M.Sc. in Molecular Medicine

The Special Centre for Molecular Medicine (SCMM) is running the M.Sc. in Molecular Medicine course since 2017. This course was originally started as an integrated M.Sc -Ph.D program in Molecular Medicine in 2015 and later converted into a M.Sc program. The goal of this program is to expose and train students in modern areas and techniques of cell and molecular biology in relation to human health and disease and the subsequent application of this training to find innovative targets for the diagnosis and therapy of different diseases. The completion of the Human Genome project and various other genomes including pathogenic organisms has opened new opportunities for the understanding of the molecular mechanisms of diseases both from the host as well as pathogen's perspectives. Students are trained to use the tools of modern biology including bioinformatics so as to understand, retrieve and exploit the wealth of information provided in the Genome projects to design modern and personalized medicines. The course structure and the contents of some the courses have been modified recently by the faculties of the centre after due deliberations and the modified course is appended below.

Eligibility:

Bachelor's degree in any branch of Basic or Applied Sciences (including MBBS/ BVSc./ B.Pharm) from recognized Universities and Institutes with at least 55% marks. Details regarding the eligibility criteria are mentioned in the prospectus.

Admission procedure:

The admission to the M.Sc. program will be through the Common University Entrance Test (CUET-PG), a Computer Based Test (CBT). The admission procedure will be as laid down by Academic Council of JNU from time to time and the existing Special committee of SCMM will oversee the program.

Duration: Two Years (Four semesters):

The course work leading to the award of an M.Sc. degree in Molecular Medicine shall be for a period of four semesters (two Monsoon Semesters and two Winter Semesters) with a compulsory requirement for submission of a research-based dissertation at the end of the 4th semester. The dissertation work will start at the beginning of the 3rd semester.

Credit Requirements:

A student will need to have earned a minimum of 72 credits including 12 credits for the dissertation at the end of two years in order to be eligible for the award of the M.Sc. degree.

Credit Distribution: Total 72 credits

First Semester: 20 Credits (including practical)

Second Semester: 21 Credits (including practical)
Third Semester: 16 Credits
Fourth Semester: 15 Credits

One credit = At least sixteen lectures per semester.

Intake: 10

Depending on the faculty strength, the intake will be up to a maximum of 10 students per year. At least one student will be assigned to each member of the core faculty of SCMM for their M. Sc. dissertation.

Special Centre for Molecular Medicine, JNU

Program: M.Sc. in Molecular Medicine

Semester-wise List of Courses offered and Credits distribution

Total Credits: 72

One credit = At least sixteen lectures per semester

Semester I		**Semester II**	
CM-401:Basic Biochemistry	3 Credits	CM-411:Molecular Biology	3 Credits
CM-402: General Microbiology	3 Credits	CM-412: Molecular Genetics	3 Credits
CM-403:Cell& Developmental Biology	3 Credits	CM-413N: Nutrition in human Health and disease	3 Credits
CM-404:Anatomy &Human Physiology of human Body	3 Credits	CM-414: Immunology	3 Credits
CM-405: Pathology	2 Credits	CM-415:Bioinformatics and Computational Biology	3 Credits
CM-406N: Lab Practical (Biosafety, Biochemistry & Microbiology)	6 Credits	CM-416N: Lab Practical (Molecular Biology and Cell Biology)	6 Credits
Total = 20 Credits		**Total = 21 Credits**	
Semester III		**Semester IV**	
Optional courses (any four):			
CM-421: Free Radicals in Metals	3 Credits	CM-451: Pharmacology & Therapeutics	3 Credits
CM-422: Cell Adhesion & Signal Transduction	3 Credits	CM-452: Bioethics & IPR	2 Credits
CM-423: Molecular basis of Infectious Diseases	3 Credits	CM-453: Diseases of National Importance	2 Credits
CM-424: Molecular Endocrinology and Endocrinopathies	3 Credits	CM-454: Dissertation-II Submission & Viva	8 Credits
CM-425: Host-Microbe relationships in health &disease	3 Credits		
CM-426: Proteomics & Metabolomics	3 Credits		
CM-427: Molecular basis of metabolic Disorders	3 Credits		
Compulsory Course:			
CM-428: Dissertation-I: Presentation	4 Credits	**Total =15 Credits**	
Total = 16 Credits			
M.Sc. Total Credits= 72			

