FURTHER DETAILS REGARDING MAIN TOPICS OF PROGRAMME No. 01/2021 (Item No: 43)

SCIENTIFIC OFFICER (BIOLOGY)
IN KERALA POLICE SERVICE (FORENSIC SCIENCE LABORATORY)

Category Number: 025/2020

ZOOLOGY

MODULE 1.

SYSTEMATICS, ANIMAL DIVERSITY, ETHOLOGY, EVOLUTION AND ZOOGEOGRAPHY

SYSTEMATICS

Basic concepts, Importance and Applications,
Theories of Biological classification, Taxonomic characters. Five kingdom classification
Hierarchy of categories, Obligatory categories of classification
Species concept
Taxonomic procedures and Tools: Collection, Preservation, Curating and Identification
Taxonomic keys: ICZN, Nomenclature, merits and demerits, ethics,
Modern Taxonomic Trends: Chemotaxonomy, Cytotaxonomy, Molecular taxonomy, Cladistics, Numerical taxonomy, Bar coding techniques

ANIMAL DIVERSITY

Lower Metazoans: Porifera, Cnidaria-Polymorphism, Ctenophora, Acoelomata, Placozoa, Mesozoa and Pseudo-coelomata
Phylogenetic position of Molluscs, Adaptive Radiation in Molluscs and Annelids.
Phylogeny of Arthropod-Monophyly and Polyphyly
Echinoderms: Classification and adaptive radiation
Hemichordates : Position in the animal kingdom, phylogeny and evolutionary significance
Chordates: Cephalochordates and Urochordates. Vertebrate Phylogeny-Agnatha, Ostraco derms and Gnathostomes Placoderms, Acanthodians, Chondrichthyes and Osteichthyes.
Structural and Functional adaptations of fishes.
Terrestrial Vertebrates: Tetrapod phylogeny - modern Amphibians, diversity, distribution, status and threats.
Reptiles – origin and adaptive radiation. Mesozoic world of reptiles and extinction.
Birds and Mammals: Origin of birds and mammals. Structural and functional modifications for aerial life.
Class Mammalia: Prototheria, Metatheria and Eutheria. Phylogeny of Mammalian orders. Adaptive radiation in mammals.
Scientific names and common names of organisms under all phylums
Organisms with special features,
Exceptions in biology

ETHOLOGY

Learning behaviour: Short and long term memory, Habituation, Classical conditioning (Pavlov's experiments), Instrumental conditioning, Latent learning, Trial and error learning, Instinct, Imprinting.

Communication behaviour: Evolution of communication, Sensory mechanisms: Electrical, Chemical, Olfactory, Auditory and Visual. Dance language of honey bees, Pheromonal communication

Orientation, Navigation, Migration (Fishes and birds), Navigation cues. Biological rhythms Circadian, Lunar periodicity, Tidal rhythms.

Social Behaviour: Aggregations, altruism, inclusive fitness, co-operation, territoriality,alarm call, social organization in insects and primates

Adaptations to stress- basic concept of environmental stress, acclimation, acclimatization, avoidance and tolerance

EVOLUTION

Pre-Darwanian, Lamarck, Darwin and Wallace and Post Darwinian concepts. Concepts of variation, adaptation, struggle, fitness and natural selection-spontaneity of mutation.

Origin and Evolution of Life, Origin of basic biological molecules, abiotic synthesis of or ganic monomers and polymers, concept of Oparin - Haldane, Miller-Urey Experiments. The RNA world. Idea of Panspermia. The First Cell. Evolution of Prokaryotes- origin of eukaryotic cells- evolution of unicellular eukaryotes, genome evolution. Geological Timescale. Major events in evolutionary timescale. Anthropocene. Tools and techniques in estimating evolutionary time scale. Mass extinction and its consequences. Fossils- fossilization and its significance.

Population Genetics. Gene pool, gene frequency, Hardy-Weinberg Law. Rate of change ingene frequency through natural selection, migration and random genetic drift. Founder effect. Isolating mechanisms and speciation. Micro, Macro and Mega evolution. Co-evolution.

Developmental and Evolutionary Genetics, Gradualism v/s punctuated equilibrium, anagenesis v/s cladogenesis,

Primate Evolution and Human Origins. Stages in Primate evolution- Prosimii, Anthropoidea and Hominids. Factors in human origin, hominid fossils. Cytogenetic and molecular basis of origin of man-African origin of modern man- Mitochondrial Eve, Y chromosomal Adam

ZOOGEOGRAPHY

Biogeographical zones of India

MODULE II

RESEARCH METHODOLOGY AND BIOSTATISTICS

RESEARCH METHODOLOGY

Basic concepts - Knowledge, Information and Data - Science, Pseudoscience. Life Science - Definition, Laws, Characteristics. Scientific temper, Empiricism, Rationalism and Units of measurements. Types of Research (Descriptive/Analytical, Applied/ Fundamental, Quantitative/ Qualitative, Conceptual/Empirical. Research and scientific method. Research Process. Research formulation -Observation and Facts, Prediction and explanation, Induction, Deduction. Hypothesis -Null and alternate hypothesis and testing of hypothesis - Research Design -Basic principles, Meaning, Need and features of good design, Important concepts. Development of a research plan -Exploration, Description, Diagnosis, Experimentation, determining experimental and sample designs.

Data collection techniques. Scientific Documentation and Communication. Information Science, Extension and Ethics:
Sources of Information -Primary and secondary sources. Intellectual Property Rights – Copy right, Patents, Trademarks, Geographical indications. Safety and precaution - ISO standards, Lab protocols, Lab animal use, care and welfare, animal houses, radiation hazards. Extension: Lab to Field, Extension communication,

BIOSTATISTICS

Data and Variable (Collection, Types, Sources).Population, Sample, Sampling Methods (Random, Cluster, Stratified and Geographical) and Sampling Errors/Bias. Organization of Data - Editing, Classification, Tabulation (forming a frequency distribution from raw data and types and characteristics of a Frequency table).Presentation of Data - Types and Characteristics of Tables and Visual aids – Graphs, Charts, Diagrams, Flow charts, Cartographs. Statistical Analysis Tools - Parametric and Non Parametric; Bivariate and Multivariate Analysis. Interpretation and Forecasting, Characteristics, Merits and De merits of Mean, Median and Mode, Range, Quartile Deviation, Mean Deviation and Standard Deviation. Correlation, Regression, Probability analysis. Probability distributions Binomial, Poisson and Normal. Chi- Square Test Student's 't' test
F-test and Analysis of Variance (ANOVA - One way)

MODULE III

BIOPHYSICS AND INSTRUMENTATION

BIOPHYSICS

Diffusion and Osmosis: Diffusion -Kinetics of diffusion, Fick's law of diffusion and diffu sion coefficient, Biological significance in animals, Electrochemical gradient,
Stokes-Einstein equation and Graham's law, Facilitated diffusion,
Gibbs-Donnan equilibrium. Osmosis- osmotic concentration and osmotic pressure, Van't Hoff's laws. Biological significance of osmosis in animals.
Radiation Biophysics: Ionizing radiation, units of radioactivity, exposure and dose. Interaction of radiation with matter – effect on nucleic acids, proteins, enzymes and carbohydrates. Cellular effects of radiation : somatic and genetic. Nuclear medicine : Internally administered radioisotopes. Radio iodine in thyroid function analysis. Renal, liver and lung function analysis. Application of radioactive tracers,
Radiation protection and therapy.

