KARNATAKA EXAMINATION AUTHORITY

SUBJECT: MICROBIOLOGY

UNIT I. MOLECULES AND THEIR INTERACTION

1. **Structure of atoms, molecules and chemical bonds and interactions** (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.).
2. **Composition, structure and function of biomolecules** (carbohydrates, lipids, proteins, nucleic acids and vitamins).
3. **Principles of biophysical chemistry** (pH, buffer, reaction kinetics, thermodynamics, colligative properties).
4. **Bioenergetics**: High energy compounds, types of phosphorylation, ETC of prokaryotes and eukaryotes Anaerobic Respiration, fermentations, chemoautotrophy, coupled reaction, group transfer, biological energy transducers, carbon assimilation.
5. **Enzymes:** Classification and nomenclature of enzymes, principles of catalysis, enzyme kinetics, regulation and mechanism of catalysis and inhibition, isozymes, ribozymes.
6. **Conformation of proteins** (Ramachandran plot, secondary structure, domains, motif and folds).
7. **Conformation of nucleic acids** (helix A, B, Z).
8. **Stability of proteins and nucleic acids.**
9. **Metabolism of carbohydrates** (Glyolysis, Pentose phosphate pathway, ED pathway, Glyoxlate cycle, Phosphoketolase pathway, Citric Acid cycle, gluconeogenesis) anabolism and catabolism of lipids, amino acids, nucleotides.

UNIT II. CELLULAR ORGANIZATION

1. **Membrane structure and function** (Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, nutrient uptake, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes).
2. **Structural organization and function**: extracellular and intracellular organelles of prokaryotes and eukaryotes
3. **Organization of genes and chromosomes in prokaryotes and eukaryotes** (Operon, genomic structure in prokaryotes, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons).
4. **Prokaryotic cell cycle** (Binary fission, Budding, Fragmentation) and **Cell division**-Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.
5. **Microbial Physiology** (Growth yield, growth curve, growth kinetics, mathematical expression of growth and characteristics, strategies of cell division, stress response and microbial photosynthesis)

UNIT III. FUNDAMENTAL PROCESSES

1. **DNA replication, repair and recombination** (Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination and transposons).
2. **RNA synthesis and processing** (transcription factors and machinery, formation of initiation complex, transcription activator and repressor, RNA polymerases, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, structure and function of different types of RNA, RNA transport).
3. **Protein synthesis and processing** (Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-

identity, aminoacyl tRNA synthetase, and translational proof-reading, translational inhibitors, Post-translational modification of proteins).

4. **Control of gene expression at transcription and translation level** (regulating the expression of phages, viruses, prokaryotic and eukaryotic genes, role of chromatin in gene expression and gene silencing).
5. **Microbial genetics** : Methods of genetic transfers – transformation, conjugation, transduction and sex-duction, mapping genes by interrupted mating, fine structure analysis of genes.
6. **Mutation:** Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, insertional mutagenesis.
7. **Structural and numerical alterations of chromosomes:** Deletion, duplication, inversion, translocation.

UNIT IV. Medical Microbiology and Immunology

1. **Host parasite interaction:** Recognition and entry processes of different pathogens like bacteria, viruses into host cell, alteration of host cell behavior by pathogens, virus-induced cell transformation, pathogen-induced diseases in humans, cell-cell fusion in both normal and abnormal cells.
2. **Cell signaling:** cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial two- component systems, bacterial chemotaxis and quorum sensing.
3. **Cellular communication:** Regulation of hematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins.
4. **Cancer** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.
5. **Innate and adaptive immune system** Cells and molecules involved in innate and adaptive immunity, antigens, antigenicity and immunogenicity. B and T cell epitopes, structure and function of antibody molecules. generation of antibody diversity, monoclonal antibodies, antibody engineering, antigen-antibody interactions, MHC molecules, antigen processing and presentation, activation and differentiation of B and T cells, B and T cell receptors, humoral and cell- mediated immune responses, primary and secondary immune modulation, the complement system, Toll-like receptors, cell-mediated effector functions, inflammation, hypersensitivity and autoimmunity, immune response during bacterial (tuberculosis), parasitic (malaria) and viral (HIV) infections, congenital and acquired immunodeficiencies, vaccines and Programmed cell death.
6. **Common parasites and pathogens of humans** (Neisseria, Corynebacterium, Vibrio, Haemophilus, Spirochetes-Treponema, Chlamydiae, Mycoplasma, diarrhoeal infections, Fungal: Dermatomycoses-Epidermophyton, Microsporum and Trichophyton: Madura foot; Subcutaneous mycoses: Sporotrichosis and Systemic mycosis: Blastomycosis, Coccodiodomycosis, Candidiasis, Opportunistic mycoses: Aspergillosis. Protozoan diseases- Leishmaniasis and filariasis. Viral diseases: Aetiology, Clinical symptoms, laboratory diagnosis and treatment: Varicella-zoster, Adenovirus, Picorna virus, Orthomyxoviruses (influenza), Coronoviridae (coronavirus), Paramyxoviruses (Measles), Rhabdoviruses, Hepatitis Viruses (HAV, HBV), H1N1, Oncogenic viruses (HPV), Arboviruses (Dengue) Prion infection-(CJD)
7. **Nosocomial infections.** Antibiotics and antimicrobial resistance.
8. **Types of Vaccines.**

