

# Pre Ph. D. Entrance Examination 2017

Surguja University Ambikapur C.G.

## Syllabus - Microbiology

**General Microbiology:** Definition, Scope, Historical aspects, important/pioneer contributors. Microbiological methods: control of microorganisms, culture media, pure culture methods and preservation methods.

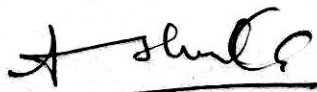
**Molecules and their interaction relevant to microbiology:**

Structure of atoms, molecules and chemical bonds. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Stabilizing interactions (Van der Waals, electrostatic, hydrogen bonding, hydrophobic interaction, etc.). Principles of biophysical chemistry (pH, buffer, reaction kinetics, thermodynamics). Structure of proteins and nucleic acids.

**Cellular organization:** Prokaryotic and Eukaryotic cell types, components, structure and function. Structural organization and function of intracellular organelles, Gram positive and Gram negative cell walls, Peptidoglycan, cell wall, cytoplasmic membrane, endospore, flagella, inclusion bodies, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast. Organization of genes and chromosomes (Operon, unique and repetitive DNA, interrupted genes, gene families, structure of chromatin and chromosomes, heterochromatin, euchromatin, transposons). Cell division including bacteria and cell cycle (Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle).

**Microbial Physiology:** Growth yield and characteristics, strategies of cell division, stress response, measurement of growth). Glycolysis, phosphorylation, redox reaction, electron carrier, membrane transport system. Metabolism of amino acids, purine and pyrimidines. Lipid metabolism. Enzymes and enzyme kinetics, mechanism of enzyme action, isozymes.

**Fundamental processes:** 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). RNA synthesis and processing



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(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). 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). 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).

**Medical microbiology :** Host parasite interaction, infection, types, different pathogens. alteration of host cell behavior by pathogens, virus-induced cell transformation. Morphological characteristics, pathogenesis, laboratory diagnosis, treatment and prevention of waterborne, foodborne, community borne pathogens. Mycotic infections, Mycoses and mycotoxins. Microbiological examination of water, indicator organisms.

**Cell signaling:** cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, two component systems, , bacterial chemotaxis and quorum sensing. Haematopoiesis, general principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins. 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.

**Immunology:** 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.

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**Microbial Photosynthesis** –photosynthetic pigments, Light harvesting complexes; oxygenic and anoxygenic photosynthesis, mechanisms of electron transport; photophosphorylation, photorespiration; CO<sub>2</sub> fixation-C<sub>3</sub>, C<sub>4</sub> and CAM pathways.

**Nutrient cycling by microbes:** Nitrate and ammonium assimilation; Dinitrogen fixation. Biofertilizer, Phosphate solubilizers, mycorrhiza. SCP, mushrooms, cultivation of edible mushrooms.

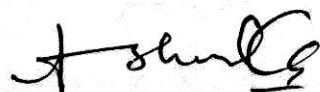
**Applied Microbiology:** Microbial fermentation and production of micro and macro molecules. Strain improvement, immobilization. Microbes and biofuels, bioremediation, biosensor and biochips. Production of recombinant proteins using microbes. Secondary metabolites - Biosynthesis of antibiotics, amino acids, organic acids, terpenes, phenols, flavinoids and their applications.

**Principles & methods of taxonomy:** Concepts of species and hierarchical taxa, biological nomenclature, classical & quantitative methods of taxonomy of microorganisms. Important criteria used for classification in each taxon. Classification of microorganisms. Phylogenetic relationships among taxa.

**Ecological principles:** The Environment: Physical environment; biotic environment; biotic and abiotic interactions. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche; resource partitioning; character displacement. Population 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. Microbial interaction Species Interactions: Types of interactions, interspecific competition, symbiosis.

**Applied Ecology:** Environmental pollution; global environmental change; biodiversity: status, monitoring and documentation; major drivers of biodiversity change; biodiversity management approaches

**Methods in biology:** 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, Iso-electric 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



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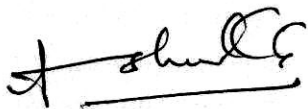


organisms. Protein sequencing methods, detection of post translation modification of proteins. DNA sequencing methods, strategies for genome sequencing. Methods for analysis of gene expression at RNA and protein level, large scale expression, such as micro array based techniques Isolation, separation and analysis of carbohydrate and lipid molecules RFLP, RAPD and AFLP techniques

**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. **Biophysical Method:** Molecular analysis using UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy. Spectrophotometry and colorimetry. **Statistical Methods:** Measures of central tendency and dispersal; probability distributions (Binomial, Poisson and normal); Sampling distribution; Difference between parametric and non-parametric statistics; Confidence Interval; Errors; Levels of significance; Regression and Correlation; t-test; Analysis of variance; X<sup>2</sup> test. **Radiolabeling techniques:** Detection and measurement of different types of radioisotopes normally used in biology, incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines. **Microscopic techniques:** Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, microscopy of living cells, staining techniques scanning and transmission microscopes, , image processing methods in microscopy. **Electrophysiological methods:** Single neuron recording, patch-clamp recording, ECG, Brain activity recording, lesion and stimulation of brain, pharmacological testing, PET, MRI, fMRI, CAT. **Electrophoretic technique, Chromatography, PCR**

**Food Microbiology:** Food spoilage, preservation methods., food borne diseases. Microbiological examination of food. Fermented foods.

**Research methodology:** meaning, characteristics, types of research. Selection of problem for research, formulation of hypothesis drafting a research proposal, criteria. Tools of research. Steps of research, sampling methods, processing of data. Writing of research paper, article, review, abstract, thesis writing. Definition, objective, scope and importance of seminar, conference, symposium and workshop. Use of information technology in research. Research ethics.



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