COURSE CONTENTS (SEMESTER-WISE)
SEMESTER - I

Course Name: Basic Biochemistry (CM 401) **Credits: 3**

Course In-charges: Prof. Suman K.Dhar and Prof. Umesh C. S. Yadav

COURSE OBJECTIVES

Basic Biochemistry course has been designed for providing adequate knowledge to the students regarding fundamentals of biochemistry that are important for Molecular Medicine. Structure and functions of bio macromolecules and their applications in diseases are of paramount importance and they are the focus of the course. Biochemistry is at the centre point of metabolic and physiological functioning of human body and any deviation may lead to affecting the wellbeing of the body directly. Therefore, an in depth understanding of the biochemical processes will not only help the students to grasp the basics it will also help them to apply their knowledge in their research and academic endeavours. The course also allows the students to get acquainted with the state-of-the-art techniques relevant for the subject as well as to provide them training for good presentation skills.

COURSE CONTENTS

Unit I: Fundamentals of Biochemistry **(4 Lectures)**

- Basic chemistry of biological materials,
- Thermodynamics of biological systems;
- Concept of free energy, entropy, enthalpy, free energy changes, high energy molecules;
- Acids, bases, pH and buffers,
- Biochemistry of macromolecules-carbohydrates, lipids.

Unit II: Membrane and transport **(4 Lectures)**

- Types of major membrane lipids, their constituents and structure; Archaeal membranes and difference from eukaryotic membranes
- Amphipathic nature of membrane; Membrane proteins and their different functions; Synthesis and sidedness of membranes
- Transport across cellular membranes, active, passive and co-transport; Exocytosis and endocytosis

Unit III: Enzymes **(9 Lectures)**

- Enzyme kinetics and mechanisms
- Coenzymes, cofactors, inhibitors; catalytic enzymes, ribozymes

- Michaelis-Menten equation., Lineweaver–Burke Plots, Competitive inhibitor, Uncompetitive inhibitor, Non-competitive inhibitor, Mixed inhibitors, Irreversible inhibitors,

Unit IV: Nucleic Acids, amino acids, peptides: Structure and function (5 Lectures)

- Nucleic acids classification, occurrence, nucleoside, nucleotides, Biosynthesis of nucleic acids bases, Chemical synthesis of Oligonucleotides
- Structures of ribosyl and deoxyribosyl nucleotides & functions
- Amino Acids: Isoelectric points (PI), pKa of Amino acids, Peptides, Proteins: structure and function; Secondary, tertiary & Quaternary structure of Proteins, Ramachandran Plot. Structure of Collagen, Keratin, Hemoglobin, Myoglobin; Protein folding, unfolding and misfolding

Unit V: Metabolism (10 Lectures)

- Glycolysis, anaerobic oxidation of glucose, citric acid cycle; mitochondrion and bioenergetics, Pentose phosphate pathway
- Storage and transport of lipids; Fatty acid synthesis and degradation
- Metabolism of amino acids, Anabolism and catabolism, Urea cycle
- Biosynthesis of proteins
- Protein modification and function
- Purine and pyrimidine metabolism
- Deficiency of different metabolic enzymes and disease outcome

Unit VI: Clinical Biochemistry (8 Lectures)

- Introduction to clinical biochemistry, Biochemical investigations, Types of laboratory tests, Discretionary or on-off tests, Biochemical profile, Dynamic function tests, Screening tests, Metabolic work-up tests, Emergency tests, Specimen collection, Identification of patients and specimens
- Clinical biochemistry of gastro intestinal tract, liver, cardiovascular system, endocrine system

Unit VII: Techniques (8 Lectures)

- Absorption and emission spectroscopy, basic concept and application
- Different chromatographic techniques (Gel filtration chromatography, Ion-exchange chromatography, thin layer chromatography), basic concepts and their application for the separation of biomolecules

Learning Outcome:

In depth study of the Biochemistry course will help the students to understand the Biochemical basis of life in general and changes in these processes during disease conditions. Students will be able to use the current Biochemical techniques to plan and carry out experiments relevant to the queries. Since this course also gives an immense opportunity to learn different protein purification techniques, it will help them to find suitable jobs in Biotechnology industries.