UNIT V. Applied Microbiology

1. **Origin of cells and unicellular evolution:** Origin of basic biological molecules; Abiotic synthesis of organic monomers and polymers; Concept of Oparin and Haldane; Experiment of Miller (1953); The first cell; Evolution of prokaryotes; Origin of eukaryotic cells; Evolution of unicellular eukaryotes; evolution of anaerobic metabolism, photosynthesis and aerobic

metabolism. The evolutionary time scale; Eras, periods and epoch; Major events in the evolutionary time scale; Origins of unicellular and multi cellular organisms. Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Molecular tools in phylogeny, classification and identification; Protein and nucleotide sequence analysis; origin of new genes and proteins; Gene duplication and divergence

2. **Fundamentals of microbial ecology-** (concept of microbial ecology, development of microbial communities, Sucession and colonization) Micobial Ecology of different Ecosystem (Structure of ecosystem, fresh water, marine, eustarine and Mangrove ecosystem), Microbes- (Atmoshpere, Lithosphere, Hydrosphere), Application of Microbial Interactions (Decomoposition, Microbial Induced Corrosion, Bio-mining, Bio-Accumulation, Biodegradation, Xenobiotics, Biogeochemical cycles- C,N,P,S) Applied Ecology: Environmental pollution; global environmental change; microbial biodiversity:
3. **Agricultural Microbiology:** Microbes and Soil fertility, Plant-microbes interactions, Biological nitrogen fixation, Nitrogen cycle, Biofertilizers (Rhizobium, Azospirillum, Azotobacter, Cyanobacteria, phosphate solubilizing microorganisms) and Biopesticides (Bacteria,Fungal and Virus). Biochemistry and genetics of nitrogen fixation (Nitrogenase enzyme, nif genes and molecular mechanism of nitrogen fixation. Role of nodulin genes in nodule development and symbiosis. Genetic engineering of BNF). **Plant pathology**-Fungi (Wilt diseases, Downy mildews, Powdery mildews, Rusts, Smuts) Bacteria (Bacterial wilt, Bacteial blight of rice, Angular leaf spot of cotton, Citrus canker) Mycoplasma (Sandal spike, Grassy shoot of sugar cane) Virus (cauliflower mosaic disease, Banana bunchy top, Cucumber mosaic, Cow pea mosaic, Tobacco mosaic Protozoa: Hartrot of coconut, Phloem necrosis of coffee Viroids: Potato spindle tuber viroid
4. **Food and Dairy Microbiology:** Microorganisms in food and Dairy, food Contamination and food spoilage. Methods of food preservation, Food borne infections and intoxication (Bacterial- Bacillus, Escherichia, Clostridium perfringens, C. botulinum, Listeria, Streptococcus, Shigella, Salmonella, Brucella, Mastitis, Staphylococcus, Mycotoxins, food borne viruses, algae and protozoa) Detection of food borne pathogens and their toxins. Microbial fermented foods, Probiotics, Prebiotics and Synbiotics, Neutraceuticals and Functional foods, SCP, SCO, and their industrial production, Quorn.
5. **Industrial Microbiology:** Types of industrial fermentation, a typical fermentor and types of fermentors, upstream and downsteam processing. Role of microbes in production of commercially important products- alcoholic beverages, enzymes, antibiotics, hormones.
6. **Genetic Engineering:** Principles of rDNA technology, Enzymes used, GMO, GMP, GMA, Gene therapy and bioethics.

VI MICROBIAL TECHNIQUES

1. Molecular Biology and Recombinant DNA methods:
Isolation and purification of RNA , DNA (genomic and plasmid) and proteins, different separation methods. Analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, Isoelectric focusing gels. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Expression of recombinant proteins using bacterial, animal and plant vectors. Isolation of specific nucleic acid sequences Generation of genomic and cDNA libraries in plasmid, phage, cosmid, BAC and YAC vectors. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms. Protein sequencing methods, detection of post translation modification of proteins. DNA sequencing methods, strategies for genome sequencing. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD and AFLP techniques.

2. Histochemical and Immunotechniques: Antibody generation, Detection of molecules using ELISA, RIA, western blot, immunoprecipitation, fluocytometry and immunofluorescence microscopy, detection of molecules in living cells, in situ localization by techniques such as FISH and GISH.

3. Biophysical Method: Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy Molecular structure determination using X-ray diffraction and NMR, Molecular analysis using light scattering, different types of mass spectrometry and surface plasma resonance methods. Chromatography and centrifugation.

4. **Statisitical 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; X2 test;; Basic introduction to Muetrovariate statistics, etc.

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