

PhD Syllabus for (Broad Area of) Molecular Medicine

MEDICAL MICROBIOLOGY SYLLABUS

Definition and scope of microbiology. Historical developments in microbiology. The impacts of microbiology in human history and society. Prokaryotic and eukaryotic cell structure. Cell membrane, cell wall, and cytoplasmic structure. Microbial Motility and flagella, Cell division and growth. DNA structure and replication. RNA synthesis and protein translation. Gene expression and regulation. Genetic variation and mutation. Taxonomy and systemic of bacteria. Major bacterial phyla. Identification and characterization methods. Structure and classification of viruses. Viral replication and life cycles. Viral pathogenesis and interactions with host cells. Energy production and ATP synthesis. Metabolic pathways: glycolysis, Krebs cycle, electron transport chain. Anaerobic and aerobic metabolism, Microbial interaction in natural environments. Microbial role in nutrient cycling. Applied aspects of environmental microbiology. Pathogenic microorganisms and diseases. Host-microbe interactions. Immunology and microbial control. Microbes in biotechnology and industrial processes. Microbial fermentation and bio-products. Genetic engineering and synthetic biology. Antibiotic resistance and Microbial evolution. Microbiome research and its implications. Cutting edge technologies in microbiology.

Cancer Biology Syllabus

Cell signalling -Cell surface receptors and their interactions with hormones,G-protein coupled receptors and their signaling mechanisms, Signal transduction pathways within cells, Second messengers' roles in transmitting signals, Regulatory mechanisms controlling signaling pathways, Two-component systems in bacteria and plants, Light-mediated signaling processes in plants, Bacterial chemotaxis and quorum sensing
Cellular communication -

Hematopoiesis regulation in the body, Fundamental principles governing cell communication, Various adhesion molecules and their roles in cell adhesion, Gap junctions facilitating intercellular communication, Significance of the extracellular matrix in cellular functions, Functions and mechanisms of action of integrins, Regulation of neurotransmission processes

Cancer biology-

Hallmarks of Cancer, Characteristics of cancer cells, Tumor initiation and progression, Tumor Microenvironment, Interactions between tumor cells and their surroundings, Angiogenesis and metastasis, Progenitor cells and their involvement in cancer development, Understanding oncogenes and tumor suppressor genes in cellular regulation, Cancer's correlation with the cell cycle and its dysregulation, Virally induced cancer and its mechanisms, Metastasis and the spread of cancer cells, Interactions between cancerous cells and normal cells, Apoptosis and its role in controlling cell growth, Therapeutic approaches targeting uncontrolled cell proliferation.

Photosynthesis and Respiration-

Light harvesting complexes and their role in capturing light energy, Mechanisms involved in electron transport during photosynthesis, Photoprotective mechanisms safeguarding against excessive light damage, CO₂ fixation pathways including C₃, C₄, and CAM pathways, Respiration's key components such as the citric acid cycle, Plant mitochondrial electron transport and its relation to ATP synthesis, The role of alternate oxidase in respiration, Understanding the photorespiratory pathway and its significance,

Plant tissue culture, Plant hormones –

Exploring plant tissue culture techniques and applications, Plant hormones: Understanding their synthesis, storage, breakdown, and transportation mechanisms, Physiological impacts and mechanisms of action of plant hormones. Plant Tissue culture: Types, techniques, nutritional requirements. Preparation and sterilization of media, preparation of explant, measurement of growth parameters. Organogenesis and Embryo genesis. Micropropagation

of medicinal and aromatic plants.

Herbal Medicine- Phytochemical and Pharmacological aspects and uses of following medicinal plants, Preliminary Phytochemical Screening. Herbal extract- Types of extracts; Extraction methods such as Maceration, Percolation, Super critical fluid extraction, Distillation Methods; Methods for drying of extracts. Selection and purification of solvents for extraction.

Transport of molecules-

Movement of water, ions, solutes, and large molecules from soil, through cells, across membranes, and within xylem and phloem, Transpiration and its role in plant water transport, Loading and unloading mechanisms of photoassimilates in plants, Secondary metabolites: Biosynthesis pathways of terpenes, phenols, and nitrogenous compounds, and their diverse functions.

Biomolecule, Cell Biology, Molecular Biology and Research Methodology

Biomolecules: Structure and function of biomolecules (proteins, nucleic acids, lipids, carbohydrates) Enzyme kinetics and mechanisms Metabolism and metabolic pathways Biochemical techniques (electrophoresis, chromatography, spectroscopy)

Cell Biology: Endosymbiotic theory, Prokaryotic and Eukaryotic Cell, Cell Organelles, Cell Cycle, Apoptosis, Necrosis, Cell Cytoskeleton, Cell Adhesion, Cell Junction, Extracellular Matrix and Cell Signalling. Molecular Biology:

Structure and function- DNA and RNA; Types of DNA and RNA. Chromosome- levels of packaging, nucleosome. Plasmids- different types and application. Central Dogma- Replication, Repair, Transcription and Translation.

Knowledge of public health issues, health promotion, disease prevention, and healthcare systems. Understanding of economic aspects of healthcare, health policy analysis, health financing.

Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India, Defining the Research Problem, Research Ethics, Necessity of Defining the Problem, Technique Involved in Defining a Problem.

Stem cell and regenerative medicine

- ❖ Embryonic stem cells (Basics)
 - ❖ Human ESCs in regenerative medicine Current status of induced pluripotent stem cells (iPSCs) & its clinical applications.
 - ❖ Mesenchymal Stem Cell Basics, Therapeutic applications of MSCs bioengineering.
 - ❖ Tissue fabrication (2D, 3D and 4D bioprinting)
 - ❖ Vascular tissue engineering
 - ❖ Muscular tissue Regeneration (Skeletal & Cardiac tissue engineering)
 - ❖ Engineering cancer microenvironments - cancer biomaterials
 - ❖ Ethical concerns on regenerative medicine research
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Bioinformatics & Statistics

Bioinformatics

- ❖ Introduction to bioinformatics and computational biology
- ❖ Sequence analysis and alignment algorithms
- ❖ Structural bioinformatics and protein structure prediction
- ❖ Genomic and proteomic databases
- ❖ Phylogenetic analysis and molecular evolution
- ❖ Functional annotation of genes and proteins
- ❖ Systems biology and network analysis

Statistics

- ❖ **Basic Statistical Concepts:** Understanding of fundamental statistical concepts, measures of central tendency, dispersion, probability.
 - ❖ **Data Analysis:** Statistical techniques, data interpretation, inferential statistics, hypothesis testing.
 - ❖ **Research Methodology:** Research design, sampling methods, data collection Techniques
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