INSTRUMENTATION

Microscopy: Light microscope and dark field microscope, Phase contrast micro scope, Differential Interference contrast (Nomarsky) microscopy, Confocal micro scope, Electron microscope –TEM, SEM, Scanning Tunnelling and Atomic Force Micro scopes., Polarising microscope, fluorescence microscope and camera lucida
Chromatography: Paper chromatography, Thin layer chromatography, Ion exchange chro matography. Gel permeation chromatography, Affinity chromatography, Gas chromatogra phy, High pressure liquid chromatography (HPLC). Electrophoresis. Paper electrophoresis, Gel electrophoresis, Polyacrylamide gel electrophoresis (PAGE) – SDS and nonSDS , Agarose gel electrophoresis , Disc electrophoresis, High voltage electrophoresis, immunoelectrophoresis, isoelectric focusing.
Colorimetry, Spectrophotometry and Spectroscopy. Principle and applications of colorimetry and spectrophotometry (UV and visual) . Spectroscopy , X-ray diffraction crystallography, Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic resonance spectroscopy (NMR), Circular dichroism spectroscopy, ESR spectroscopy, Mass spectroscopy.

Centrifugation: Basic principles of sedimentation, Types of centrifuges, Analytical and Preparative centrifugation, Differential and density gradient centrifugation. Radioisotope Detection and Measurement. Dosimetry: Ionization chamber, GM counter, Solid and liquid scintillation counters, Autoradiography.
Nanotechnology: Nanosensors and Nanomedicines,
Radio Immuno Assay, Enzyme Linked Immuno Sorbant Assay (ELISA).
pH meter, Principle and working. Types of pH meters.
Electrophysiological methods: ECG, EEG, PET, MRI, CAT,
Biological and Histological Techniques: Fixation, preparation of temporary and permanent slides, whole mounts, smears, squashes and sections. Specimen preparation for TEM, SEM, shadow casting, freeze fracturing, freeze etching, negative staining. Microphotography.
Cytochemical and histological methods- Microtome techniques, fixation, staining.
Cytochemistry of nucleic acids, detection of carbohydrates, proteins and lipids.

MODULE IV

BIOCHEMISTRY, PHYSIOLOGY AND IMMUNOLOGY

BIOCHEMISTRY

Macromolecules and their subunits. Chemical bonds of biomolecules. **Carbohydrates:** Classification of carbohydrates with examples-Structure of monosaccharides- glucose, fructose, galactose, mannose and ribose. Isomerism - Structural isomerism (functional group isomerism) and stereo isomerism (optical isomerism)- mention epimer, anomer and enantiomer with examples , Mutarotation Biological roles of monosaccharides.
Structure and biological roles of maltose, sucrose, lactose, trehalose and cellobiose.
Hompolysaccharides - Structure and biological roles of cellulose, starch, glycogen, inulin and chitin. Heteropolysaccharide - Structure and biological roles of hyaluronic acid, chondroitin, chondroitin sulphate, keratan sulphate, heparin and agar-agar **Proteins:** Amino acids, Classification: (a) on the basis of number of amino and carboxyl group (b) on the basis of the chemical composition of side chain (c) based on the polarity of side chain (R) Amphoteric properties of amino acids pk value and Isoelectric point (pI) of amino acids. Peptide bond and peptides (di, tri, tetra, oligo and polypeptide). **Structure of protein.** Primary structure, Secondary structure (-helix -parallel & antiparallel and B-pleated sheet), random coil conformation, Tertiary structure, Quarternary structure. Brief note on protein domains, motifs, folds and Ramachandran plot. Biological roles of proteins **Lipids:** Classification of lipids -Simple lipids (fats, oils and waxes), compound lipids (phospholipids, glycolipids, lipoproteins and sulpholipids) and derived lipids. Biological roles of lipids - as food reserves (storage lipids), structural lipids in membrane, as signals, as co-factors, as pigments, as insulators, as vitamin carriers. Prostaglandins - Chemical nature and functions. Fatty acids - definition; essential fatty acids. Classification with examples- Saturated, unsaturated, hydroxyl and cyclic fatty acids Nomenclature of fatty acids - Genevan system. **Nucleic acids:** Structural organization of DNA (Watson -Crick model) Structural organization of t-RNA;. Biological roles of nucleotides and nucleic acids
Enzymes: Classification- (I.U.B. system). Mechanism of enzyme action: Formation of enzyme substrate complex- Michaelis-Menten theory, Fischer's template theory and Koshland's induced fit theory. Factors influencing enzyme action. Enzyme kinetics - Michaelis-Menten equation - derivation; significance of K_m and V_{max} Values. Lineweaver-Burk equation and double reciprocal plot of enzyme reaction. Enzyme inhibition - Competitive, non-competitive and uncompetitive inhibition, suicide inhibition and feedback inhibition. Classification, Structure and functions of Vitamins. Vitamins as co-enzymes.

Bioenergetics: Laws of thermodynamics and biological system- Enthalpy, Entropy, Free energy concept. Energy of activation, Standard free energy change. Role of ATP as a free energy carrier in the biological system.

Metabolism and biosynthesis of biomolecules. **Carbohydrate metabolism**. Glycolysis - Fate of pyruvic acid Citric acid cycle; Pyruvate dehydrogenase complex and ketoglutarate dehydrogenase complex Electron transport system and oxidative phosphorylation; Redox potential, Chemiosmotic hypothesis; inhibitors of electron transport chain Gluconeogenesis, Glycogenesis, Glycogenolysis; regulation of glycogen synthesis and breakdown . Pentose phosphate pathway (HMP pathway) and its significance Uronic acid pathway **Amino acid metabolism:** Biosynthesis and degradation of amino acids - glutamic acid, phenyl alanine, methionine, tryptophan, isoleucine, histidine, valine. Fate of amino acids in the body. Transamination, Decarboxylation and deamination reactions in the biological system. **Lipid metabolism** Oxidation of fatty acids Biosynthesis of fatty acids. Biosynthesis of cholesterol **Nucleic acid metabolism.** Biosynthesis and degradation of purines and pyramidines

PHYSIOLOGY

Nutrition: Constituents of normal diet and their daily requirements. Physiological calorie value of food stuffs. Antioxidant nutrients. Movements of GI tract: deglutition, gastric motility and emptying, intestinal motility and defecation. Mechanism of absorption of monosaccarides, amino acids and lipids and vitamins. The role of hormones and neurotransmitters in the control of gastrointestinal Motility.Energy balance and obesity-causes and consequences. BMR and its significance.

Excretory System: Introduction: Brief description of different types of excretory organs in different animal groups (flame cells, green glands, malpighian tubules). Functional anatomy of mammalian kidney, nephron and juxtaglomerular apparatus- structure ,parts and function. Urine formation (glomerular filtration, tubular reabsorption and tubular secretion) Regulation of water balance -Mechanism of concentration of urine – Counter Current system . Renal regulation of acid- base balance & electrolyte balance. Structure of urinary bladder, micturition reflex and micturition. Renal clearance – definition, concept and significance; clearance value of urea, creatinine, phosphate, potassium, chloride and sodium.

