BANKURA UNIVERSITY

SYLLABUS OF RET (RESEARCH ELLIGIBILITY TEST) IN BOTANY

SUBJECT

Microbiology

1. **History of Microbiology and bacterial classification**: - Early history and milestone discoveries in Microbiology
2. **Bacterial Taxonomy**:- Brief idea about the modern approach of bacterial taxonomy.
3. **Ultrastructure of prokaryotic cell**:- Cell wall and cell membrane of bacteria and archaea; Muerin biosynthesis; capsule, pili, and flagella. Mechanism of flageller movement and chemotaxis; Reserve material and other cytoplasamic inclusions; Endospore – structure, formation and regulation of endospore formation and germination.

4. **Bacterial genetic material**: – Structure and replication of bacterial chromosome; Plasmid – structure type and properties, episome; Spontaneous and induced mutation of bacteria.
5. **Bacterial growth and nutrition** :- Growth curve, growth factor, growth kinetics ; batch and continuous culture; synchronous culture , enrichment culture, diauxic growth; Microbial growth control by disinfectant, antiseptic and chemotherapeutic agents – a brief account of their types and mode of action. Brief idea about Autotrophy, heterotrophy and Mixotrophy.
6. **Genetic recombination in bacteria:** – Molecular mechanism of Transformation, Conjugation, Transduction, Gene mapping and Complementation test.
7. **Gene regulation and metabolic inhibition in bacteria**: - Operon concept; *lac* and *trp* operon; catabolic repression, attenuation and riboswitch; allosteric control, types of feedback inhibition and isozyme.
8. **Microbes in N_2 Cycle**:-Nitrification, Denitrification, Ammonification; Mechanism of biological N_2 fixation; structure and regulation of *nif* gene.
9. **Virus:** - Organization and structure of Capsid, Viral genome –types and structure; Replication of virus and viral nuclic acid, Lytic and lysogenic cycle of bacteriophage , regulation of lysogeny , induction of lysogeny and significance of lysogeny; Viroid and Prion.
10. **Fundamentals of Immunology**:- Innate and acquired immunity, T-cell, B-cell, MHC, Cytokines, Antigen- types and characteristics; Structure and functions of immunogloblins, Cell mediated and Humoral Immunity; Ag-Ab reactions and Immunological techniques – RIA, ELISA .

Phycology

1. Modern criteria of algal classification with special emphasis on chloroplast ultrastructure, flagella and pigments.
2. Endosymbiosis and its significance in algae.
3. Cyanophyta: General features & ecology; genetic recombination; heterocyst structure and function; affinities.
4. Rhodophyta: General features; specialities in sexual reproduction and post-fertilization changes.
5. Chlorophyta: Characteristic features of different classes highlighting distinctive features of different orders; evolutionary trends.
6. Photosynthetic Stramenopiles: distinctive features
    a) Diatoms: Features and ecology.
    b) Xanthophyceans: General features, parallelism with green algae & affinities.
    c) Phaeophyceans: General features & ecology; lifecycle patterns.
7. Algal biotechnology: aquaculture, bioremediation, biodiesel, bioethanol and hydrogen production by algae, carbon sequestration by algae, algae as health food; Industrial use of algae, photobioreactors and raceway ponds.

Mycology

1**. Position of fungi in modern systematic:** Modern approaches towards classification of fungi.
2**. Ultrastructural features of fungal cell structures:** Nucleus and its division, cell wall and its biochemical composition, tissue organization, modifications of fungal hyphae.

