

SPECIAL CENTRE FOR MOLECULAR MEDICINE JAWAHARLAL NEHRU UNIVERSITY

Ph.D. Programme in Molecular Medicine

COURSE STRUCTURE

FIRST SEMESTER (12 Credits)

Compulsory Course

CM601: Concepts and perspective of molecular medicine (3 Credits)
By Prof. Vibha Tandon, Dr. Shailja Singh & Dr. Vijay PS Rawat

Optional courses (Opt any three)

CM602: Molecular basis of infectious diseases (3 Credits)
By Prof. Suman K. Dhar

CM603: Molecular Basis of Metabolic Disorders (3 Credits)
By Prof. C.K. Mukhopadhyay

CM605: Nuclear Receptors in Health and Disease (3 Credits)
By Prof. Rakesh K. Tyagi

CM610N: Cell Adhesion & Signaling (3 Credits)
By Dr. Saima Aijaz

CM612: Pharmacology and Therapeutics (3 Credits)
By Prof. Vibha Tandon

CM613: Adaptive Immunity (3 credits)
By Prof. Gobardhan Das

CM614: Mammalian Microbiome and Innate Immunity (3 Credits)
By Dr. Dipankar Ghosh

CM615: Biology of Cancer (3 Credits)
By Prof. Vibha Tandon

CM616: "Host pathogen interactions and therapeutic intervention strategies (3 credits)
By Dr. Shailja Singh

Note: *At present above optional courses are being offered by our Centre.*

SECOND SEMESTER (3 Credits)

Compulsory Courses

CM651: Presentation of a research proposal (1 Credit)

CM652: Laboratory techniques (2 Credit)

- Electrophoretic and hybridization techniques.
- Western, Northern and Southern blotting.
- Ultracentrifugation, liquid chromatographic techniques.
- Polymerase Chain Reaction (PCR) and Reverse Transcriptase PCR.
- Electrophoretic mobility shift assay (EMSA), DNA sequencing, DNA footprinting.
- Bacterial, fungal and mammalian cell culture.
- Transient and stable DNA transfection.
- Fluorescence and confocal microscopy.
- Reporter gene assays.
- Use and analysis of radioisotopes.
- Genomics, microarray and proteomics – theory and applications.

CM653: Research and Publication Ethics (RPE) (1 Credit)

COMPULSORY COURSE

CM601: Concepts and perspective of molecular medicine

Basic biochemistry, molecular biology and genetics relevant to Molecular Medicine. Human genome: implication and applications. Single Nucleotide Polymorphism. Gene therapy as a potential tool to cure human diseases. Recombinant molecules in medicine. Transgenic and knock out animal models. Stem cell research and its application in human health. Intellectual property right issues and ELSI (Evaluation of the Ethical, Legal and Social Implications program).

OPTIONAL COURSES (ANY THREE)

CM602: Molecular basis of infectious diseases

Current topics in fungal, parasitic, bacterial and viral genetics (with the emerging knowledge of sequence databases available and ongoing projects). Understanding the mechanisms available for genetic variability in different pathogens to defy host immune system. Host signalling in response to infections. Bacterial two component signalling systems. Bacterial adhesins, virulence factors. Protein and DNA secreting systems and pathogenicity island. Molecular basis of antimicrobial resistance and its detection. Molecular approaches in clinical microbiology.

CM603: Molecular Basis of Metabolic Disorders

Introduction to metabolic disorders; Insulin dependent and independent diabetes; Obesity and Fatty Liver Disease; Cardiovascular diseases; Neurodegenerative diseases like Parkinson; Ageing; Inherited metabolic disorders; Physiological, oxidative and nitrosative stress in metabolic disorders; Inflammation and immunity in metabolic diseases; Metabolomics, metabolomic profiling, biomarkers and metabolic diseases; Model organisms and animals in understanding molecular basis of metabolic diseases.

CM605: Nuclear Receptors in Health and Disease

Nuclear Receptor superfamily: an introductory overview; structural and functional domains of nuclear receptors; ligand-mediated regulation of nuclear receptor function; nuclear receptor localization; receptor-ligand interactions and gene transcription regulation; co-activators and co-repressors; SRC/ p160, CBP/p300, histone (acetylase, deacetylase, methylase, demethylase), ATP dependent chromatin remodellers; receptor regulation by post-translational modifications e.g. phosphorylation, sumoylation, ubiquitination, acetylation, deacetylation, methylation etc.; nuclear receptors as drug targets; xenobiotic receptors and drug metabolism; screening and analysis of therapeutic ligands by high-throughput microscopy, co-transfection and transcriptional assays; steroid hormones and their receptors; molecular basis of endocrinopathies: endocrine-related cancers (prostate, breast, endometrial cancers); ligand-independent transcriptional activation of steroid hormone receptors; endocrine disruptors and selective steroid receptor modulators; current concepts and future challenges.

CM610N Cell Adhesion and Signaling

Principles of cell adhesion; role of cell adhesion in tissue homeostasis, embryonic development, cell movement, wound repair, tumour growth and metastasis; classification of cell adhesion molecules, cell-cell adhesion complexes including tight junctions, adherens junctions and gap junctions; cell-extracellular matrix adhesion, adhesion-based signalling pathways including E-cadherin and β -catenin mediated signaling, integrin-mediated signalling, receptor tyrosine kinase signaling, G-Protein-coupled receptors; Rho GTPases and Mitogen-activated Protein Kinase pathways; Endothelial cell adhesion molecules; Blood-Brain Barrier and related diseases including Parkinson's disease, Alzheimer's disease and Multiple Sclerosis; Blood-Retina Barrier and related eye disorders; Mechanism(s) regulating the disruption of cell adhesion complexes in various diseases; Prospects and strategies for cellular therapies in cell adhesion-related disorders.