Respiratory system: Introduction: Brief description of major respiratory organs (tracheal system, book lungs, gills and ctenidia). Physiological anatomy and histology of respiratory passage and lungs. Mechanism of pulmonary ventilation (inspiration & expiration) .Alveolar ventilation, dead space and its effect on alveolar ventilation. Role of surfactant in alveolar expansion. Pulmonary volumes and capacities – definition & normal values (tidal volume, inspiratory reserve volume, expiratory reserve volume, residual volume, functional residual capacity, inspiratory capacity, vital capacity, total lung capacity). Exchange of gases- partial pressures involved-lung and tissues. Oxygen dissociation curve – factors affecting binding of oxygen to haemoglobin (PO_2,PCO_2,CO, pH, body temperature, diphosphoglyceric acid level, foetal haemoglobin and also myoglobin). Neural and chemical regulation of respiration: Respiratory centres & factors regulating respiration.

Nervous system: Organisation of human brain. Cerebrum and cerebral lobe. Cerebral cortex and its functional areas- Motor cortex, Broca‟s area ,cortex and its association area, gustatory cortex, visual cortex and its association area, auditory cortex and its association area, olfactory cortex, wernick‟s area, Brodman map, cerebral dominance . Cortical white matter- commissures, association fibers, projection fibers, corpus callosum and fornix, basal nuclei, Brain stem, Cerebellum, Diencephalon –. Functional brain systems - Limbic system and reticular formation. Protection of brain – Meninges, cerebrospinal fluid- formation and function, blood brain barrier and its function. Diseased states of brain - schiz ophrenia,

Alzheimer's disease, Senile dementia & Parkinson's disease. somatosensory. Memory- types of memory- short term, intermediate long term and Long term memory, consolidation of memory. PNS and Autonomic nervous system.Spinal cord – structure. Reflex action, reflex arc, monosynaptic and polysynaptic reflexes , inverse stretch reflex and golgi tendon organ.

Special senses Vision: Structure of eyeball Fluid systems of the eye Layers of Retina and photoreceptors (rods & cones) Neuronal cell types and neural circuitary of the retina and visual pathways from retina to visual cortex Image formation Taste: Primary sensations of taste. Taste buds, Physiology of taste , Smell: Olfactory membrane and receptor cells Physiology of olfaction, Tactile response: Mechanoreceptor, Pain receptors , . Thermal receptors, Formation of image on the retina. A brief general account of electrophysiology of vision Photochemistry of vision and colour vision

Cardiovascular system : Structural organization of myogenic heart (in human beings). Physiological anatomy of cardiac muscle – specialized tissue. Cardiac cycle. Neural and chemical regulation of heartfunction. Blood volume and blood pressure. Physiological anatomy of coronary blood flow, Ischemic heart disease. Lymphatic System. Lymph channels of the body. Composition and formation of lymph. Functions of lymph and lymphatic system including.

Muscle physiology, Skeletal, Smooth and Cardiac muscles , physiology of muscle contraction, muscle proteins, molecular mechanism of muscle contraction, muscle twitch, rigor mortis, summation.

Endocrinology: Invertebrate and vertebrate endocrine system. Endocrine glands. Synthesis, physiologic role, control and mechanisms of hormone action. Neuro-endocrine regulation of hormone action. Disorders of hormonal imbalance in Man.

Reproductive physiology: Anatomy and histology of adult testis and ovary. Reproductive cycles of mammals and their hormonal control. Physiology of implantation, pregnancy, parturition, and lactation.

Environmental Physiology: Thermoregulation. Comfort zone, normal body temperatures (oral, skin & core). Temperature regulating mechanism (hot & cold) , role of hypothalamus, thyroid and adrenal glands.

IMMUNOLOGY

Hematopoiesis – Lymphoid and myeloid lineages. Hematopoietic growth factors. Genes that regulate hematopoiesis. Regulation of hematopoiesis. B- Lymphocytes, T- lymphocytes and Antigen presenting cells. Antigens Immunogenicity, Antigenicity. Factors that influence immunogenicity. Adjuvants. Haptens. Epitopes. Properties of B-cell and T- cell epitopes. Immunoglobulins (Antibodies) Structure and function of Antibody molecules. Generation of Antibody diversity. Immunoglobulin gene. Antigenic determinants of immunoglobulin - (a) Isotype (b) Allotype (c) Idiotype. B-cell receptor (BCR). Monoclonal Antibodies. Production of Monoclonal Antibodies (Hybridoma technology). Clinical uses of Monoclonal Antibodies. Antibody Engineering. Antigen- Antibody interactions Strength of antigen – antibody interactions. (a) Antibody affinity (b) Antibody avidity. Cross- reactivity. Precipitation reactions. Immunotechnics – ELISA, RIA, Western Blot, Immunoelectrophoresis, Flow cytometry and fluorescence .Humoral immunity. Cellular immunity. T- Cell receptor, TCR-CD3 complex. Activation, maturation and differentiation of B-Cells and T-Cells. Immune effector mechanism. Cytokines. Cytokine antagonists. Cytokine secretion by TH1 and TH2-cells.Cytokine related diseases. (a) Bacterial septic- shock (b) chaga‟s disease) (c) lymphoid and myeloid cancers. Therapeutic uses of cytokines. Toll- like receptors.

The Complement system. The functions of complement components. Complement activation (a) Classical pathway (b) Alternate pathway (c) Lectin pathway. Regulation of complement system. Biological consequences of complement activation. Complement deficiencies. Major Histocompatibility Complex (MHC) General organization and inheritance of MHC. MHC molecules and genes. Cellular distribution of MHC. Antigen-

processing and presentation-Exogenous and Endogenous pathways. Presentation of non-peptide antigens. Transplantation immunology Auto graft, Allograft, Isograft and xenograft Immunological basis of graft rejection. Role of cell- mediated responses. Transplantation antigens. General immune suppressive therapy. Hypersensitivity Reactions. Allergens IgE- mediated (type- I) hypersensitivity. Antibody- mediated cytotoxic (type- II) hypersensitivity. Immune complex- mediated (type- III) hypersensitivity.
TDTH- mediated (type- IV) hypersensitivity Vaccines.: Active and passive immunization. Whole organism vaccines. Recombinant vector vaccines. DNA vaccines. Synthetic peptide vaccines. Multivalent vaccines. Immunity and malnutrition and immune deficiency diseases. Immunity and malnutrition. Primary immune deficiency diseases. (a)Burton‟s disease
(b) Di-George syndrome and SCID. Secondary immune deficiency - AIDS. Transmission of HIV. Vaccines to prevent AIDS. Autoimmunity

