Department of Botany
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Syllabus & Sample Question Paper for Entrance Test for Admission to Ph. D in Botany – 2021

1. **Bryophytes - diversity in structure and reproduction**

a. General characters of bryophytes, criteria used for classification, classification as given by Proskauer (1957), alternation of generation in the life history of bryophytes, bryophytes as amphibians of plant kingdom.

b. Hepaticopsida: distinguishing features, morphology and anatomy of sporophyte and gametophyte, vegetative and sexual reproduction in Marchantiales (*Riccia, Marchantia*) and Jungermanniales (*Pellia, Porella*).

c. Anthocerotopsida: distinguishing features, morphology and anatomy of sporophyte and gametophyte, vegetative and sexual reproduction in *Anthoceros, Notothylus*

d. Bryopsida: distinguishing features, morphology and anatomy of sporophyte and gametophyte, vegetative and sexual reproduction in *Funaria, Polytrichum*

2. **Fossils of bryophytes, pteridophytes and geological time scale.**

a. Geological time scale: concepts of epoch, era, period; origin of important plant groups during different periods in geological history.

b. Fossils- types, causes of fossil formation, methods to study fossils and reorganization of fossil genera.

c. Fossil bryophytes: *Naiadita lanceolate, Sporogonites exuberans, Hepaticites kidstonii.*

d. Fossil pteridophytes: *Rhynia, Calamites, Sphenophyllum. Lepidodendron.*

3. **Cell organelles - structure and function**

a. Mitochondria: Structure and functions, genome organization, protein import and mitochondrial assembly (protein targeting to the mitochondrial inner membrane, outer membrane and intermembrane space)

b. Chloroplast: Structure and functions; genome organization, import and sorting of chloroplast proteins. Peroxisomes: structure, functions of peroxisomes, peroxisome assembly and import of peroxisomal proteins.

c. Endoplasmic Reticulum: Structure, types, targeting to ER (Cotranslational and Posttranslational translocation of proteins into the ER), protein folding and processing in the ER, protein misfolding and unfolded protein response, protein export from ER.

d. Golgi complex: organization of Golgi, protein glycosylation within Golgi, mannose phosphoralation, protein sorting and export from the Golgi apparatus, mechanism of vesicular transport and vesicle fusion.

4. **Cell Signaling**

a. Basic elements of cell signaling system, signaling molecules (extracellular and intracellular-secondary messenger), receptors (intracellular and cell surface), specific example of plant receptors.

b. Signaling via G-protein-coupled receptors; G-proteins, cyclic AMP and protein kinase A, protein kinases and phosphatases, calcium as an intracellular messenger, calciumcalmodulin complex, inositol phospholipid.

c. Signaling via enzyme-coupled receptors: receptor tyrosine kinases, tyrosine kinases associated receptors, serine/threonine kinases receptor

d. Nitric oxide as an intracellular messenger, bacterial and plant two-component signaling systems, light signaling in plants, chemotaxis, quorum sensing, scatchard plot.

5. DNA - structure, replication, damage and repair

a. DNA structure and types, DNA as genetic material, Denaturation and renaturation of DNA, Concept of melting temperature (Tm).

b. Mechanism of DNA replication, Rolling-Circle Replication, Semi-conservative replication of double stranded DNA.

c. Chromatin structure, Nucleosome organization, Chromosome structure - centromere and telomere.

d. Molecular basis of gene mutation, Gain and Loss of function mutation and their consequences, DNA damage, Repair of DNA; Photo-reactivation, Base excision, Nucleotide excision and Mismatch repair.

6. Translation and post-translational modifications

a. Genetic code: Concept, degeneracy, wobble hypothesis.

b. Translation: Mechanism of protein synthesis in prokaryotes and eukaryotes, inhibitors of translation.

c. Post-translational modifications, ubiquitin mediated protein degradation (ubiquitinproteasome pathway).

d. Analysis of gene expression: Restriction fragment length polymorphism, DNA fingerprinting, DNA Microarray.

7. Plant taxonomy: bases and historical background

a. Classification, taxonomy, systematics; historical background of angiosperm classification (concept of artificial, natural and phylogenetic approaches to classification).

b. Importance of and need for taxonomy: importance of taxonomy in biology; relevance of taxonomy to society; need for taxonomy in unraveling biodiversity.

c. Bentham & Hooker's and Engler & Prantl's systems of classification (outline and merits & demerits)

d. Takhtajan's system of classification (outline and merits & demerits); Angiosperm Phylogeny Group (APG) (outline of APG classification).

