

2021

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DEPARTMENT OF MICROBIOLOGY

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Syllabus for PhD Entrance Examination in Microbiology 2021

Part (A) Research Methodology

- Statistical methods for data analysis: Mean, Standard deviation & standard error. Concept of probability and its significance. Distribution of the difference of two sample mean and proportions. Comparisons of two means and two proportions including paired Student T-test. Hypothesis & testing of hypothesis. Acceptance and rejection regions. Type I and Type II errors and their probabilities.
- Application of computers in microbiology: Different types of scientific journals, encyclopedia, magazine and scientific databases. Internet resources: Pubmed, ScienceDirect. Images (grey scale, RGB) and their resolution. Powerpoint slides as presentation application. Microsoft word and text editing applications. Data analysis softwares for graphs, charts and tables e.g. Sigma Plot, Origin, Excel spreadsheets.
- Concept of Biosafety levels (BSL-1 to 4), Biological hazards related to pathogens, genetically modified organisms. Chemical hazards: toxic chemicals and hazardous gases. Confinement and disposal of biohazardous waste.
- Ethics and best practices in microbiology: Good laboratory practices, Data manipulation, Plagiarism, Difference between predatory journals and approved scientific journals.
- Different types, application and principles of microscopy e.g. Bright field and dark field microscopy, fluorescence microscopy, phase contrast microscopy, electron microscopy (Scanning and Transmission). Components of bright-field and fluorescence microscope. Principles and applications of chromatography e.g. paper, thin layer, gel filtration, ion-exchange, reverse phase, affinity, gas chromatography and HPLC. Principle and applications of electrophoresis: SDS-PAGE, Isoelectric focusing (IEF), pulse field and Agarose gel electrophoresis. Principle, design and applications of spectrophotometer (UV visible, Mass, IR), centrifuges and batch fermenter. Buffers and concept of pH, Determination of pKa, Buffer in biological systems, isoelectric point.

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Part (B) Microbiology

1. General Microbiology:

- **General:** Major scientific contributions of Antony Van Leeuwenhoek, Lazzaro Spallanzani, Edward Jenner, Hans Christian Gram, Joseph Lister, Louis Pasteur, Martinus Beijerinck, Robert Koch, Alexander Fleming, Selman Abraham Waksman. The features and basis of three domain classification for Archaea, Bacteria and Eukarya. Structure and function of eukaryotic organelles and processes e.g. Endoplasmic reticulum, golgi body, nucleolus, nucleus, ribosome, lysosome, chloroplast, mitochondria, plasma membrane, pinocytosis, phagocytosis, autophagy.
- **Bacteriology:** Composition and application of popular bacterial growth media e.g. enrichment media, selective media and minimal media. Isolation of pure bacterial culture and its characteristics e.g. Pour plate, spread plate, streak plate, and serial dilution method. Principle and procedures of bacterial staining techniques (Gram staining, Endospore staining, Acid fast staining, Capsule staining). Difference between Gram +ve and -ve bacteria. Ultrastructure of bacteria (Cell wall, Plasma membrane, Capsule, Flagella, Pili and Endospore). Nutritional classification of bacteria (photoorganotrophs, photolithotrophs, chemoorganotrophs, chemolithotrophs, aerobic, anaerobic and facultative, microaerophilic aerotolerants). Bacterial growth curve, binary fission, sporulation, generation time, asynchronous growth, synchronous growth, batch culture, continuous culture. Bacteria chemotaxis, components and its mechanism.
- **Virology:** Nomenclature and molecular classification of virus. Ultrastructure of T even bacteriophage (bacterial virus), TMV (plant virus) and Herpes simplex virus (animal virus). One-step growth curve, Lysogenic and Lytic cycle.
- **Mycology:** Characteristics of division Mycota. Thallus organization and its modifications. Mode of fungal reproduction (asexual and sexual cycles, structures involved in reproduction, parasexual cycle). Fungal association (Mycorrhiza, Lichen). Life cycle of representative fungi e.g. *Mucor*, *Rhizopus*, Yeast. Fungal growth media (PDA, SDA) and solid state fermentation method.

2. Biochemistry and molecular biology:

- Structure and function of biomolecules (carbohydrates, lipids, proteins, nucleic acids and vitamins). Enzyme kinetics, enzyme inhibition, Allosteric enzyme, Rate limiting enzymes in multistep reaction, ribozyme and abzyme. Glucose catabolism and energy pathways: Glycolysis, Entner-Doudoroff pathway, pentose phosphate pathway, TCA

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cycle, glyoxalate cycle, electron transport chain and oxidative phosphorylation. Mechanisms of solute transport across membranes (Passive and ATP driven).