MODULE V

CELL BIOLOGY, MOLECULAR BIOLOGY AND BIOINFORMATICS

CELL BIOLOGY

Cellular Membranes: Membrane structure and chemistry, dynamic nature of the plasma membrane, membrane functions, Diffusion and osmosis, Facilitated diffusion,
Active transport, Bulk transport. Nucleus and nuclear membrane membrane potentials, ion channels.
Cell junctions: Cell adhesion and Extracellular matrix Basal membrane and laminin, Collagen, Proteoglycan, Fibronectin. Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes. Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens. Junctions and desmosomes. Tight junctions, Gap junctions and Plasmodesmata.
Structural organization and function of intracellular organelles: Endoplasmic reticulum, Golgi complex, Ribosome, Mitochondria. Lysosome, Chloroplasts, Peroxisomes and Glyoxysomes
Organization of chromosomes and genes.: Structure of chromatin and chromosomes, heterochromatin, euchromatin –unique and repetitive DNA. Chromosomal changes-euploidy, aneuploidy, chromosomal aberrations- Structural alterations-gene mutations-molecularchanges- deletion, duplication, translocation, inversion and sister chromatid exchange. Interrupted genes and gene families. Concept of gene-Allele, multiple alleles, pseudoallele, complementation tests. Extrachromosomal inheritance- inheritance of mitochondrial and chloroplast genes, maternal inheritance.
Cell Signalling: Basic principles of cell communication. Extracellular messengers (signalling molecules), role of Calcium and Nitric oxide (NO) as intracellular and intercellular messengers. Receptors: G- Protein coupled receptors, Receptor tyrosine kinases (RTK), Ion channel receptors, Cytokine receptors (Tyrosine kinase linked receptors).Second messengers: Cyclic-AMP, Cyclic-GMP, Inositol 1,4,5-trisphosphate (IP3), Di-acyl glycerol (DAG). Signalling pathways: G-protein coupled receptor (GPCR) and cyclic AMP pathway – role of protein kinase A (PKA), GPCR pathway in rod cells, Receptor protein tyrosine kinase and Ras-MAP kinase pathway, JAK-STAT pathway, Calcium phosphatidyl- inositol pathway, Phospho Inositide 3-kinase (PI3 kinase),Transforming growth factor (TGF) signaling pathway. Regulation of signaling pathways.
Cellular Reproduction: Cell cycle: Mitosis, meiosis and Structure of chromosomes, Control of cell cycle, Checkpoints in cell cycle. Control of cell division and cell growth. Apoptosis-extrinsic and intrinsic pathways, significance.

Cancer: Basic properties of a cancer cell, Types of cancer, Causes of cancer, Genetics of cancer, Tumour suppressor gene, Oncogene. New strategies for combating cancer: Immunotherapy, Gene therapy, Inhibiting cancer promoting proteins, Inhibiting formation of new blood vessels.

MOLECULAR BIOLOGY

DNA replication: Semi-discontinuous synthesis-Okazaki fragments Replication origin and replication fork Unit of replication, extra chromosomal replicon of bacterial Ti plasmid Enzymes/proteins of replication- Primase, Replisomes, Helicase, DNA polymerases, Single strand binding proteins, Topoisomerases and Ligase; Fidelity of replication Replication of the ends of eukaryotic chromosome – role of telomerase, Models of DNA replication – Rolling circle model and looped rolling circle model, D-loop model, θ-model, Inhibitors of DNA replication – Methotrexate and Flu rodeoxyuridylate

Safe guard systems of DNA. Restriction enzymes: significance, role and features of Type I, II & III restriction enzymes Modification: enzymes and significance Repair: Major kinds of damage to DNA and causes Repair mechanisms: Direct reversal, Mismatch repair, Excision repair, Recombination repair, SOS response

Transcription of mRNA in prokaryotes and eukaryotes: Structural organisation and life span of mRNA; monocistronic and polycistronic mRNA Transcription in prokaryotes and eukaryotes, Promoter (mention Pribnow, TATA, CAAT and GC box), enhancer and silencer sites, Transcription factors; Transcription activators and repressors, Characteristic features of RNA polymerases of phages, prokaryotes and eukaryotes and their functions, Post transcriptional modification of RNA, Capping, Polyadenylation, Splicing, RNA editing

Genetic code: Characteristics of genetic code, Start codons and stop codons, Degeneracy of the code: Wobble hypothesis and isoacceptor tRNAs, Special features of the genetic code in mitochondria, mitochondrial tRNA, Variations in the genetic code in Mycoplasma and Tetrahyme Point mutations that alter genetic code (missense, nonsense & frameshift)

Ribosome: The site of protein synthesis: Structure, Composition; Reconstitution experiments . Active centres Biogenesis of ribosome in eukaryotes

Translation in prokaryotes and eukaryotes: Aminoacylation of tRNA & initiation, elongation and termination of protein synthesis Aminoacyl tRNA synthetases & initiation, elongation and termination factors Translational proof-reading Differences in protein synthesis between prokaryotes and eukaryotes Translational inhibitors in prokaryotes and eukaryotes – role of tetracycline, streptomycin, neomycin, chloramphenicol, erythromycin, puromycin and diphtheria toxin Post- translational modification of proteins: protein folding (role of chaperones) and biochemical modifications

Control of gene expression at transcription and translation level:: Regulation of gene expression in Phages – alternate patterns of gene expression for control of lytic and lysogenic cycle in λ phage Regulation of gene expression in bacteria – basic features of tryptophan, lac, arabinose and galactose operons Regulation of gene expression in eukaryotes – Role of chromatin in regulating gene expression Activation and repression of transcription Regulation of translation by gene arrangement Regulation of translation by alternate pathways of transcript splicing Antisense RNA strategies for regulating gene expression si RNA and mi RNA in regulation

Eukaryotic genome: Special features of eukaryotic genome Features, components and re-association kinetics of Unique, Moderately repetitive and High repetitive DNA Junk DNA, Satellite DNA and Selfish DNA, Cot value and complexity of genome, Organisation of human genome

Interrupted genes: Definition and explanation: Organisation and special features of interrupted genes Interrupted genes in eukaryotes, exons and introns-R loops, significance of introns. Genes-within-genes (overlapping genes) Bacteriophage Ö X174., Evolution of interrupted genes Gene families: Definition and concept, Classification with example, Simple multigene family - organisation of rRNA gene in Xenopus.

Complex multigene family - organisation of histone genes in sea urchin and tRNA genes in Drosophila Developmentally controlled complex multigene family e.g., globin gene Globin genes and its products, Organisation of globin genes and its expression in Man, Evolution of globin genes

Concept of an evolutionary clock, Pseudogenes, Transposable genetic elements - Transposons: Definition, features and types Transposition and mechanism, Transposons in bacteria

IS elements, Tn family Mu phage as a transposable element Transposons in eukaryotes. SINE, Alu family ;LINE,L1 P elements in Drosophila, Transposons in Maize, Retroviruses and transposition

Molecular mechanisms involved in recombination of DNA : Genetic recombination – Site specific recombination Non-homologous recombination Homologous recombination: Molecular mechanism involved in homologous recombination of DNA in eukaryotes- Holliday model: Holliday intermediate, heteroduplex DNA, gene conversion Role of Rec A protein in genetic recombination

Microbial genetics: Prokaryotic genome- Escherichia coli genome – basic feature Methods of genetic transfers in bacteria– transformation (in *Streptococcus pneumonia*), conjugation and sexduction, transduction. Mapping genes by interrupted mating (in bacteria) Organelle genome: Chloroplast genome. Mitochondrial genome, Special features of yeast and human mitocondrial genome.