Recommended Reading Materials:

1. Biochemistry Ed Lubert Stryer. W.H. Freeman and Company, New York. 9th Edition. 2019.
2. Principles of Biochemistry. Ed Lehninger, Nelson and Cox.CBS publishers and distributors.8th Edition, 2021.
3. Harper's Biochemistry. by Kathleen Botham, Owen McGuinness, P. Anthony Weil, Peter Kennelly, Victor Rodwell. Appleton and Lange series, Stamford, Connecticut. 32ndEdition, 2022.
4. Textbook of Biochemistry with Clinical Correlations. Ed. Thomas M. Devlin. Wiley-Liss Publishers. 7th Edition, 2010.
5. Biochemistry. Donald Voet and Judith G. Voet. John Wiley & sons, Inc. 4th Edition, 2011.

Course Name: General Microbiology (CM 402) **Credits: 3**

Course In-charges: Prof. Anand Ranganathan& Prof. Shailja Singh

COURSE OBJECTIVES

This course designed for comprehensive learning of general microbiology as a component of M.Sc. in Molecular Medicine students. This course covers the medical and molecular aspects of parasitology, mycology, virology, and bacteriology to infection. The course equips students with the knowledge of diagnosing and treatment modalities of diseases caused by bacteria, fungi and parasites. The course combines lectures, seminars and practical laboratory classes, culminating in a laboratory-based practical experience. The course offers a significant level of theoretical and practical understanding of the subject, which aids students in following a career in clinical sciences or academic and industrial research.

COURSE CONTENTS

Unit I: General Bacteriology (6 Lectures)

- Overview of microbial worlds, Cell structure, microscopy, staining, basic principles and Purpose of classification systems,
- Detailed structure, morphological change during growth.
- Various optical methods available for viewing microorganism and their applications.
- Microbe classifications; bacteria, fungi, parasites and viruses

Unit II: Cultivation, Growth and Survival of Microorganisms (12 Lectures)

- Growth, Growth parameters, Definition and measurement of bacterial growth,

- Survival of micro-organisms in natural environment, Environmental and other factors affecting growth
- Growth requirements, Sources of metabolic energy, Nutrition
- Methods of cultivation, Microbial Metabolism, Metabolism of biosynthesis and growth
- Biosynthesis pathways, Energy Yielding metabolism, Regulation of metabolic pathways
- Metabolic pathways, anaerobic carbon metabolism, anaerobic respiration, sulphate respiration, nitrogen fixation, fermentation & diverse products and their purification
- Sterilization & Disinfection

Unit IV: Bacterial Genetics (15 Lectures)

- Structure and replication of bacterial DNA plasmids
- Variation, Mutation, Transfer of genetic material, Recombine DNA technology
- Transductions, conjugation, CRISPR/Cas9, Phages library
- Microbes in extreme environments (extremophiles), Thermophiles and their applications, isolation of bacteria and phage from natural source

Unit V: Role of antimicrobial agents &microbial resistance (9 Lectures)

- Antimicrobial chemotherapy.
- Antigen and antibodies
- Toxins, antitoxins
- Mechanisms of resistance
- Role of microbes in human welfare: antibiotics, discovery of penicillin, streptomycin, immunization etc.

Unit VI: Microbes in health and disease (6 Lectures)

- Collection and handling of various samples
- Laboratory safety
- Quality control
- Antimicrobial susceptibility and assay

Learning Outcome: The students will gain a comprehensive understanding of the molecular and medical aspects of microbiology, by excelling in microbial classifications, cell structures, growth patterns, and genetic variations. Moreover, the students will become proficient in microbial cultivation methodologies, understanding metabolic pathways, and antimicrobial agents, while simultaneously ensuring laboratory safety and conducting quality control measures. Equipped with both theoretical knowledge and practical skills, the students will be well-equipped to pursue careers in clinical sciences, academic research, or industrial sector, contributing significantly to the healthcare advancements.