8. Photochemistry and photosynthesis

a. Photosynthesis: concept, historical background, photosynthetic pigments (types and role), photosystems (concept, constitution and role).

b. Electron transport system; mechanism of electron transport pathways (cyclic and noncyclic electron transport).

c. Carbon assimilation pathways: Calvin cycle (C3 pathway), C4 pathway ; relative efficiency of C3 and C4 plants.

d. Crassulacean acid metabolism (CAM) pathway; photorespiration and its significance.

9. Plant nitrogen and sulfur metabolism

a. Enzymes: concept, definition, properties and classification; kinetics of single-substrate enzyme catalyzed reactions- Michaelis-Menton equation and its significance.

b. Sulfur uptake, reduction of sulfate, significance of ATP sulfurylase, Amino acid biosynthesis

c. Nitrogen metabolism: nitrogen in environment; mechanism of nitrate uptake and assimilation; ammonium assimilation; need for nitrogen in metabolism.

d. Biological nitrogen fixation; nodule formation and nod factors, importance of nitrogen fixation, nitrogen fixing plants.

10. Genetic engineering techniques

a. Polymerase Chain Reaction: Principle, Types –Multiplex, Hot-start, Nested, Touch down, RT, qRT; Applications and importance.

b. Cloning: TA cloning, Restriction enzyme dependent and independent cloning, linkers and adapters and homopolymer tailing.
c. Site-directed mutagenesis, construction and screening of genomic and cDNA libraries.
d. DNA sequencing - chemical degradation, enzymatic methods and next generation sequencing.

11. Population and Community ecology

a. Characteristics of populations: density, natality, mortality, survivorship curves, dispersion, age structure and pyramids, dispersal, life tables: age-specific mortality and survival. Population growth curves: exponential growth and logistic growth curve, population regulation: density dependent and density independent factors
b. Community structure and characteristics, species richness and evenness, levels of diversity, species area curve, disturbance and species diversity, guilds, plant communities; life forms, stratification and phenology, ecotones, edges, keystone species and community control, Nagoya protocol.
c. Ecological niche: concept of habitat and niche, niche width and overlap, fundamental and realized niche, ecological compression, competitive exclusion principle, coexistence, resource portioning and character displacement.
d. Ecological successions: types, mechanism of succession, changes involved in succession, concept of climax communities, models of succession.

12. Chromosome organization

a. Structure of eukaryotic chromosome; nucleosome model; banding patterns for identification of chromosomes (Q, C, N, G and R bands).
b. Morphology of chromosomes: centromeres, secondary constriction; knob; telomeres; satellite and nucleolar organizer region (NOR).
c. Specialized chromosomes: Structure, occurrence and behaviour of B and Sex chromosomes, Polytene and lampbrush chromosomes.
d. Karyotype symmetry; chromosome numbers; symbols & terminology; Karyotype evolution, euchromatin and heterochromatin. Organization of Chloroplast and Mitochondrial genome.

13. Fungi

a. Recent trends and criteria used in the classification of fungi with reference to vegetative and reproductive structures.
b. Structure, Reproduction and Life cycle of Gymnomycota (Cellular slime moulds (Dictyostelium), Plasmodial slime moulds (myxomycetes); Mastigomycota- (Coelomomyces, Plasmodiophora).
c. Structure, Reproduction and Life cycle of Amastigomycota and Zygomycotina – (*Mucor*, *Synephalastrum*, *Blakeslea*).
d. Structure, Reproduction and Life cycle of Ascomycotina (*Morchella*, *Neurospora*, *Claviceps*); Basidiomycotina (*Puccinia*, *Melampsora*) and Deutromycotina (*Fusarium* and *Curvularia*).

14. Nutrition, reproduction and utility of bacteria

a. Nutrition and Nutritional types of bacteria; nutritional mutants and their importance.
b. Modes of bacterial reproduction: asexual and sexual - conjugation, transformation and transduction.
c. Host-pathogen interaction, ecological impacts of microbes; symbiosis (Nitrogen fixation).
d. Utility of bacteria: Bioremediation, energy production, waste processing; importance of cyanobacteria.

