# Joint Syllabus for RET and MPhil entrance test, Botany

**Taxonomy of Angiosperms**

1. Methods of nomenclature. Sources of Names
2. International Code of Nomenclature - Basic Principles. Major Rules:
   (a) Type concept; (b) Principle of priority; (c) Valid & effective publication; (d) Starting points of Nomenclature, and (e) Limitations to the principle of priority
3. Character Concept - a generalized idea
4. Taxonomic Data Sources: (a) Anatomy, (b) Cytology, (c) Embryology, (d) Palynology, (e) Phytochemistry, (f) Genome Analysis, (g) Nucleic acid hybridization
5. The Species Concept; origin of closed carpel
6. Taxonomic Tools: Herbaria, Floras, Serological & Molecular Techniques, Computer and Geographic Information System (GIS)
7. Botanic Gardens – importance, acronyms. Processing of herbarium specimens
8. Plant classification - its need, philosophy and brief history
9. Taxonomic hierarchy
10. Phenetic versus phylogenetic systems, cladistics; Current systems of Classifications
11. Taxonomic literature and artificial keys
12. Characterization and phylogeny of: Basal angiosperms and Magnoliids; Basal monocots; Petaloid monocots; Commelinids; Basal eudicots and Caryophyllids; Rosids; Asterids
13. Biodiversity - importance and preservation; Conservation Hotspots, IUCN guide lines; invasions & introductions, endemism
14. Flora and vegetation of Eastern Himalaya
15. Forest Resources of North Bengal
16. Ethnobotany: concept, need, methods of survey; sacred groves

**Microbiology**

1. Diversity: Classification and survey of microorganisms; Microbial phylogeny as revealed by rRNA sequencing
2. Morphology and anatomy of cells: Morphology; Cell surfaces (glycocalyx, cell wall, flagella, and pili) and their role; Plasma membrane (bacterial and archaeal); Prokaryotic chromosome: Ribosome; Endospores
3. Metabolism: Photosynthesis (anoxygenic and oxygenic); Chemosynthesis; Fermentation (alcoholic, Entner-Doudoroff pathway; lactic acid – homo and hetero, propionic acid, mixed acid, butanediol and butanol; Stickland reaction); Respiration (anaerobic and aerobic)
4. Growth: Measurements of growth; Growth cycle of populations; Generation time; Continuous culture; Synchronized growth; Diauxy; Environmental factors influencing growth
5. Nutrition: Organic growth factors; Inorganic requirements; Physical and ionic requirements
6. Genetics: Replication of prokaryotic chromosomes; Molecular basis of mutation; Isolation of mutants; Gene transfer mechanisms (transformation, transduction, and conjugation); Lactose and tryptophan operons
7. Taxonomy: Nomenclature; Species concept; Criteria for classification
8. Virology: Morphological classes of viruses; Structure of Adenovirus, Tobacco mosaic virus, and coliphage $T_4$; Principles of viral taxonomy; Assay of viruses; Lytic cycle; Lysogeny

**9.** Food and industrial microbiology: Commercial production of fermented dairy products (curd and cheese), fermented beverages (beer and wine), fermented vegetables (sauerkraut), pharmaceuticals (penicillin and cyanocobalamin), and enzymes (amylase and protease)

**10.** Biological nitrogen fixation: Biology and biochemistry; Enzymology of nitrogenase; Rhizobial association with plant roots and root nodulation; Commercial production of rhizobia