BIOINFORMATICS

Primary databases - Nucleotide sequence databases: GenBank, EMBL, DDBJ ; Protein sequence databases: SWISSPROT, PIR; Structure databases: PDB, NDB; Secondary databases: PROSITE, Pfam, CATH; Composite databases: OWL; Literature database: PubMed; Database searching – Entrez; Database sequence submission – BankIt. Types of sequence alignment, methods of sequence alignment, scoring schemes, gaps and gap penalties, construction of phylogenetic trees. Structural genomics, functional genomics, comparative genomics, data mining in proteomics – Microarrays, significance of proteomics and drug design, Systems Biology, metabolomics, gene network, synthetic biology

MODULE VI

DEVELOPMENTAL BIOLOGY AND GENETICS

DEVELOPMENTAL BIOLOGY

Basic concepts of development Cell fate, potency, determination and differentiation. Commitment, Specification - autonomous, conditional, syncytial . Genomic equivalence and cytoplasmic determinants, Morphogenetic gradients, Genomic Imprinting, The stem cell concept- Progenitor cells, Adult stem cells, Mesenchymal stem cells, Multipotent adult stem cells, Pluripotent Embryonic stem cells, Induction, Competence, Determination and Differentiation, Morphogenetic gradients, Cell fate and cell lineages.Genomic equivalence and Cytoplasmic determinants.

Gametogenesis, fertilization and early development: Production of gametes- Spermatogenesis and Oogenesis, Ultrastructure of gamates, Cell surface molecules in sperm-egg recognition in animals (sea urchin and mammals) Zygote formation-Encounter of sperm and egg, Capacitation, Acrosome reaction, Activation of ovum, Amphimixis, Prevention of Polyspermy Cleavage and blastula formation, Gastrulation and formation of germ layers in amphibia,

Embryogenesis and Organogenesis : Axis formation in amphibians - The phenomenon of the Organizer- Nieuwkoop center., primary embryonic induction, mechanism of axis formation, Anterior-Posterior patterning in Amphibians- Hox code hypothesis Anterior posterior patterning in Drosophila – anterior forming genes (bicoid, hunchback), posterior

forming genes (nanos, caudal), terminal forming gene (torso), segmentation genes- gap genes, pair rule genes, segmentation polarity genes, homeotic selector genes, realistor genes Dorso-ventral patterning in Drosophila. –dorsal protein gradient Limb development in chick- Formation of the Limb Bud, Generating the Proximal-Distal Axis of the Limb, Specification of the Anterior-Posterior, Limb Axis, Generation of the Dorsal-Ventral Axis. Insect wings and legs formation. Eye lens induction.

Transcription factors induced in the organizer. Neural induction, Regional specificity of induction, Genetic specificity of induction (Paracrine factors - Hedgehog family, Wnt family, TGF, BMP). Surface receptors and signal transduction pathway - RTK pathway, Smad pathway, Wnt pathway, Hedgehog pathway and cell death pathway.

Differential gene transcription - exons and introns, promotors, silencers, enhancers, transcription factors, DNA methylation, genomic imprinting, dosage compensation, differential RNA processing; Control of gene expression: translational and post translational control of gene expression.

Metamorphosis of Amphibians and Insects; Hormonal control of metamorphosis.

Heterochrony- neoteny, progenesis; regeneration - different types of regeneration; Histological processes during regeneration; Polarity and Metaplasia in regeneration;

Teratogenesis, Malformations and disruptions, Gene – phene relationship, Autophene, Allophene and Pleiotrophy;

Teratogenic agents (Retinoic acid, pathogens, alcohol, drugs and chemicals, heavy metals); Environmental oestrogens. Infertility-Test tube babies (In vitro fertilization and embryo transfer). Cloning experiments- (Amphibians, Mammals and Human).

GENETICS

Principles of Genetic Transmission: Mendelian Principles, Extension of Mendel's principles: allelic variation and gene function- incomplete dominance and co-dominance. Gene action- from genotype to phenotype - penetrance and expressivity, gene interaction epistasis, pleiotropy, genomic imprinting, phenocopy.

Molecular Organization of Chromosomes. Sex determination, sex linkage, sex limited and sex influenced characters in Man Genome size and C-value Paradox. Structure of eukaryotic chromosome, nucleosome model. Chromosome condensation - euchromatin and heterochromatin. Repetitive nucleotide sequences in eukaryotic genomes, kinetics of renaturation: Cot and Cot curve. Unique and repetitive sequences. Mini and micro satellites. Molecular structure of centromere and telomere. Polytene chromosomes and Lampbrush chromosomes. Chromosome banding techniques.

Gene Fine Structure: The definition of gene. The standard genetic code, redundancy and Wobble.DNA Structure- alternate forms of the Double Helix. Gene synthesis (in vitro synthesis) – works of Khorana and Kornberg.

Genetic Linkage, Chromosome Mapping. Chromosome theory of heredity, Linkage and recombination of genes in a chromosome, crossing over as the physical basis of recombination, Gene conversion, Recombination mapping with two-point and three –point test cross in Drosophila, Coincidence and Interference. Genetic mapping by tetrad analysis in Neurospora. Mitotic recombination. Genetic recombination in Phage, deletion mapping, conjugation mapping, mapping by interrupted mating, mapping with molecular markers and mapping using somatic cell.

Human Genetics: Karyotype, pedigree analysis, Chromosome anomalies : autosomal and sex chromosomal disorders. Lod score for linkage testing, genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits; human genome and mapping.

Epigenetics: Epigenetics - from phenomenon to field, a brief history of epigenetics - over view and concepts; chromatin modifications and their mechanism of action, concept of 'histone-code' hypothesis, epigenetics in *Saccharomyces cerevisiae*, position effect variegation, heterochromatin formation and gene silencing in Drosophila.

Quantitative and Population Genetics: Polygenic inheritance, analysis of quantitative traits, quantitative traits and natural selection, molecular analysis of quantitative traits, phenotypic plasticity

MODULE VII

ECOLOGY, BIODIVERSITY CONSERVATION

ECOLOGY

Ecology and Environment: Concepts of habitats, niche, niche width and overlap, fundamental and realized niche, resource partitioning, character displacement. Gaia hypothesis. Concept of limiting factors- Liebig's law, Shelford's law. Ecological indicators.

Ecosystem - Structure and Function. Food chain, food web, trophic levels. Ecological efficiencies, Ecological pyramids, Biogeochemical cycles- patterns and types (CNP).

Tropical versus Temperate Ecology.

Population Ecology: Population group properties, Natality and mortality. Population age structure, Growth forms and concept of carrying capacity. Population fluctuations, density dependent and density independent controls. Life history strategies, r & k selection. Population structure, aggregation, Allee's principle, isolation, dispersal and territoriality, survivalship curves, life tables, Population interactions- types, positive and negative, interspecific and intraspecific interactions. Ecological and evolutionary effects of competition, Lotka Volterra model,

Community Ecology: Concept of community - community structure and attributes, ecotone and edge effect. Ecological succession: types and mechanism, concept of climax. Species diversity in community and it's measurement Alpha diversity, Simpson's diversity index, Shannon index, Fisher's alpha, rarefaction. Beta diversity Sorensen's similarity index, Whittaker's index, Evenness, Gamma diversity,

Resource Ecology: Natural Resources: Soil-soil formation, physical and chemical properties of soil. significance of soil fertility. Mineral resources with reference to India. Impact of mining on environment; Forest resources deforestation, forest scenario of India. Aquatic resources - Freshwater and water scarcity, water conservation measures - case studies from India; Wetlands and its importance, international initiatives for wetland conservation - Ramsar sites. Sand mining and its impacts. Wetland reclamation- causes and consequences.

Ecosystem monitoring- GIS, Physics of remote sensing, role of remote sensing in ecology, GPS and its application; EIA- tools and techniques, Ecosystem Modelling.