Recommended Reading Materials:

1. Industrial Microbiology by Arvind H. Patel, ISBN-13 978-9385750250, Laxmi Publications, 2nd Edition, 2022

2. Microbiology by Lansing Prescott, John Harley, Donald Klein.ISBN-13 978-0072951752, Publisher McGraw-Hill Education, 6th Edition, 2004.
3. Microbiology by J. Michael Pelczar, E.C.S. Chan, Nobel R. Krieg, ISBN-13978-8176711234 Affiliated East West Press Private Limited New Delhi, 5th Edition, 2023.

Course Name: Cell & Developmental Biology (CM403) Credits: 3

Course In-charges: Prof. Rakesh K. Tyagi, Prof. Vibha Tandon, Dr. Vijay P. S. Rawat & Dr. Saima Aijaz

COURSE OBJECTIVES

This course is designed to provide detailed insights into the advances in cell structure and function as well as the processes that govern the development of living organisms. On successful completion of the course, the student will be able to comprehend the normal cellular processes, dynamics, inter- and intra-cellular signaling, how alterations and deviations in cellular structure contribute to normal life processes and also in the onset of disease. The developmental biology component is designed to give detailed information starting from fertilization to the mechanisms that regulate the fate of individual cells leading to their differentiation into specialized organ systems. The course will help students to gain a better understanding of the underlying basis of diseases that arise due to defective programming at different stages of development.

COURSE CONTENTS

Unit I: **Basics of Cell Biology (8 Lectures)**

- Introduction to Cell Biology; structure and function of cells
- Membrane structures and functions, membrane models
- Cell compartmentalization: structure and function of cellular organelles
- Cell cycle and cell division, Mechanisms and regulation of cell cycle check points, DNA damage and response, DNA repair pathways
- Basic concepts of cell specialization, cell types (epithelial, mesenchymal) and functions
- Introduction to Stem cell biology (embryonic, adult and IPSC)

Unit II: Cell organelles and associated diseases (8 Lectures)

- Introduction to cellular disorders
- Nucleus: nuclear membrane, nuclear pore, nucleoplasm, Functions of chromosomes, chromosome territories
- Mitochondria, its genome and associated diseases
- Golgi complex, Endoplasmic reticulum, lysosomes storage diseases,
- Cytoskeleton: microtubules, microfilaments & intermediate filaments

Unit III: Cell signaling and intracellular trafficking (8 Lectures)

- Interactions between nucleus and plasma membrane
- Mechanisms of protein sorting and targeting

- Different classes of receptors, Intracellular receptors, cells surface receptors, ion channel receptors
- Intercellular communication and associated signaling pathways
- Intracellular signaling, G protein coupled receptors, Autocrine signaling, Endocrine signaling,
- Cell death pathways, Programmed cell death, Events in Apoptosis, Caspases the executioners of apoptosis, Necrosis, Genes involved in cell death,
- Signaling pathways and associated diseases

Unit IV: Advanced techniques in cell biology (8 Lectures)

- Cells as experimental models, Relative strengths of Model Organisms
- Fluorescent proteins and advances in live cell imaging
- Sub-cellular fractionations
- DNA transfections, promoter-reporter assays, ChIP analysis
- Concluding remarks

Unit V: Introduction to early embryonic development (8 Lectures)

- Embryonic patterning in different organisms *(*selected topics in *Drosophila, C. elegans*, Zebrafish, *Xenopus,* mouse), fertilization, cleavage, gastrulation, germ layer formation and organogenesis
- Determination of fate maps of individual cells and tracing of cell lineages: use of dyes, genetic labeling and transgenic chimeras
- Embryonic homologies: analogous and homologous structures, developmental anomalies, teratogens
- Genomic equivalence, differential gene expression in organogenesis, 3'- and 5'- regulatory regions
- Epigenetics: DNA methylation and acetylation in the control of gene expression and inheritance patterns, Genomic imprinting, dosage compensation