**Mycology and Plant Pathology**

1. Economic importance of Fungi (General account), Fungi as pathogen and biocontrol agents (general account), Human diseases of Fungi.
2. Ulrastructure of fungal cell; Cell wall composition and biogenesis.
3. Protoplast isolation, fusion, regeneration and reversion.
4. Translocation in mycelia.
5. Somatic recombination in fungi.
6. Molecular genetic analysis of fungi. Extra chromosomal and transposable genetic elements in fungi.
7. Cell cycle control points in yeast.
8. Protein secretion in yeast: Secretion pathway; directed secretion; morphology of secretary pathway; processing, modification and folding of secretary proteins.
9. Fungi in industry & medicine: Antibiotics- Penicillin; Organic acids – Citric acid; Plant growth regulator- Gibberellin, alcohol and Fungal enzymes (general account)
10. Fungal toxins: Host non selective toxins- cercosporin (Mode of action); Host specific toxins- structure, mode of action and concept of $V_b$ gene
11. Mycotoxins- aflatoxin biosynthetic pathway with enzymatic and genetic informations.
12. Penetration, infection, invasion of host tissue, relationship between pathogen and host factor(s), structural and biochemical defense mechanism in plant
13. Mycorrhizae: interaction; Specific recognition in mycorrhizal association; Application as biofertilizer and bioprotector in forestry and agriculture
14. Structural and chemical decay of wood by decaying microorganisms
15. Details studies of fungal diseases: Damping off, powdery mildew, downy mildew, smut, bunt, rust, wilt, root rot, leaf spots, leaf blight and gall of economically important crops
16. Bacterial diseases: bacterial leaf blight of rice, bacterial wilt of potato, bacterial canker of tomato, crown gall of rose
17. Nematode disease: General features; Mechanism of nematode injury to plants; Factors affecting survival and parasitism of nematodes; Molecular approach in the management of virulence genes in potato cyst nematodes
18. Virus disease: Symptoms, carrier, transmission, interaction of virus and host; role of nucleic acid in virus infection; establishment and development of virus infection; control strategies
19. Plant disease control: chemical control and biological control of phytopathogens, insect pest and weeds. Application of avirulence genes in control of plant pathogens

**Plant Biochemistry**

1. Carbohydrates : Structure and function; Plant storage carbohydrates; Cell wall- structure & function; Glycoproteins & proteoglycans
2. Lipids and membranes : Structure and function; types and function of membrane lipids
3. Proteins : Amino acid components and structural features; Primary, secondary, tertiary, quarternary and supra-molecular structures; Non-covalent interactions in relation to structural

conformation; Ramachandran plots; Amino acid sequencing and purification strategies

4. Nucleic acids: Composition, three dimensional structures; $T_m$ values and CoT curves
5. Enzymology : General catalytic properties; Enzyme kinetics- Michaelis–Menton and Lineweaver Burke plots; Negative and Positive co-operativity; Regulation of enzymes; Allosteric enzymes; Isozymes; Role of coenzymes and cofactors
6. Membrane Transport : Membrane transport proteins; Primary and secondary active transport; Kinetic analysis of transport mechanisms; Membrane $H^+$ and $Na^+$-$K^+$ ATPase
7. Photochemistry and photosynthesis: General concepts; photosynthetic pigments and light harvesting complexes; photo-oxidation of water; mechanisms of electron and proton transport; Benson-Calvin cycle; $CO_2$ concentrating mechanisms
8. Respiration : Overview of plant respiration; Glycolysis; TCA cycle, Electron Transport systems and ATP synthesis; Alternative oxidase system
9. Lipid metabolism: Fatty acid biosynthesis and breakdown; Synthesis of storage and membrane lipids
10. Protein synthesis: Transcription, translation and post-translational modifications; protein degradation
11. Amino acid biosynthesis: $\alpha$ Ketoglutarate and Oxaloacetate families
12. Nucleic acid biosynthesis : Synthesis of nucleotides; DNA replication

**Cytology and Genetics**

1. Mendel's principles of inheritance and extension of Mendel's law, chromosome theory of heredity; evolving concept of gene; linkage, crossing over and recombination at the molecular level, chromosome mapping; molecular basis of chromosome pairing in mitosis-meiosis; cytological variation-an overview.
2. Structure of DNA and chromosome, DNA polymerases-DNA synthesis, unique aspects of eukaryotic chromosome replication; gene expression and chromosome organization; Dosage compensation and genetic imprinting, PTGS, RNA interference.
3. Alien gene transfer and evolution of major crop plants, basic techniques to identify, amplify and clone genes, methods of transgenic plant development; Bt-crop controversy and biosafety.

