biofertilizer, pollution indicators and Food.

Plant Pathology: Plant diseases caused by viruses, phytoplasma, bacteria, fungi and nematodes. Causal organism, symptoms and management of powdery mildew of cucurbits, loose smut of wheat, Tikka disease of groundnut. Red rot of sugarcane, Bacterial blight of rice, Citrus-canker, Tobacco mosaic virus, and sandal spike,

#### **Unit III: Plant Systematics I: Diversity of Algae and Bryophytes**

Algae: Thallus organization, cell structure and reproduction in Cyanophyceae, Chlorophyceae, Phaeophyceae, Rhodophyceae, Bacillariophyceae and Economic importance.

Bryophytes: Morphology and reproduction - Marchantiales, Anthocerotales, Polytrichales and Economic importance.

#### **Unit IV: Plant Systematics II: Diversity of Pteridophytes and Gymnosperms:**

Pteridophytes: Morphology and reproduction of Psilotales, Lycopodiales, Selaginellales, Equisetales, and Marseliales. Stellar Evolution, Heterospory and Seed habit

Gymnosperms: General characters of Gymnosperms. Classification (Sporne 1974, Bhatnagar and Moitra 1996). Recent advances in the study of Gymnosperms. Gymnosperms of India: distribution and conservation status.

## **Unit V: Plant systematics III: Taxonomy of Angiosperms**

Taxonomy and systematic: their aims and phases.

Characters: analytic and synthetic; qualitative and quantitative; primitive and advanced, homologous and analogous; homoplasy; monophyly, polyphyly and paraphyly. Charactercoding. Construction of cladograms; polarity and rooting. Principle of parsimony, Phenetic methods: Similarity matrix, cluster analysis.

Concepts of species and hierarchical taxa, botanical nomenclature (ICN) - History of ICBN/ICN - typification, priority, publication, author citation, homonym, synonym, tautonym, autonym, basionym. Evolutionary relationships among taxa.

Classification systems prior to Darwin: Systems based on habit, sexual systems, systems based on form relationships. Post-Darwinian systems: Systems based on Ranales school, systems based on Englemann school. Phenetic and phylogenetic systems of classification. Vegetation types of India. Methods of vegetation analysis. Palynology; Mellittopalynology; Geopaleopalynology; Aeropalynology; Pollen allergy.

## **Unit VI: Ecology and Environmental Biology**

Ecological Principles

The Environment: Physical environment; biotic environment; biotic and abiotic interactions.

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, interdemec 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; structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, estuarine).

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, Indian case studies on conservation/management strategy (Biosphere reserves, Wildlife Sanctuaries). Rare, endangered species. Conservation strategies.

Bioremediation and Phytoremediation

## Unit VII: Plant Physiology and Phytochemistry

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 photoassimilates.

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.

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.

Nitrogen metabolism – Biological nitrogen fixation, 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.

Secondary metabolites - Biosynthesis of alkaloids, flavonoids, phenols, terpenes and nitrogenous compounds and their roles.

Stress physiology – Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses.

## Unit VIII: Fundamental processes and Inheritance Biology

Prokaryotic and Eukaryotic cell structure, Cell cycle and its regulation

DNA replication, repair and recombination in prokaryotes; RNA synthesis and processing in prokaryotes; Protein synthesis and processing in prokaryotes

Control of gene expression at transcription and translation level, (regulating the expression of prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).

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 determination in *Melandrium*

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.

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

Population genetics – Populations, Gene pool, Gene frequency; Hardy-Weinberg Law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; Adaptive radiation; Isolating mechanisms; Speciation; Allopatricity and Sympatricity; Convergent evolution; Sexual selection; Co-evolution.

## **Unit IX: Methods in Biology**

Molecular Biology and Recombinant DNA methods: Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels. Molecular cloning, Expression of recombinant proteins using bacterial and plant vectors. Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. Protein sequencing methods, DNA sequencing methods

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; X<sup>2</sup> test

Radiolabeling techniques: Detection and measurement of different types of radioisotopes normally used in biology, safety guidelines.

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

Spectroscopic techniques: UV- visible spectrophotometry, FT-IR,