Applied Ecology: Environmental Pollution-types, causes and consequences. Concept of waste, types and sources of solid wastes including e-waste; Environmental biotechnology and solid waste management- aerobic and anaerobic systems. Concept of bioreactors in waste management. Liquid wastes and sewage. Bioremediation- need and scope of bioremediation in cleaning up of environment. Phytoremediation, bio-augmentation, biofilms, biofilters, bioscrubbers and trickling filters, Energy audit, Green technology and sustainable development, ecological foot print, carbon foot print, carbon credit, ecotaxes

Deforestation- surface albedo- snow and ice- volcanic activity-dust particles- Greenhouse gas concentrations -Atmosphere- ocean heat exchange-Atmospheric carbon dioxide Variations- human influences: Global climate changes – causes and consequences. Physical evidence for climatic change – Historical and archaeological evidence-Glaciers – Vegetation Ice cores – Dendron climatology- Pollen analysis-Sea level change

Toxicology- Principles, toxicants- types, dose and effects, toxicity of heavy metals.

BIODIVERSITY CONSERVATION

Biogeography and Conservation. Principles and major approaches to conservation and environmental management. Role of UN- conventions, protocols; Climate change and the emerging discussions mitigation and adaptation; Role of UNFCC and IPCC. Country specific laws- mention major environmental/ conservation laws and rules in India-Wildlife Protection Act 1972 amended 1991, Forest Conservation Act, 1980, Air (Prevention and Control of Pollution) Act 1981, Water (Prevention and Control of Pollution) Role of Intergovernmental and Non-governmental organizations in conservation-IUCN, WCMC,WRI,WWF, CI and Green Peace. National and Local NGOs.

MODULE VIII

MICROBIOLOGY AND BIOTECHNOLOGY

MICROBIOLOGY

History and scope of microbiology: Contributions of Louis Pasteur, Robert Koch, Alexander Flemming and Edward Jenner.

Microbial Taxonomy and Phylogeny, Major characteristics (classic and molecular), Numerical taxonomy, Taxonomic ranks, Phylogenetic studies, Phenetic classification, Bergey‟s Manuel

Bacterial cell structure and function, Plasma membrane and internal system - Cytometrix, inclusions, ribosomes, nucleoid

Bacterial cell wall Peptidoglycan - structure- Gram positive and gram negative cell wall- Mechanism of gram staining, Components external to cell wall; pili and fimbriae, capsule and slime layers, Flagella and motility

Microbial nutrition: Nutritional requirements, Nutritional types (Auto, Hetero, Chemo, Phototrophs & obligate parasites), Culture media and types of media. Mixed microbial population and pure cultures.

Microbial growth: Growth curve -synchronous growth, Continuous culture, Influence of environmental factors on growth, Measurement of growth, Measurement of cell numbers- Petroff, Hassuer counting Chamber, Spread plate and pour plate techniques Measurement of cell mass-Turbidity and microbial mass measurement

Utilization of energy: Biosynthetic process- peptidoglycan synthesis, amino acid synthesis, Non synthetic processes -Bacterial motility and transport of nutrients.

Viruses: General structural properties, Types: DNA viruses, RNA viruses, and enveloped viruses

Microbial diseases : Human diseases caused by viruses- AIDS, Rabies, Measles, Swine Flu, Bird flu, SARS, Fungal diseases- Candidiasis, Human diseases caused by bacteria- Typhoid, Cholera, Tetanus, Leprosy, Tuberculosis and Pneumonia.

Control of microorganisms: Disinfectants- physical- Heat, filtration and radiation Chemical agents - Phenol and Phenolic compounds, alcohols, halogens and aldehydes. Antibiotics- Penicillin , Cephalosporins, Chloramphenicol, Tetracyclines. Microbial drug resistance.

Microbial fermentation: Lactic acid fermentation-Homolactic and heterolactic fermenters, Dairy products -cheese and yogurt . Alcoholic fermentation.

Environmental microbiology: Microbiological analysis of drinking water. Microbial Bioremediation. Biogas plant.

BIOTECHNOLOGY

Historical aspects, definitions and scope of Biotechnology. Biotechnology in India. Tools and Techniques in Recombinant DNA Technology: Vectors: cloning and expression vectors - Plasmids, Ti and Ri plasmids, cosmids, phasmids, phagemids, bacteriophage, SV40, vectors with combination features; PUC19 and Bluescript vectors, shuttle vectors, viral vectors, BAC and YAC vectors. Restriction enzymes and DNA modifying enzymes. Polymerase chain Reaction- different types and applications. Chromosome walking, chromosome jumping, DNA foot printing. Molecular Markers and Probes-SNP, VNTR, RAPD, RFLP, SSR, STMS, FISH and GISH. DNA sequencing methods- Maxim and Gilberts chemical degradation method, Sanger and Cousin method, Automated DNA sequencers. Site directed mutagenesis, molecular chimeras. Cloning Methodologies - Gene isolation Shot gun method, Genome libraries, cDNA libraries, Chemical synthesis. Splicing and integration of isolated gene- cohesive end ligation, homopolymer tailing, extending linkers. Methods of rDNA transfer to host cells- $CaCl_2$ treatment, Virus delivery. Selection and screening of the transformed cells, Blue-white screening, Colony hybridization methods, Reporter genes, Fusion proteins. Southern, Northern, Western, Dot Blot, DNA finger printing.

Animal Biotechnology: Cell and Tissue culture: Basic techniques of mammalian cell culture, disaggregation of tissue and primary culture, maintenance of cell culture and cell separation. Growth media: Physicochemical properties, natural and artificial, Balanced salt solutions, Complete Media, Serum, Serum-Free Media and protein free media and their applications. Biology and characterization of cultured cells, measurement of viability and cytotoxicity. Manipulation of cultured cell and tissues- scaling up of animal cell culture, cell synchronization, cell transformation, organ and histotypic culture. Tissue engineering: strategies and developments in tissue engineering, Biomaterials. Contamination: Source of contamination, Type of microbial contamination, Monitoring, Eradication of contamination, Cross-Contamination. Cryopreservation - importance and process of cryopreservation, cryopreservation of embryos, Cryogenics. Transfection Methods: $CaPO_4$ precipitation, Short Gun, Electroporation, Lipofection, Microinjection, Agrobacterium mediated gene transfer. Somatic cell nuclear transfer- reproductive cloning and therapeutic cloning. Gene knockout and knockin technology. Applications of transgenic animals. Stem cell culture : General and historical aspects, properties and types of stem cells, advantages and disadvantages, stem cell niche, application of stem cell technology in medicine.

Biotechnology in Healthcare: Disease prevention – DNA vaccines. Disease diagnosis - Probes, Monoclonal antibodies, detection of genetic disorders. Disease treatment - Therapeutic proteins, hormones and growth factors. RNAi, Drug targeting, Gene therapy. Forensic medicine. Biosensors-different types, applications - medical and non medical. Biochips and their application.