Unit VI: Cell-cell communication in embryonic development (8 Lectures)

- Cell adhesion (ECM and junctions) and migration, epithelial morphogenesis, generation of embryonic asymmetry
- Signaling cascades, autocrine, paracrine and juxtacrine signaling, FGF, RTK, Hedgehog, Wnt, TGFβ, notch-delta signaling in the induction and specification of the dorsal-ventral axis in *Drosophila* and *Xenopus*, mesodermal patterning, establishment of the anterior-posterior axis
- Segment formation in Drosophila and the regulatory genes, Structure and function of Hox genes.

Learning Outcome:

Students will understand and appreciate the structures and coordinated functioning of the basic cellular components and the working diversities of eukaryotic cells. Through this course, they will not only recognize the normal functioning of cells but also the diseases inflicted by their dysregulated states. The developmental Biology component of the course will allow the

students to understand the molecular and cellular aspects of the origin of different organisms. This knowledge will help the students to understand developmental and other birth defects so that targeted therapies can be designed.

Recommended Reading Material:

1. The Cell: A Molecular Approach (2019) by Geoffrey M. Cooper
2. Essential Cell Biology (2019) Bruce Alberts, Alexander Johnson, Karen Hopkin, Martin Raff, Keith Roberts, Dennis Bray, Julian Lewis, Peter Walter. (5th International Student Edition).
3. Textbook of Biochemistry, Biotechnology, Allied & Molecular Medicine, Editors: G. P. Talwar, Seyed E. Hasnain, Shiv K. Sarin, Prentice Hall of India, pp809-819 (2016).
4. Nelson, D. and Cox, M.M. (2009). Lehninger Principles of Biochemistry. W.H. Freeman and Company, New York.
5. Developmental Biology (Ninth Edition), 2010 by Scott F. Gilbert. Publisher: Publishers Sinauer Associates, Inc., USA
6. Principles of Development (Fourth Edition) 2010 by Lewis Wolpert and Cheryll Tickle. Publisher: Oxford University Press, United Kingdom.

Course Name: Anatomy & Physiology of Human Body (CM 404) Credits: 3

Course In-charge: Dr. Dipankar Ghosh

COURSE OBJECTIVES

The course attempts to develop basic understanding of anatomy and physiology of the human body to help bridge basic molecular medicine with clinical sciences. The course covers important aspects of gross anatomy and micro anatomy with basic physiology and cell biology. The target of this course is to impart uniform academic strength in the area of human anatomy and physiology and prep them to comprehend the anatomy and physiology.

Unit I. Introduction to General Physiology & Anatomy (6 Lectures)

- Introduction to the human anatomy
- History of Introduction to Anatomical Planes
- Brief introduction to biochemical pathways of human system
- The application of anatomy and physiology in molecular medicine

Unit II. Nervous System: Anatomy of the Nervous System (6 Lectures)

- The Central nervous system. The Peripheral nervous system. The Autonomic nervous system
- The anatomy of the brain and cranial nerves
- The cells of the nervous system. Synapse, generation of action potential; vision; hearing and tactile response
- The physiology of neuro-signalling. Sensory perception. Motor responses

Unit III. Musculo-Skeletal System (6 Lectures)

- Major bones and muscles of the human system. Anatomy of the axial skeleton and the Appendicular skeleton system

- Classification and functions of tendons and ligaments
- Physiology of bone formation and cells of bone
- Overview of muscle tissues, types of muscles and ultrastructure. Theories and physiology of muscle contraction

Unit IV. Respiratory System: Physiologic Anatomy of the Pulmonary Circulatory System (6 Lectures)

- Halden's Law
- Pulmonary Ventilation (Functions of the Respiratory Passageways Mechanics, Pulmonary Volumes and Capacities)
- Principles of gas exchange and transport

Unit V. Cardiovascular & Circulatory System (10 Lectures)