3. **Life cycle patterns:** Basic pattern of sexuality, sexual mechanisms and their correlations in different groups of fungi, Parasexual cycle-basic concept.
4. **Fungal symbionts:** Mycorhizae-basic concept and their applications. Lichen-Phycobiont and mycobiont, histology, biology and physiology of lichen thallus, economic importance of lichen.
5. **Beneficial uses of fungi:** Fungi in medicine and antibibtic production, alcohol production and organic acid production; industrial production of alcohol and penicillin.
6. **Edible Mushrooms:** cultivation technology, nutritional and medicinal properties of mushrooms.
7. **Fungi as animal parasites:** Mycoses of vertebrates- types and symptoms, insect fungus association. .
8. **Mastigomycotina:** A comprehensive knowledge with emphasis on occurrence of sex hormones and sporangia to conidia transition.
9. **Ascomycotina:** A comprehensive knowledge with emphasis on types of ascocarps and methods of spore dispersal.
10. **Basidiomycotina:** A comprehensive knowledge with emphasis on fruiting structures and methods of spore dispersal.
11**. Deuteromycotina:** A general account with emphasis on sporulating structures of the members, classification with special reference to conidial ontogeny.
12. **Fungal diseasesin animal and man** and their management.

Plant Pathology

1. History of the development of Plant Pathology.
2. Plant diseases: Classification and types.
3. Pathogenesis: Contact, entry and penetration, infection of host tissue and disease development relationship between pathogen and host factor(s).
4. Plant pathogen in offence: enzymes, toxins and growth regulators.
5. Host plant in defense: structural and biochemical defense; concept of horizontal and vertical resistance.
6. Physiological changes in host plants as a result of infection: Photosynthesis, Respiration Translocation of water and nutrients; Molecular changes in protein and nucleic acid in diseased plants.
7. Plant disease epidemiology: Factors responsible for development of plant disease epidemic; Disease forecasting and Remote Sensing; Computer simulation technique.
8. Strategies of plant disease management: Cultural, chemical, biological and integrated management of pest and diseases; Biopesticides and their applications in management of plant diseases.
9. Seed pathology: Factors responsible for seed deterioration, effect of fungal deterioration of seeds and grains, mycotoxin production and control of seed deterioration.
10. Wood decay: Decay of wood and wood products by wood rotting fungi; Structural and biochemical changes of wood as a result of decay.
11. Study of plant diseases: Symptoms, etiology, disease cycles and control measures of some important diseases of the following crops: Rice, Wheat, Potato, Sugarcane and Tea.

Bryology

1. Introduction: Diversity in forms, habitats, economic importance and ecological values.
2. Classification of Bryophytes – traditional and modern systems.
3. Brief idea about: a) Bryophyte phylogeny b) Fossil Bryophytes c) Photoperiodism
d) Water relations e) Axenic culture of Bryophytes h) Peristome characteristics and their importance i) Broad ideas.

Pteridology

1. Introduction about pteridophytes.
2. Concept about primitive and advanced characters as proposed by Bower.
3. An idea about the outline system of classifications of ferns by Copeland (1947) and Pichi Sermolli (1977).
4. Comparative studies on the vegetative and reproductive organographies, evolutionary tendencies and affinities of the members belonging to different groups of Rhyniopsida. Zosterophyllopsida, Trimerophytopsida, Psilopsida, Lycopsida (Drepanophycales, Protolepidodendrales, Lycopodiales, Selaginellales, Lepidodendrales and Isoetales) and Sphenopsida (Hyeniales, Sphenophyllales, Calamitales and Equisetales).
5. A comparative study of the members belonging to the following taxonomic groups and also their systematic treatments, evolutionary tendencies and affinities: (a) Coenopteridales, (b) Marattiales, (c) Ophioglossales, (d) Filicales (Schizaeaceae, Gleicheniaceae, Cyatheaceae, Polypodiaceae), (e) Salviniales, (f) Marsileales.
6. Stelar concept, types and evolution
7. Soral evolution in ferns
8. Spores : Types, germination pattern, gametophyte development and types.

9. Mating systems in ferns, control of sexuality in homosporous pteridophytes by Antheridogen activity, Apogamy and Apospory.