Biotechnology in Industry and Agriculture: Metabolite production. Antibiotics, Organic acids, Amino acids, Vitamins, Upstream processing, downstream processing. Microbial enzymes and biotranformation- Microbial production of enzymes, fermentation, Enzyme engineering and applications. Food industry- Single cell protein, probiotics. Transgenic plants- Plants with resistance to Pests, plants with increased shelf life. Biofertilizers and microbial inoculants, biotechnology of nitrogen fixation, biocontrol agents, biopesticides, bioinsecticides, Terminator gene technology

Environmental Biotechnology : Sewage treatment. Solid waste management. Biodegradation of xenobiotic compounds. Bioremediation and Biorestoration. Microbial leaching and mining. Biofuels. Transgenics and environment.

Intellectual Property Rights, Biosafety and Bioethics: Introduction to Intellectual Property Rights, Types of IP: Patents, Trademarks, Copyrights. Basics of Patents Types of patents; Indian Patent Act 1970; Recent Amendments, Protection of New GMOs. IPs of relevance to Biotechnology and few Case Studies (Rice, Neem, Curcumin). Introduction to History of GATT, WTO, WIPO and TRIPS. Biosafety concepts and issues. General

guidelines for recombinant DNA research activity. Biosafety protocol 2000. Bioethics: Principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc. Ethics in post genomic era-genetic testing and genetic screening.

MODULE IX

ECONOMIC ZOOLOGY, ENTOMOLOGY, FISHERIES, WILDLIFE BIOLOGY AND HUMAN GENETICS

Insect pests of agricultural crops, control measures, economically important insects, Common Aquaculture practices, culture fishes, classification of fish, ornamental fishes, chromosomal anomalies in human, inborn errors in metabolism, molecular diagnosis techniques, classification of mammals, endemic Indian birds,

MODULE X

RECENT DEVELOPMENTS IN ZOOLOGY

BOTANY

MODULE -1

PHYCOLOGY

1. Classification of algae - Fritsch and Smith
2. Recent trends in classifications
3. General features of algae - thallus organization, vegetation, sexual and asexual reproduction and life cycle
4. Pattern of life cycle and salient features of the following classes: Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta
5. Economic importances of algae : Biofertilizers, Food industry, Industrial and medicinal importances, algal bloom

MYCOLOGY

1. Classification of fungi - Alexopoulos and Mims (1979), Ainsworth and Bisby (1983)
2. General features of fungi - thallus structure, cell wall structure, heterothallism, parasexuality and reproduction
3. Salient features of following classes- Myxomycota, Mastigomycota, Zygomycota, Ascomycota, Basidiomycota and Deuteromycota
4. Fungal associations - symbiosis, saprophytism, mycorrhiza, endophytes, lichens
5. Economic importances of fungi - degradation of pesticides and wastes, decomposition of organic matter, degradation of lignin, significances in medicine and industry, fungal toxins and human health

PLANT PATHOLOGY

1. Principles of plant pathology - biotic and abiotic agents and various symptoms of plant diseases
2. Process of infection and defense mechanisms - enzymes, toxins, structural and biochemical defense systems
3. Disease management - chemical, biological and quarantine measures
4. Common diseases of crops in Kerala - paddy, coconut, rubber, arecanut, pepper, ginger, cardamom, coffee and tea

BRYOLOGY

1. General account on morphology, anatomy and life cycle of the following groups: Hepaticopsida, Anthoceratopsida and Bryopsida
2. Origin, evolution and economic importances of bryophytes - indicators of pollution, horticulture, medicine etc..

PTERIDOLOGY

1. General account on morphology, anatomy and life cycle of the following groups -Psilopsida, Psilotopsida, Lycopsida, Sphaenopsida and Pteropsida
2. Heterospory, seed habit, stelar evolution
3. Economic importances of pteridophytes - as biofertilizers, in horticulture, medicine, ecological indicators, as weed, in food industry

GYMNOSPERMS

1. General account on morphology, anatomy and life cycle of the following groups -cycadopsida, coniferopsida and gnetopsida
2. Economic importances of gymnosperms

MICROBIOLOGY

1. Bacteria: ultra structure, major groups, nutritional types and reproduction
2. Viruses: ultrastructure, major groups, nutritional types, replication
3. Brief account on phones, viroids, virions, mycoplasmas, interferons, actinomycetes, bacteriophages
4. Economic importances of microbes- in ecology, food, industry, medicine, agriculture and other industries

PALAEOBOTANY

1. Geological time scale and evolution of plant groups
2. Types of fossilization
3. Fossil pteridophytes and gymnosperms

MODULE-II

ANGIOSPERM ANATOMY

1.Tissues - meristem, secretory and excretory tissues, primary and secondary tissues
2. Anatomy of stem, root and leaf - both primary and secondary structure in stem and root
3. Anomalous secondary growth in dicot and monocot stems
4. Brief account of nodal anatory, wood anatomy and floral anatomy

MICROTECHNIQUE

1. Tools in microtechnique -microscopy, micrometry, camera lucida, cryostat, microtomes (rotary and sledge)
2. Fixing, killing, dehydration, clearing, embedding, staining and mounting - reagents used in each step
3. Brief account on vital staining, double staining, whole mount, maceration and histochemical tests for carbohydrates, proteins and lipids

EMBRYOLOGY

1. Microsporogenesis and male gametophyte development
2. Megasporogenesis and embryosac development
3. Pollination, fertilization and embryogeny in both monocots and dicots
4. Endosperm types, polyembryony, parthenocarpy and apmixis

PALYNOLOGY

1. Ultrastructure of pollen wall, pollen morphology, - NPC system of classification of pollen apertures
2. Contributions of Dr. PKK. Nair to palynology
3. Palynology in relation to taxonomy
4. Aeropalynology and melittopalynology and pollen allergy

PLANT BREEDING

1. Methods in crop improvement and achievements - plant introduction, selection, mutation breeding, polyploidy breeding and hybridization
2. Consequences of inbreeding, heterosis and incompatibility
3. Back cross breeding, resistance breeding (disease resistance and stress resistance), vertical and horizontal resistances
4. Seed production and certification, major centres of crop production in India
5. Plant breeder's rights, national biodiversitypolicy
6. Methods of vegetative propagation of plants

EVOLUTION

1. Origin of life - theories of evolution, classical and modern
2. Speciation

MODULE-III

TAXONOMY

1. Principles of taxonomy - plant nomenclature, taxonomic hierarchy, phylogeny of angiosperms, taxonomic keys
2. Classification systems - artificial, natural and phylogenetic
3. Interdisciplinary approaches to angiosperm systematic (anatomy, embryology, morphology, cytology, palynology, chemotaxonomy, numerical taxonomy, molecular taxonomy)
4. Study of the following families and their characteristic features: Ranunculaceae, Magnoliaceae, Capparidaceae, Polygalaceae, Cryophyllaceae, Malvaceae, Leguminosae,

Myrtaceae, Melastomaceae, Cucurbitaceae, Rubiaceae, Asteraceae, Asclepiadaceae, Boraginaceae, Lamiaceae, Amaranthaceae, Euphorbiaceae, Orchidaceae, Scitamineae, Liliaceae, Commelinaceae, Arecaceae, Araceae, Cyperaceae, Poaceae.