4. Genetics and plant breeding- introduction, objectives, tools and methods of plant breeding, cytogenetic basis of plant breeding, germplasm resources and conservation, breeding rice; biotechnology and molecular plant breeding.
5. Population genetics - introduction, genetic analysis of complex traits, prediction-broad sense and narrow sense heritability, QTL analysis; Hardy-Weinberg principle, natural selection, Darwin's theory of evolution, molecular phylogenies, rates of molecular evolution and modes of speciation.
6. Nuclear DNA content and its organization; recombinant DNA and PCR; DNA fingerprinting; restriction maps, physical maps using molecular markers; isolation, sequencing and synthesis of genes; multi gene families in eukaryotes.
7. Mutation at morphological, biochemical and molecular level; nucleic acid and their structure; synthesis, modification and repair of DNA; repetitive and unique DNA sequences; split genes, overlapping genes and pseudo-genes.
8. Transcription in prokaryotes and eukaryotes; RNA processing; translation in prokaryotes and eukaryotes; Operon circuits; Lac operon-Tryptophan operon, attenuation and antitermination, Circuits of lytic cycle and lysogeny; the genetic code and its evolution; codon-tRNA interaction, protein synthesis and evolution of protein synthesis.
9. Plasmids, IS elements; transposons and retro-elements, Sex-linked, sex-limited and sex-influenced traits, sex determination, sex differentiation; maternal effects and cytoplasmic inheritance

10. Regulation of eukaryotic gene regulation- an overview, ways of regulation of gene expression, post-transcriptional regulation of gene expression.

**Plant Physiology and Pharmacognosy**

1. Transport and translocation of water and solutes Properties and movement of water molecules; Water balance of the plant; Water transport through xylem; Mechanism of loading and unloading of photo-assimilates and translocation in the phloem; Assimilate allocation and partitioning
2. Sensory Photobiology: Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; Photophysiology of light induced responses; Stomatal movement; photoperiodism and biological clocks; Molecular mechanism of actions of photomorphogenic receptors, signaling and gene expression.

3. Plant growth regulators and elicitors: Physiological effects, mechanism of action and signal transduction of auxins, gibberellins, cytokinins, ethylene and abscisic acid; Biological action of Brassinosteroids and peptide hormones
4. Physiology of plant development and flowering: Embryogenesis - apical-basal & radial patterning; Developmental control of root and shoot apical meristem; leaf development and ; Endogenous clock and its regulation; Concept of Florigen; Genetic and molecular analysis of floral induction and development.
5. Pharmacognosy: Ethnic and modern concepts; Interdisciplinary spectrum of Pharmacognosy; Herbalism and Phytotherapy; Drugs and technical products; Pharmacopeias; Preparation of herbal drugs for commercial market.
6. Ethnomedicine: Concept, history and its scope; Interdisciplinary approaches in ethnobotany; Collection of ethnic information; Traditional knowledge and utility of some medicinal plants of North Bengal
7. Quality control of drugs: Drug Evaluation – Organoleptic, Microscopic, Biological, Chemical and Physical; Guidelines for the assessment of herbal medicines; Drug adulteration

8. Methods of plant analysis: Extraction and purification of natural products; Chromatographic study of drugs; Spectroscopic techniques; Methods of identification analysis of results; Applications of phytochemical analysis
9. Secondary metabolites: Characteristic features of secondary metabolites of plant origin; Basic metabolic pathways and origin of secondary metabolites; Basic classification and biological significance of terpenes, phenolics and nitrogen-containing compounds
10. Chemistry and pharmacology of herbal drugs: Classification of active plant constituents with source and phytotherapeutic properties; Routes of drug administration; Absorption, metabolism and fate of drugs; Mechanism of drug action and tolerance