Plant Physiology

1. Solute transport and photoassimilates translocation: uptake, transport and translocation of water, ions, solutes and macromolecules, mechanisms of loading and unloading of photoassimilates.

2. Present day concept of phytohormones and plant growth regulators; Phytohormone families and members of each family; growth promoting and retarding chemicals; general mode of phytohormone action; hormone binding proteins; second messengers; gene activation; examples of target cells for hormone action; a brief idea about modern techniques for hormone assay.

3. Auxins: Chemistry, biosynthesis and degradation/deactivation of IAA; a brief account of the auxin structure and activity relationship; antiauxins and auxin antagonists; mechanism of auxin action – acid growth theory, auxin mutants and signaling.

4. Gibberellins: Diversity, chemical and structural characteristics of gibberellins; biosynthesis of GAs, antigibberellins and their site of action, role of gibberellins on cereal seed germination, dwarfism and flowering; mode of action of gibberellins, gibberellin mutants and signaling.

5. Cytokinins: Chemical and structural characteristics, biosynthesis and degradation; role of cytokinins in cell division, chloroplast development, senescence, movement of nutrient, organogenesis and embryogenesis; mode of action, cytokinin mutants and signaling.

6. Abscisic acid: Chemical and structural characteristic, biosynthesis and degradation; role of ABA in seed maturation, germination, gravitropism and stomatal closure; mode of action, ABA mutants and signaling.

7. Ethylene : Hormonal status; chemical characteristics, biosynthesis and metabolism; triple responses, Yang cycle; factors regulating ethylene biosynthesis; quantification of ethylene, mode of ethylene action; its role in higher plants, commercial uses of ethylene, ethylene mutants and signaling.

8. Seed dormancy: Types, control mechanism, chemical and physical manipulative methods of breaking seed dormancy; biological significance of dormancy.

9. Flowering: Photoperiodic control, hormonal regulation; nature of floral stimulus; experimental evidence to prove the mobile nature of floral stimulus, gene- induced regulation floral development, ABC model, second messenger and flowering.

10. Senescence: Types of senescence, biochemical indices of senescence, physiobiochemical changes occurring during leaf senescence, senescence regulatory genes.

11. Fruit ripening: Climacteric and nonclimacteric fruits; hormonal regulation of fruit ripening, biochemical changes occurring during fruit ripening.

Biochemistry and Molecular Biology of Plants

1. The atom and chemical bonds, stabilizing interactions, reaction orders, pH, buffer, physicochemical properties of water.

2. Carbohydrate metabolism: Glycolysis and its control and significance; TCA Cycle and Oxidative Phosphorylation; Pentose phosphate pathway and its control and significance; Gluconeogenesis and its control and significance, Glyoxalate cycle.

3. Amino acids and Proteins : Classification and structures, properties, determination of amino acid sequence in a polypeptide; Structural organization of Proteins, Post translational modification of protein, , chaperone and protein folding, protein targeting, Ramachandran plot

4. Enzyme kinetics: Deduction of Michaelis-Menten equation, Lineweaver-Burk plot; enzyme inhibition, isozymes, allosteric enzymes, ribozymes and abzymes.

5. Lipid metabolism: biosynthesis and oxidation of fatty acids

6. Photosynthesis and Photorespiration:

Photosynthesis: Z-scheme, PCRC, Different modes of CO_2 concentrating mechanisms, energetics and significance. Photorespiration: Compartmentalized reactions, regulation,, energetics and significance; Structural and functional characteristics of Rubisco and its regulation

7. Cell signaling: Signal perception Molecular mechanisms of signal transduction and regulation.

8. DNA & RNA Metabolism: DNA topology, DNA damage and repair transcription, processing, regulation, post-transcriptional control and gene silencing,

9. Gene expression: Principles of gene regulation; Regulation of gene expression in prokaryotes and eukaryotes.

10. Plant genes, promoters, intron splicing, vectors, codon optimization, gene mapping and cloning of plant genes

11. Recombinant DNA technology: Principles and methods of recombinant DNA technology- expression of cloned genes in *E. coli*, cloning in yeast: transformation in yeast, yeast artificial chromosome (YAC), retrovirus like vector (Ty) in yeast/shuttle vector, Molecular improvement of crops.