MORPHOLOGY

1. Flower as a modifiedshoot
2. Floral whorls and their parts - fruits and seed morphology
3. Vegetative morphology = leaf, root and stem

ECONOMIC BOTANY

1. Common cereals, millets and pulses
2. Vegetables, spices, beverages crops
3. Timbers, fibres, sugar and oil yielding crops
4. Medicinal plants

ETHONOBOTANY

1.Methods of ethnobotanical studies
2. Contributions of SK. Jain to ethnobotany
3. Common plants of ethnobotanical importance in Kerala
4. Sacred groves and their importance

PHYTOGEOGRAPHY

1. Factors affecting plant distribution
2. Phytogeographic zones of India
3. Soil, climate and vegetation of India

FOREST BOTANY

1. Major and minor forest products with special reference to Kerala
2. Significances of forest on environment
3. Consequences of deforestation and industrialization

ENVIRONMENTAL BIOLOGY

1. Habitat ecology - terrestrial, fresh water, wet land and marine
2. Population ecology - community ecology and ecological succession
3. Ecosystems - structure, function and types and biomes ,
4. Species interactions - competitions, herbivory, carnivory, symbiosis etc..
5. Biogeochemical cycles and environmental pollution - air, water and noise
6. Global environmental problems - ozone depletion, global warming, acid rain, nuclear hazards, El-nino, climate change,
7. Environmental impact assessment and major programmes - UNEP, IUCN, MAB, Earth Summit, CBD

MODULE - IV

CELL AND MOLECULAR BIOLOGY

1. A brief account on structure, function of cells and cell organelles, - prokaryotic and eukaryotic cells, cytoskeleton - organization and mobility
2. Origin, Ultrastructure and function of cell membrane, cell organelles

3. Chemistry of chromosome - DNA, RNA, kinetochore, NOR and constriction of chromosomes
4. Numerical and structural variations of chromosomes
5. Cell divisions - stages, synaptonemal complexe, theories and mechanism of crossing over and molecular mechanism of crossing over
6. Cell differentiation - characteristics and mechanisms
7. Prokaryotic and eukaryotic DNA replication
8. Molecular nature of genes
9. Molecular tools for studying genes and gene activities
10. Techniques of DNA analysis - preparation of DNA and RNA probes, hybridization, autoradiography, DNA finger printing
11. DNA sequencing, chemical synthesis of nucleotides
12. PCR and FISH and their applications

GENETICS

1. Mendelian genetics and gene interation
2. Linkage and crossing over, gene mapping
3. Polygenic inheritance
4. Extra chromosomal inheritanace
5. Microbial genetics - transduction, transformation and conjugation in bacteria, Lysogeny and lytic cycle in viruses
6. Nucleic acids - DNA and RNA types, structure, function and replication
7. Mutations, DNA damage and repair
8. Genetic code and gene expressions - protein synthesis, gene regulations - prokaryotes and eukaryotes
9. Translation, post translation and post transcription
10. Gene synthesis - Khorana -Kornberg
11. Population genetics - Hardey-Weinberg equilibrium - genetic drift, genetic load, consanguinity and its genetic effects
12. Human genetics - blood group systems - ABO, Rh and MN blood groups, human karyotype and syndromes caused by its aberrations, genetic counseling, pedigree analysis
13. Brief account of human genome project

MODULE-V

PLANT PHYSIOLOGY

1. Water relation to plants - absorption and transpiration of water - opening and closing of stomata - factors affecting water transport
2. Mineral nutrition - hydroponics, aeroponics
3. Nitrogen metabolism in plants
4. Photosynthesis - C3, C4 and CAM cycle in detail, photorespiration
5. Respiration - oxidative photophosphorylation
6. Ascent of sap - source and sink relationship
7. Growth and development - role of phytohormones, photoperiodism, vernalization, florigines
8. Stress physiology - water, salt, hot and cold stress - heat shock proteins, adaptations

9. Seed germination - physiological and biochemical Changes

BIOCHEMISTRY

1. Carbohydrates - structure, function and metabolism, inter conversion
2. Lipids - structure, function and metabolism, biosynthesis of fatty acids, alpha and beta oxidation
3. Amino acids and proteins - structure and properties and classification of amino acids and proteins, amino acid metabolism, Ramachandran plot, verification of proteins
4. Enzymes - major groups, relation of enzyme activity, enzyme kinetics, assay, regulation, allosteric enzymes, isoenzymes, ribioenzymes, coenzymes
5. Vitamins - classification, function and sources of vitamins and their role as co-enzymes

BIOPHYSICS

1. pH and buffers
2. Microscopy - bright field, phase contrast, fluorescent and electron microscope (SEM and TEM), photometry, colorimetry
3. Chromatogram - gel filteration, ion exchange, affinity, TLC, GC, HPLC, HPTLC, GCMS
4. Electrophoresis - AGE, PAGE, SDS-PAGE, isoelectrofocusing, ELISA
5. Centrifugation - density gradient and ultra centrifugation
6. Biophysical methods for analysis of biopolymers - x-ray diffraction, fluorescent, NMR spectroscopy, UV, visible and ESR spectroscopy, ORD/CD, atomic absorption and plasma emission spectroscopy
7. Radiation dosimetry, radioactive isotopes, autoradiography, Cerenkov radiation, liquid scintillation techniques

BIOSTATISTICS

1. Sampling methods and errors
2. Process and presentation of data - tables and graphs
3. Measures of central tendency - mean, median, mode
4. Measures of dispersion - range, quartile deviation, mean deviation, standard deviation and coefficient of variations
5. Probability - basic concept, theorems
6. Experimental design - randomnized block, latin square
7. Tests of significance - T-tests, Chi-square, F-tests, ANOVA
8. Correlation and regression analysis

MODULE - VI

BIOTECHNOLOGY

1. Plant tissue culture techniques - direct and indirect regeneration
2. Somatic cell genetics and somatic clonal variations
3. Somatic embryogenesis - artificial seeds, protoplast culture, somatic hybridization, impacts in plant breeding
4. Haploid production- anther and ovule culture - applications

5. Production of secondary metabolites - cell immobilization - bioreactor technology, in vitro strategies of germplasm conservation
6. Isolation of genomic and organellar DNA. Methods of gene identification - vector mediated and vectorless PCR, genomioc and cDNA libraries
7. Gene transfer techniques - direct and indirect traspossors as vectors - gene silencing
8. DNA markers - RFLP, RAPD, AFLP and Antisense RNA
9. Blotting techniques - Northern, Southern and West
10. Transgenic biology - gene cloning and transformation technique in plants-gene targeting and sequence tag
11. Genetically modified organisms and foods, social and ethical considerations, IPR issues, patents and biopiracy

BIOINFORMATICS

1. Introduction to data structures, data base concepts, tools for searching, homology searching
2. Application of databases in biology
3. Sequence databases .sequence comparison, structural databases, proteomics and genomics (elementary)
4. Major bioinformatic resources - NCBI, EBI, EMBL, GENBANK, DDBJ, SWISSPROT, PDB
5. Tools in bioinformatics - BLAST, CLUSTAL -X, CLUSTAL-W, Phylip, GENSCAN
6. Applications of bioinformatics - transcriptomix, metabolomics, pharmacogenomics (brief account only)

COMPUTER APPLICATIONS

1. Computer application in biology
2. Computer packages for biostatistics and numerical taxonomy
3. Hardware and software parts of a computer
4. Internet online biology resources, public library of sciences, online publications, electronic journals and books

MODULE – VII

Recent developments in Botany

NOTE: - It may be noted that apart from the topics detailed above, questions from other topics prescribed for the educational qualification of the post may also appear in the question paper. There is no undertaking that all the topics above may be covered in the question paper