**Phycology**

1. General overview: Definition, basic characteristics of algae- Thallus structure, cytomorphology and ultrastructure of cells, nutrition, reproduction, modern system of classification, gene sequencing and algal systematic.
2. Evolution of the chloroplast in algae, endosymbiosis and origin of eukaryotic photosynthesis; Algae and environment; photosynthesis in algae.
3. Prokaryotic algae- Cyanobacteria, prochlorophyta- morphology, cell structure, pigment and chloroplast, reproduction, ecology, utilization in agriculture/food/industry.
4. Characteristictics of Chlorophyceae/ Bacillariophyceae /Phaeophyceae/ Rhodophyceae/Pyrnesiophyceae/ Xanthophyceae/ Chrysophyceae/ Dinophyceae /Glaucophyta.
5. Biogeochemical role of algae, algal culturing-culture type, media. Algal utilization **Bryology**

1. Salient features and alternative pathways in life cycles of bryophytes
2. Spore germination in liverworts and mosses
3. Phylogeny and evolution of Bryophytes
4. Bryophytes as indicators of pollution
5. Useful chemical constituents
6. Fossil bryophytes as indicators of past environment and past plant communities

**Pteridology**

1. Introduction; Outline of classification and systematic treatment of Pteridophytes
2. Early land plants; Basic terrestrial adaptations; Vegetative and reproductive organography
3. Evolutionary significance of the members of Rhyniopsida. Zosterophyllopsida, Trimerophytopsida, Psilopsida, Lycopsida (Drepanophycales, Protolepidodendrales, Lycopodiales and Lepidodendrales) and Sphenopsida (Hyeniales, Sphenophyllales and Equisetales).
4. Biochemical aspects of gametophyte differentiation; antheridogens- chemical nature and mode of action; Phytochemistry of pteridophytes.
5. Stelar concept, types and evolution in Pteridophyta
6. Telome theory and origin of megaphyll, evolution of reproductive structures
7. Systematic treatments; evolutionary tendencies and affinities of major taxonomic groups of Filicophyta ; Eusporangiate and leptosporangiate ferns; Soral evolution in ferns
8. Heterospory and evolution of seed habit

Gymnology

1. Classification and salient features of major taxa
2. Origin and evolution of gymnosperms
3. Distribution through different era
4. Distribution in India: Fossil and living

Palaeobotany

1. Processes of fossilization
2. Reconstruction
3. Dating of fossils
4. Form taxa
5. Palaeoecology

**Ecology**

1. Origin of life (including aspects of prebiotic environment and molecular evolution), Concepts of evolution, Theories of organic evolution, Mechanisms of speciation and extinctions; Hardy-weinberg genetic equilibrium, genetic polymorphism and selection; Origin and evolution of economically important microbes, plants and animals.
2. Concepts and dynamics of ecosystem, components, food chain and energy flow, productivity and biogeochemical cycles; Types of ecosystem: Grassland and Savannas, Shrubland and Deserts, Tundra and, Taiga. Temperate forests, Tropical forests, Lakes and Ponds, Freshwater wetlands, Streams and Rivers, Oceans, Estuarine and Mangrove.
3. Population ecology (Basic characteristics with examples, life table, survivorshipcurves, growth curves) and biological control; Community structure and organization; Environmental pollution; Sustainable development; Economic importance of microbes, plants and animals.
4. Interactions between environment and biota; Concept of habitat and ecological niches; Limiting factor; Energy flow, food chain, food web and trophic levels; Ecological pyramids and recycling,

biotic community-concept, structure, dominance, fluctuation, succession, N, P, C and S cycles in nature.

5. Ecosystem dynamics and management; Stability and complexity of ecosystems; Environmental impact assessment, Principles of conservation; conservation strategies; cryopreservation, Sustainable development. Ethical issues related to new-crops and introduction of transgenics. Climate change.