- Principles of cell signalling e.g. cyclic nucleotides, GPCR, Post translational modification e.g. phosphorylation, glycosylation, ubiquitination, nitrosylation, methylation, acetylation, lipidation and proteolysis, 5' capping, 3' polyadenylation, and RNA splicing.

3. Molecular biology:

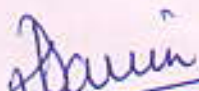
- DNA structure, replication and regulation: A, B and Z-DNA, concept of Watson-crick double helix structure, semi-conservative mode of DNA replication. Enzymes and proteins involved in replication and modification (Restriction enzymes), DNA damage, mutagenesis and repair (types of mutagens, ames test of mutagenesis). Structure of chromatin.
- RNA structure, synthesis and regulation: Cloverleaf structure of tRNA, mechanism of transcription, transcription activator, repressor and inhibitors (rho dependent and independent), cis acting and trans acting elements, RNA polymerases, RNA splicing, microRNA.
- Protein structure, synthesis and regulation: amino acids, primary, secondary, tertiary and quaternary structure, mechanism and processing of translation (e.g. amino acid activation, initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, Post- translational modification of proteins, inhibitors of translation).
- Regulation of gene expression, operon concept (lac and trp operon), gene silencing (RNA interference, epigenetic regulation).
- Gene transfer methods: transformation, conjugation, transduction, cloning and expression plasmids, transposons. Gene therapy.
- Molecular biology techniques: Sequencing (Nucleic acid, Protein), Blotting (southern, northern and western), Gene amplification (Polymerase chain reaction, ligase chain reaction, quantitative PCR). RFLP and RAPD, SNP, VNTR analysis, Gel electrophoresis.

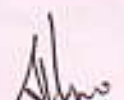
4. Immunology and Medical Microbiology:

- Concepts of antigens, antigenicity and immunogenicity, epitope and paratope, phagocytosis, inflammation, hypersensitivity and autoimmunity, immunity to infections.


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- Players of innate immunity e.g. Complement system and Leucocytes (Mast cells, Basophils and Eosinophils, Natural killer cells and Phagocytes e.g. Macrophages, Neutrophils, Dendritic cells).
- Players of adaptive immunity e.g. Lymphocytes e.g. T cells and B cells. Their types and function. T cell receptors, B cell receptors. Structure and function of antibody molecules. Antigen presentation and role of MHC molecules. Generation of antibody diversity, monoclonal antibodies, antigen-antibody interactions.
- Concept of Epidemiology, symptomatology and vaccines (live microorganism, attenuated organism, genetically modified organism, protein, edible, synthetic, recombinant and anti-idiotypic vaccine). General description of microbial pathogens, endotoxins, exotoxins, mycotoxins. Diagnosis, prevention and therapy of - meningitis, tuberculosis, leprosy, urinary tract infection, cholera, ring-worm, syphilis, diphtheria, mycotoxicosis, opportunistic fungal pathogens, dermatophytes, HIV and Herpes.
- Prevention of disease: Antibiotics e.g. Types (antibacterial and antifungal), classification, mode of action and mechanism of resistance to antibiotics. Probiotics (Characteristics of Probiotics organism, application for curing enteric disease and induction of host immunity).

5. Environmental and industrial Microbiology:

- Environmental factors influencing microbial distribution and diversity of microbes e.g. light, temperature, precipitation (rainfall), humidity of air, atmospheric gases and wind; topographical factors, edaphic factors. Extremophile: anaerobes, halophiles, acidophile, alkalophile, thermophile, barophile. Microbes of indoor and outdoor environment, their collection techniques and methods of enumeration. Significance of microbes in water quality, test for portability of water, microbial treatment of sewage and Eutrophication.
- Types and control of Fermenters/bioreactors e.g. stirred tank, bubble column, airlift reactor, stirred and air driven reactors, packed bed, fluidized bed, trickle bed. Fermenter modes and processing e.g. mode (batch, fed-batch, and continuous

operation) and Downstream processing: Filtration, centrifugation, cell disruption, dead stage concept, aqueous two-phase liquid extraction, adsorption, chromatography. Types of fermentation methods (Submerged and solid state fermentation).

- Industrial production of primary and secondary metabolites through fermentation e.g. Antibiotics (penicillin), Solvents (Ethanol), Single cell protein (SCP), Enzymes (Amylase, Protease).