- Physiologic anatomy of the cardiovascular system - the heart, the venous and the arterial system.
- The Cardiac cycle - Diastole and Systole, Pressure pulsations; Systolic and Diastolic pressures.
- The Coronary Circulation. Control of Excitation and Conduction in the Heart.
- Hematopoiesis and the cells of the circulatory system - RBC development & maturation, physiology of the lymphatic system. Spleen and Thymus

Unit VI. Gastro-Intestinal System (6 Lectures)

- The anatomical and functional organization of the GI system
- Overview of the cells and physiology of esophagus, stomach, small intestine, large intestine, liver, and pancreas
- The islets of Langerhans. Peyer's patches
- The enzymology of digestion. Metabolic functions of Liver. GI motility
- Major GI hormones and actions. The GI barrier and immunity

Unit VII. Endocrine System & Reproductive System (4 Lectures)

- Types and functions of major human hormones: The Pituitary Gland and Hypothalamus. The Thyroid Gland. The Parathyroid Glands. The Adrenal Glands. The Pineal Gland.
- Organs with secondary endocrine functions. Adipokines.
- Male and Female Reproductive System. Gonadal and Placental Hormones.
- Hormonal control of reproductive system. Development of sperm. Oocyte development & menstrual cycle. Fertilization
- The anatomy of the Kidneys, Ureters, Bladder, Prostate, Urethra, Adrenal Glands
- Physiology of urine formation - the glomerular filtration, tubular secretion and reabsorption, renin-angiotensin-aldosterone system

Learning Outcome:

Recommended Reading Material:

1. Best and Taylor's Physiological Basis of Medical Practice.
2. Guyton & Hall; Textbook-Medical-Physiology.
3. Ganong's Review of Medical Physiology, 24th Edition (LANGE Basic Science).

4. Harper's Illustrated Biochemistry.
5. Gray's Anatomy for Students. 4th Edition. Authors: Richard Drake, A. Wayne Vogl, Adam Mitchell.

Course Name: -Pathology (CM-405) **Credits: 02**

Course In-charges: Dr. Dipankar Ghosh and Dr. Souvik Bhattacharjee

COURSE OBJECTIVES

The course aims to teach the pathological basis of diseases, targeting different human organs and covering the molecular and cell biology of major diseases. The target of this course is to impart uniform academic strength to students who enter the master course in molecular medicine with little or no knowledge of human diseases and clinical medicine.

COURSE CONTENTS

Unit I. Basic Concepts in Pathology (6 Lectures)

- Introduction to Pathological basis of diseases
- Stress and Cellular Adaptation
- Cell injury and Mechanisms - ATP depletion, mitochondrial damage, ROI, Membrane permeability damage, DNA damage
- Types of Cell Death - Apoptosis, Necrosis and Autophagy
- Introduction to general pathological lab tests (diagnosis)and common interpretations: Complete blood count (CBC), Standard biochemical tests (Kidney function tests (KFT), Liver function tests (LFT), C-reactive protein (CRP), Lipid panel and Blood Sugar, HbA1c. Electrocardiogram (ECG), Biopsy, IHC, Automation in pathology

Unit II. Pathology of Cellular Injury and Inflammation (4 Lectures)

- Principles of inflammation and clinical symptoms
- The pathology of inflammation, tissue injury and sepsis. Causes of Edema, Effusion, Transudate, Exudate
- Purulent and suppurative inflammation, Exudative Inflammation, Granulomatous Inflammation, Interstitial Inflammation
- Pathology of Hypersensitivity

Unit III. Blood and Cardiovascular Pathology (4 Lectures)

- Hematological disorders- Anemia, Leukemia, Neutropenia
- Cardiovascular diseases, Atherosclerosis, Hypertension, Myocardial infarction

Unit IV. Respiratory Pathology (4 Lectures)

- Common upper respiratory and lower respiratory infections including Covid-19
- Granulomatous diseases (tuberculosis), Non-infectious obstructive diseases (asthma, emphysema, COPD)

Unit V. Gastro-intestinal and Hepato-biliary Pathology (4 Lectures)

- Overview of GI infections (special emphasis to Cholera and Helicobacter infections - gastric ulcers)
- Microbiota& intestinal dysbiosis, Inflammatory bowel disorder (IBD)
- Hepatic steatosis, Cirrhosis, Viral Hepatitis