Taxonomy of Angiosperm & Phytogeography

1. Taxonomy and Systematics - Concept, objective and relevance to conservation

2. Plant Nomenclature – ICN, Principles, Rules, Recommendations and Appendices, Type concept, Valid publication and Rejection of names.

3. Taxonomic hierarchy, delimitation of taxa and attribution of rank. Species concept.

4. Recent Systems of Angiosperm classification including APGII (2009).

5. Taxonomic literature: Types, definition and examples.

6. Objective Taxonomy: Phenetics and Cladistics: Principles, Methods, Merits and Demerits.

7. Biosystematics-methods, categories and relationship with traditional taxonomv.

8. Circumscription and phylogeny: Magnoliales, Hamamelidales, Apiales, Lamiales, Campanulales, Alismatales, Pandanales, Cyperales and Orchidales.

9. Biodiversity: components, levels, values, Hotspots and conservation.

10. Concept of Phytogeography: Endemism, Plant migration, Disjunction, Vicariance, Phytochorionomy (Brief introduction).

11. Major Phytochona of the World and India.

Palynology & Reproductive Biology:

1. Microspore tetrads, polarity of spores and pollen grains.
2. Spore-pollen morphology: Symmetry, shape, size, aperture patterns, NPC System for numerical expression of apertural details, exine stratification, surface structures and sculptures of sporoderm; LO-analysis and edge-analysis.
3. Chemical nature of sporopollenin, development of pollen wall, Ubisch body, exineless pollen grains. Extraexinous wall material - perine, viscin-threads. pollen-kitt.
4. Application of palynology: Palynology in taxonornic and phylogenetic deductions; Aeropalynology with reference to allergy; Melissopalynology; Palaeopalynology; Forensic palynology.
5. Pollen dispersal units; concept of anthesis.
6. Pollination modes; floral constructions with respect to specific pollination modes.
7. Pollination syndromes/floral syndromes, with special reference to melittophilous, miophilous and lepidiphilous flowers.
8. Breeding systems, different levels of structural and functional adaptations for higher degree of outbreeding; self-incompatibility and compatibility control with reference to pollen-pistil interactions.

Evolution:

9. Early ideas leading to the firm establishment of the reality of evolution.
10. Pre Darwinian scenario of the theories on evolution.
11. Darwinian paradigm: Natural Selection as the driving force of evolution.
12. Mendelian and Post-Mendalian developments in understanding the cause of heritable changes among the individuals of a species.

Gymnosperms:

1. Introduction to gymnospermy; general features of gymnosperms.
2. Origin of seed-habit: Origin and evolution of nucellus and integument; switchover from zooidogamy to siphonogamy - hydrasperman reproduction, prepollen and evolution of typical gymnospermous pollen grains.
3. Progymnospermopsida: Geologic distribution, characteristic features, range of vegetative morphology and reproductive structures and classification; the plexus progymnosperms as the progenitor of gymnosperms.
4. Classification of gymnosperms.
5. Geologic and geographic distributions, general features, organography and phylogeny of major clads of gymnosperms.
6. Development of female gametophytes among extant gymnosperms.
7. Embryogeny including polyembryony and karyology of extant gymnosperms.
8. Economic importance of gymnosperms with reference to timber, paper and board, resin, essential oils, drugs and food.

Palaeobotany:

9. Definition of fossil.
10. Principals of correlation and stratigraphy; dating of rocks; outline of Standard Geologic Time Scale.
11. Chemical evolution and origin of life; early life forms as known from Precambrians; origin of eukaryotes.
12. Mass extinctions with special references to the floral changes through Permo-Trassic (P-T) and Cretaceous-Tertiary (K-T) transitions.
13. Continental Drift Hypothesis.
14. Introductory idea of the importance of fossil plants in palaeoecological studies.