CM612: Pharmacology and Therapeutics

An introductory Overview, Structure and Relationship for Pharmacophore Identification, Transmembrane Signal Mechanism, Efficacy of drug, ADME, Toxicology of drug, Pharmacokinetics, Pharmacodynamics, Drug metabolism, Biomarkers, Epigenetic Modifications and Emerging targets, Epigenetic effects in Humans, Epigenetics of Microorganism, Therapeutics, Chemical and Synthetic Therapeutic Drugs and Classes, Tumors : Weakened mitotic checkpoint, Biostatistics, Chemotherapy of Parasitic and Microbial infections, Separation Techniques, Medicinal Plants.

CM-613: Adaptive Immunity

Introduction to adaptive immunity, Classification of lymphocytes, Evolution of lymphocytes, Functional diversity of lymphocytes, Thymus education of T cells, Generation of B cell subsets, Antibody diversity, Antibody production and class switching, Helper T cells, Cytotoxic T cells, Helper T cell differentiation, Helper T cell subsets, Memory T cells, Peripheral energy, regulatory T cells, Regulation of adaptive infectious diseases, Immunity in auto immune diseases, Cytokines in infections.

CM614 Mammalian Microbiome and Innate Immunity

I. Epithelial barrier and the Innate Immune Paradigm

- a. Determinants and significance of epithelial barrier in mammalian host defense
- b. Innate Immune Paradigm : Pathogen Associated Molecular Patterns (PAMPs) and Pattern Recognition Receptors (Janeway); Danger Hypothesis(Matzinger)

II. Mammalian Innate Immune Determinants

- a. *Receptors*: Toll-like-receptors (TLR), NOD-like receptors (NLR), RIG-I-like receptors (RLR)
- b. *Effectors*: Cationic Antimicrobial Peptides, Proteins and Reactive Species
- c. *Mediators*: Cytokines, Chemokines, Neuro-Immune modulators and Cross-Kingdom Signalling mediators
- d. *Signalling Pathways*: NF-kB, MAP Kinase
- e. *Processes*: Autophagy and Inflammasomes

III. Host-Microbiota Interactions in Immune Modulation, Health & Disease

- a. Human Epithelial Microbiome and concept of Parasitism, Mutualism, Commensalism
- b. Microbial Associations in Immune Education, Tolerance and Probiotics
- c. Dysbiosis, Sepsis, Inflammation and diseases related to Innate Immune Dysregulation

IV. Concepts of Host-Microbe Immune Relationships in Translational Research

- a. Innate - adaptive immune cross talk and vaccine/adjuvant technology
- b. Probiotics in Host Health/Immune Homeostasis
- c. Cutting-edge topic of the year

CM615: Biology of Cancer

Overview of the hallmarks of cancer. Mutagens, carcinogens, and mutations. Tumor viruses and the discovery of oncogenes. Mechanisms of oncogene activation. Role of growth factors and receptors in carcinogenesis, RAS signaling in cancer, Familial cancer syndromes and the discovery of tumor suppressors. Biomarkers, Epigenetics of Cancer. Cell cycle control and the pRb tumor suppressor. Apoptosis and the p53 tumor suppressor. Cellular senescence, Telomeres, cellular immortalization, and tumorigenesis. Cancer stem cells, DNA repair mechanisms. Angiogenesis, Metastasis. Treatment-traditional chemotherapies, radiotherapy, immunotherapy, targeted therapy. Cellular effects of radiation - Effects of Ionizing and non-ionizing radiation on cells, DNA, chromosomes and membrane, cell survival, division delay and cell cycle check points. Applications of new technologies in prevention, assessing risk, diagnostics, and treatment.

CM616: "Host pathogen interactions and therapeutic intervention strategies" (3 credits) By Dr. Shailja Singh, Associate Professor

This course focuses on fundamental aspects of pathogen-host interactions and covers the biological mechanisms and processes, which lead to pathogenesis and disease following infection. There is a component on the therapeutics development that target pathogen-host interactions. There will be tutorial on modern research methods and approaches applied this field. Overall, course will provide both an overview and an update on the recent advances in the study of host-pathogen interaction at the cellular and molecular levels.

This course comprises following topics:

A basic introduction to different pathogens of viral, bacterial, fungal and parasitic origin and their respective hosts. A brief introduction of the pathogen life cycle, genetic mechanisms in pathogen biology and pathogen-host interactions. Pathogen genome structure and gene expression, antigenic variability, epidemiology, population genetics and evolution. Experimental approaches to study host pathogen interactions, genome wide approaches to study host-pathogen interactions, Identification of virulence factors, animal models, mechanisms of pathogenesis, monitoring host response, survival strategies of pathogens, manipulation and reprogramming of the intracellular environment, pathogen molecules that mediate interactions with host, and the role these interactions play in host recognition and modulation and disease progression.

Tutorial Learning Objectives:

1. Identify the evolutionary outcomes of host-pathogen interactions at the molecular level.
2. Differentiate the multiple cellular and molecular mechanisms used by the pathogens to gain access into their host.
3. Classify the pathogen strategies to evade the host/vector defense mechanisms.
4. Judge the merit and limitations of the experimental approaches used to address the host pathogen interaction.
5. Describe disease pathology as an outcome of host-pathogen interactions.