Unit VI. Renal and Genito-urinary Pathology (3 Lectures)

- Obstructive and Vascular diseases, bacterial urinary tract infections, chronic kidney disease (CKD)
- Common sexually transmitted diseases

Unit VII.Neuro- and Endocrine Pathology (4 Lectures)

- Neurodegenerative Diseases
- Pituitary Disorders
- Thyroid Disorders and Diabetes

Unit VIII. Pathology of Bone and Muscles (3 Lectures)

- Osteoporosis, Arthritis, Muscular dystrophy and Atrophy.

Learning Outcome:

This course is designed to help students diagnose the routine and complex clinical phenotypes associated with pathological conditions. The associated lectures will help students correlate clinical and laboratory findings with pathology findings and identify misinterpretations and the causes of death due to diseases (apart from purely metabolic causes). Eventually, the students will form high quality diagnostic opinions in a given clinical situation with appropriate and relevant samples**.**

Recommended Reading Materials:

1. Robbins Basic Pathology. 10th Edition. Editors: Vinay Kumar, AbulAbbas, Jon Aster. Hardcover ISBN: 9780323353175, eBook ISBN: 9780323394130. Publisher. Elsevier . 2017.
2. Rapid Review Pathology (Edward Goljan). Publisher: Elsevier; ISBN: 9788131230305, 9788131230305, 2018
3. Underwood's Pathology: A Clinical Approach. 7th Edition. ISBN: 9780702072123
4. Imprint: Elsevier. Publisher: Churchill Livingstone. 2013

Lab Practical (Biosafety, Biochemistry & Microbiology) (CM406N) Credits: 6

Course In-charges: Dr. Dipankar Ghosh, Prof. Suman K. Dhar, Prof. Umesh C. S. Yadav, Prof. Vibha Tandon, Prof. Anand Ranganathan & Prof. Shailja Singh

COURSE OBJECTIVES

This course is designed to develop and inculcate the basic laboratory skills in the students in the areas of Biosafety, Biochemistry and Microbiology. The students will be able to comprehend the principle behind various methods and techniques in these areas and also learn them through performing or hands on experimentation. On the successful completion of the course the student will be able to execute the learnt laboratory skill sets independently or with minimal supervision and the same will be helpful in their dissertation work, Ph.D. thesis work and beyond in their academic and research career.

COURSE CONTENTS: List of Practicals:

Unit I: Biosafety and safe laboratory practices

Course In-charge: Dr. Dipankar Ghosh

- Basic training in biosafety & occupational hazards
- Fire hazard, biohazard, radiation hazard, chemical hazard
- Safe handling of the equipments and machines
- General laboratory safety measures
- Preparation of lab notebook, data recording and lab manuals

Unit II: Biochemistry

Course In-charge: Prof. Suman K. Dhar, Prof Umesh C. S. Yadav & Prof. Vibha Tandon

- Weighing and solution preparation; pipetting skills
- Concept of buffer and preparation of buffer solution, phosphate buffer, acetate buffer
- Principles of spectrophotometer and uses, estimation of protein, DNA, RNA
- Different chromatographic methods: principles and uses; Thin layer chromatography
- Separation of ATP, ADP and Pi using ATPase
- Gel filtration chromatography: separation low and high molecular mass containing proteins
- Ion exchange chromatography
- Ultracentrifugation: principles and uses; subcellular fractionation of organelles using ultracentrifugation
- Enzyme kinetics and purification: Alkaline Phosphatase

Unit III: Microbiology:

Course In-charge: Prof. Shailja Singh

- Basic bacterial culture and growth curve, cell number counting, growth of λ phage, plaque counting
- Testing of temperature sensitive bacterial and phage strains
- Gram staining

- Microscopy
- Site directed mutagenesis
- Making of genomic library
- Testing of auxotrophs
- Isolation of bacterial genomic DNA, plasmid DNA
- Short- and long-term storage of bacterial, fungal and phage stocks

Learning Outcome:

The laboratory practical course will enable the students to understand the principles and to gain practical experiences for a wide range of biochemical techniques, microbiology methods and basic biosafety measures that need to be taken for Life Sciences research. These include but are not limited to spectroscopy, enzyme kinetics, different types of chromatography techniques for macromolecular purification, growth pattern of different microbes and associated biochemical processes. Overall, these practical courses will not only help the students to get in depth knowledge regarding how to analyze different biochemical and microbiological dataset, they will also be ready for Biotechnology industries.