**Biostatistics and Bioinformatics**

1. Sampling and sample designs: Classification and tabulation of data; Diagrammatic and graphic presentation
2. Measures of dispersion: Variance, Mean Deviation, Standard Deviation
3. Correlation and regression analysis
4. Binomial and poisson distribution
5. Tests of hypothesis
6. Analysis of variance (Anova)- Bivariate & multivariate
7. Bioinformatics and its application in biological research.
8. Biological databases – Primary, Secondary databases; Structural database- SCOP, CATH, PDB; Resources- NCBI, ExPASY,EBI.
9. Substitution Matrix – PAM, BLOSUM, PSSM.
10. Algorithm behind searching tools: BLAST, PSI-BLAST, PHI-BLAST, Hidden Markov Model.
11. Dynamic programming algorithm and its use in sequence alignment. Multiple and Pairwise alignment. Basic ideas on multiple sequence alignment editors – Clustal W, Bioedit.
12. Phylogeny: Rooted, Unrooted tree. Tree generation methods – UPGMA, NJ, Maximum parsimony. Bootstrapping and its importance.
13. Homology modeling, Molecular dynamics, Monte Carlo simulation.

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2. Evolution of the chloroplast in algae, endosymbiosis and origin of eukaryotic photosynthesis; Algae and environment; photosynthesis in algae.
3. Prokaryotic algae- Cyanobacteria, prochlorophyta- morphology, cell structure, pigment and chloroplast, reproduction, ecology, utilization in agriculture/food/industry.
4. Characteristictics of Chlorophyceae/ Bacillariophyceae /Phaeophyceae/ Rhodophyceae/Pyrnesiophyceae/ Xanthophyceae/ Chrysophyceae/ Dinophyceae /Glaucophyta.
5. Biogeochemical role of algae, algal culturing-culture type, media. Algal utilization **Bryology**

1. Salient features and alternative pathways in life cycles of bryophytes
2. Spore germination in liverworts and mosses
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4. Bryophytes as indicators of pollution
5. Useful chemical constituents
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5. Stelar concept, types and evolution in Pteridophyta
6. Telome theory and origin of megaphyll, evolution of reproductive structures
7. Systematic treatments; evolutionary tendencies and affinities of major taxonomic groups of Filicophyta ; Eusporangiate and leptosporangiate ferns; Soral evolution in ferns
8. Heterospory and evolution of seed habit

Gymnology

1. Classification and salient features of major taxa
2. Origin and evolution of gymnosperms
3. Distribution through different era
4. Distribution in India: Fossil and living

Palaeobotany

1. Processes of fossilization
2. Reconstruction
3. Dating of fossils
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**Ecology**

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3. Population ecology (Basic characteristics with examples, life table, survivorshipcurves, growth curves) and biological control; Community structure and organization; Environmental pollution; Sustainable development; Economic importance of microbes, plants and animals.
4. Interactions between environment and biota; Concept of habitat and ecological niches; Limiting factor; Energy flow, food chain, food web and trophic levels; Ecological pyramids and recycling,

biotic community-concept, structure, dominance, fluctuation, succession, N, P, C and S cycles in nature.

5. Ecosystem dynamics and management; Stability and complexity of ecosystems; Environmental impact assessment, Principles of conservation; conservation strategies; cryopreservation, Sustainable development. Ethical issues related to new-crops and introduction of transgenics. Climate change.

**Biostatistics and Bioinformatics**

1. Sampling and sample designs: Classification and tabulation of data; Diagrammatic and graphic presentation
2. Measures of dispersion: Variance, Mean Deviation, Standard Deviation
3. Correlation and regression analysis
4. Binomial and poisson distribution
5. Tests of hypothesis
6. Analysis of variance (Anova)- Bivariate & multivariate
7. Bioinformatics and its application in biological research.
8. Biological databases – Primary, Secondary databases; Structural database- SCOP, CATH, PDB; Resources- NCBI, ExPASY,EBI.
9. Substitution Matrix – PAM, BLOSUM, PSSM.
10. Algorithm behind searching tools: BLAST, PSI-BLAST, PHI-BLAST, Hidden Markov Model.
11. Dynamic programming algorithm and its use in sequence alignment. Multiple and Pairwise alignment. Basic ideas on multiple sequence alignment editors – Clustal W, Bioedit.
12. Phylogeny: Rooted, Unrooted tree. Tree generation methods – UPGMA, NJ, Maximum parsimony. Bootstrapping and its importance.
13. Homology modeling, Molecular dynamics, Monte Carlo simulation.