Plant Anatomy

1. Organization of shoot and root apical meristems. Changes in shoot apex during transition to flowering.
2. Development and differentiation: Polarity, symmetry, pattern formation (brief idea of genetic control of differentiation and organogenesis).
3. Origin, differentiation and phylogeny of xylem and phloem.
4. Leaf morphogenesis (brief idea of genetic control of differentiation and organogenesis).
5. Xylotomy and its importance.
6. Ultra structural features of sieve tube elements and their importance.

Pharmacognosy

1. Definition. History and scope of Pharmacognosy including indigenous system of medicine.
2. Drugs: Various systems of classification of drugs of natural origin, Morphological and microscopic examination of drugs.
3. Extraction and purification of natural products; Chromatographic study of drugs; Spectroscopic techniques; Methods of identification and analysis of results; Applications of phytochemical analysis.
4. Importance of Crude drug; Preparation of drugs for commercial market: a) Collection, Harvesting, Drying, Garbling, Packaging, storage and preservation. b) Drug evalution. Significance of pharmacopoeial standards, Adulteration, contamination and substitution.
5. Pharmacological activities of natural products, its' importance in pharmaceutical industries.

6.Silviculture: Definition, scope and objective; Farm forestry, social forestry and agro Forestry; Natural and artificial regeneration of forests; Non-timber forest products of economic values.

7. Plants as a source of petroleum substitute.

Ecology

1. The Environment**:** Physical environment; biotic environment; biotic and abiotic interactions.
2. Ecosystem:Structure and function; energy flow and mineral cycling (CNP); primary production and decomposition.
3. Habitat and niche:Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement.
4. opulation 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.
5. Species interactions:Types of interactions, interspecific competition, herbivory, carnivory, pollination, symbiosis.
6. Community ecology:Nature of communities; community structure and attributes; levels of species diversity and its measurement; edges and ecotones.
7. Ecological succession:Types; mechanisms; changes involved in succession; concept of climax.
8. Applied ecology:Environmental pollution; global environmental change.
9.Conservation of Biodiversity–Brief idea about *In situ* (Afforestation, Social Forestry, Agro forestry, Botanical Gardens, Biosphere Reserves, National Parks, Sanctuaries and Sacred Groves and *Ex situ* (Cryopreservation, Gene Banks, Seed Banks, Pollen Banks, Sperms Banks, DNA Banks, Tissue Culture and Biotechnological Strategies), ecorestoration, environmental education.

Genetics and Plant breeding

1. Introduction to Plant Genetics: Brief history of classical and molecular genetics; Extension of Mendelism; Allelism; Gene action, Interaction with environment, Penetrance and expressivity; Gene interaction – epistasis, pleiotropy, polygenic inheritance.
2. Linkage, Crossing over and Chromosome Mapping: Physical basis of crossing over; Recombination and gene mapping; Construction of genetic and physical mapping.
3. Genome Organization in Eukaryotes: Genome types; Eukaryote nuclear genome; gene concept; Organization of structural and functional components of chromosome-centromere, telomere, NOR; Sex chromosome in plants; Genome duplication, alteration and their evolutionary role; Genes and gene number, content and C-value paradox.
4. Structural and Numerical Alterations of Chromosomes: Deficiency, Duplication, Inversion, Translocation and their meiotic behavior; Origin and significance of haploids, aneuploids, euploids, autopolyploids and allopolyploids.
5. Genetic Integrity and Diversity: Basis of chromosome separation; Recombination mechanism; Evolutionary significance, genetic control; Structure and function of Transposable elements and their role in evolution; Repair and retrieval system of genes.
6. Genomes, Genomics and Proteomics: Basic concept of geneome sequencing- Arabidopsis, Rice and Human Genome; Genome annotation, Synteny, Gene Search and Comparative Genetic data; Proteomics – Application, Protein expression profiling.
7. Population Genetics and Plant Breeding: Defination, Gene Frequency in population; Genetic Equilibrium; Hardy-Weinberg Law; Speciation Mechanism; Breeding system and genetic consequences in plants; Qualitative and quantitative traits; Marker Assisted Breeding for agronomic importance; QTL mapping.