15. Recombinant DNA technology

a. Overview of recombinant DNA technology. Restriction and modification systems, restriction endonucleases and other modifying enzymes used in manipulating DNA molecules.

b. Separation of DNA by gel electrophoresis. Extraction and purification of plasmid DNA.
c. Plasmids, cosmids, binary, shuttle and bacteriophages as vectors for gene cloning. Cloning vectors based on *E. coli*, plasmids, pBR322, pUC8, pGEM3Z.
d. Joining of DNA fragments: DNA ligases, ligation of DNA molecules. sticky ends, blunt ends, linkers and adapters.

16. Plant anatomy

a. Organization of Shoot Apical Meristem (SAM) and Root Apical Meristem (RAM); Development of leaf from shoot apical meristem
b. Primary vascular tissues: structure and components of xylem and phloem; cambium structure, development and types role in wound healing.
c. Cork: structure, ontogeny, function and commercial importance of cork. Anomalous secondary growth; secondary growth in monocots and dicots.
d. Salient features of the following woods. a) *Tectona grandis* b) Shorea *robusta* c) *Cedrus deodara* d) and *Tectona grandis*

17. Research methodology

a. 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.
b. Biophysical methods: Analysis of biomolecules using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, structure determination using X-ray diffraction and NMR; analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods.
c. Methods in field biology: Methods of estimating population density of plants, ranging patterns through direct, indirect and remote observations, sampling methods in the study of behavior, habitat characterization-ground and remote sensing methods, plant sampling and Herbarium techniques.
d. Computational methods: Nucleic acid and protein sequence databases; data mining methods for sequence analysis, web-based tools for sequence searches motif analysis and presentation.
e. 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 test; basic introduction to Multivariate statistics.

Model Paper for Entrance Test

1. Which of the following is an example of an energized nucleotide?
   a. G M P
   b. d C M P
   c. U M P
   d. d C T

2. In both repressible and inducible systems, transcription is controlled by:
   a. Operator gene through regulator gene
   b. Regulator gene through operator gene
   c. Promoter gene through regulator gene
   d. Operator gene through regulator and promoter gene

3. In Kreb's cycle FDA participates as electron acceptor during the conversion of:
   a. Succinyl CoA to Succenic acid
   b. Alfaketo gluterate to Succinyl CoA
   c. Succenic acid to Fumaric acid
   d. Fumaric acid to malic acid

4. First APG Version of classification came in the year
   a. 1998
   b. 2002
   c. 2004
   d. 2016

5. Hardy-Weinberg genetic equilibrium holds good for:
   a. Panmictic population
   b. Mendelian population
   c. Assortative mating population
   d. Diassortative mating population

6. In case of interaction where two dominant genes are similar in their individual effects but both are essential to produce a different phenotype, the genes are known as:
   a. Complementary genes
   b. Supplementary genes
   c. Epistatic genes
   d. Hypostatic genes

7. Maize is a:
   a. Monoecious species
   b. Hermaphrodite species
   c. Andromonoecious species
   d. Gynomonoecious species

8. Chromosomes number in the secondary nucleus of an embryo sac in a plant with 2n=16 will be:
   a. 8
   b. 16
   c. 24
   d. 32

9. *Amborella* is
   a. Basal angiosperm
   b. Advanced angiosperm
   c. Intermediate in position
   d. All of the above

10. Species have wide geographical range often develop locally adopted populations called:
    a. Prototypes
    b. Paratypes
    c. Syntypes
    d. Holotypes

11. *Morchella esculenta* is a:
    a. Fungus
    b. Bryophyte
    c. Pteridophyte
    d. Gymnosperm

12. *Gingko biloba* is a. An angiosperm
    b. A bryophyte
    c. A pteridophyte
    d. A gymnosperm

13. Select the odd one out:
    a. Symbiosis
    b. Parasitism
    c. Herbivory
    d. Abscision

14. Largest family of the Angiosperms is
    a. Orchidaceae
    b. Poaceae
    c. Asteraceae
    d. Fabaceae

15. Gemma cups are present in
    a. Pteridophytes
    b. Bryophytes
    c. Gymnosperms
    d. Fungi

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