Cell biology and Bioinformatics

1. Introduction: Cellular organization – its origin and evolution
2. Biomembranes: Structural models, composition and dynamics, biogenesis and assembly, transport of macromolecules and ions.
3. Mitochondria: Biogenesis, origin and evolution, mitochondrial genome.
4. Chloroplast: Biogenesis, origin and evolution, chloroplast genome.
5. Nucleus: Chromatin organization and activation, packaging and its higher order structure, chromosome, basic nucleolar structure structures and dynamics.
6. Cytoskeletons: Nature, intermediate filaments, microtubules, actin-binding filaments.
7. Cell signaling and interaction: Signal transduction, its basic components and types, intercellular junctions and adhesions.
8. Cell cycle: Phases and control in Yeasts; Cancer – molecular events, proto-oncogenes, tumor-suppressor gene and their inter-play, therapy.
9. Bioinformatics: Genome and protein information resources, sequence analysis, multiple sequence alignment, homology and analogy, pattern recognition, analysis package, application and prospects in medicine and agriculture.

RESEARCH METHODOLOGY

Statistics

1. Variable and attribute, primary and secondary data.
2. Sampling and sample designs: Classification and tabulation of data; Frequency distribution; Diagrammatic and graphical presentation.
3. Central tendency: Arithmetic, geometric and harmonic mean; Median; Mode.
4. Measures of disparsion: Variance; Mean deviation; Standard deviation and error; Moment; Skewness and kurtosis.
5. Correlation and regression analysis: Bivariate and multivariate.
6. Normal, binomial and poisson distribution.
7. Test of hypothesis: t, u and Chi square test.
8. Analysis of variances and covariance: Bivariate and multivariate.
9. Calculations of mean, variance, standard deviation, standard error, coefficient of variance, Use of t-test for comparing two means.
10. Determination of the relationship between variables using correlation and regression analysis.
11. Analysis of variance: ANOVA, ANCOVA, *U*-test.
12. Use of Chi-square test for goodness of fit.

Instrumentation

1. Isolation and purification of Protein, RNA, DNA (genomic and plasmid); Analysis of and proteins, RNA and DNA by one and two dimensional gel electrophoresis, isoelectric focusing gels;
2. Protein sequencing methods, detection of post-translation modification of proteins; Isolation, separation and analysis of carbohydrate and lipid molecules
3. DNA sequencing methods, strategies for genome sequencing; Methods for analysis of gene expression at RNA and protein level, Micro array based techniques;
4. Molecular cloning of DNA or RNA fragments in bacterial; expression of recombinant Proteins using bacterial and plant vectors; Isolation of specific nucleic acid sequences; generation of genomic and cDNA libraries in plasmid BAC and YAC vectors;
5. RFLP, RAPD and AFLP techniques
6. Analysis of biomolecules using UV/visible, fluorescence, NMR; Structure determination using X-ray diffraction
7. Different Radiolabeling techniques, Incorporation of radioisotopes in biological samples, molecular imaging of radioactive material.
8. Fermentation Technology.
9. Demonstration of instruments; Electrophoretic techniques (1D, 2D); Chromatographic Techniques (Paper, Thin Layer, HPLC, GC), Restriction Mapping, RAPD, Transformation, PCR, SEM, Confocal and TEM.
10. Microscopy: Principles of light and electron microscopy; Light, Fluorescence, Confocal, SEM, TEM and AFM.