Recommended Reading Material:

- Principles and techniques of practical biochemistry. Ed Keith Wilson and John Walker. Cambridge; University Press. 2010
- Molecular Cloning- A Laboratory Manual. J. Sambrook, E. F. Fritsch and T. Maniatis. Cold Spring Harbor Laboratory Press. 1989.

SEMESTER - II

Course Name: Molecular Biology (CM411) **Credits: 3**

Course In-charge: Prof. Anand Ranganathan

COURSE OBJECTIVES

This course is aimed at providing fundamentals of Molecular Biology to the students along with introduction to nucleic acids, the principles of Nucleic acids, the structure, functions, regulations and their applications. Biomolecules are at the core of metabolic and physiological functioning of living organisms including the transmission of the information from generation to generation. Understanding of the mechanisms that affect life due to the antibiotic resistance will help students comprehend the basics and apply the same in their research and academic pursuit.

COURSE CONTENTS

Unit I: Evolution, DNA Structure, functions and Mechanism of replication and transcription

(12 lectures)

- History and Concept of Evolution and their types
- DNA, discovery, structure and genetic code elucidation
- Mechanism of the DNA replication and transcription: Replication of genetic material in prokaryotes and eukaryotes. DNA Replication and stress; DNA transcription
- DNA Sequencing : Methods of DNA Sequencing: Sanger Sequencing, Maxam and Gilbert sequencing method, Pyro sequencing, Helios sequencing, Nanopore sequencing

Unit II : RNA Structure, functions and their processing (12 lectures)

- RNA, discovery, structure and their types
- tRNA structure, synthesis, properties
- RNA Splicing: Post transcriptional modification and RNA processing: mRNA, tRNA and rRNA
- Ribozymes: Function and types
- non coding RNA, LncRNA/SncRNA, microRNA
- RNA modification: methylation, phosphorylation

Unit III: Regulation of gene expression (12 lectures)

- Promoters and regulators &: An overview of regulation of gene expression in prokaryotes and eukaryotes. Role of promoter and Regulators in gene expression
- Mechanism of the Gene regulation: Regulation of gene expression in viruses, prokaryotes and eukaryotes, nucleotide binding proteins. Activators, repressors, enhancers, silencer elements
- Recombination & Repair
- Reporter genes: Discovery and the applications of Green Fluorescent Protein (GFP)

Unit IV: Mechanisms of cell survival (12 lectures)

- Mechanism of action the Quorum sensing (Bacterial communication phenomenon) and implication in disease and disease management
- Synthesis of antibiotics, Polyketide Synthases – types, structure, mechanism of action
- Comparison of FAS and PKS, Mode of action of antibiotics, Beta-lactamase and Dihydrofolate reductase
- Mechanism of antibiotic resistance

Learning Outcome:

Understanding of gene structure, expression and regulation of gene expression in both prokaryotes and eukaryotes for application in molecular research.

Recommended Reading Materials:

1. David L. Nelson; Michael M. Cox. Lehninger Principles of Biochemistry, Seventh Edition, 2017
2. Gene by Benjamin Lewin, XIIth Editions, Oxford Univ. Press, U.K. (2020)
3. Molecular Biology of gene by Watson, 12th Editions. (2016)

4. Molecular Cell Biology, Lodishet. al., (2007), W.H. Freeman and Company, New York, USA
5. Molecular Biology of the Cell, Alberts et. al., (2008), Garland Science, Taylor & Francis Group, New York, USA.
6. Evolution, Barton, N. H., Briggs, D. E.G., Eisen, J. A., Goldstein, A. E., Patel, N. H., Cold Spring Harbor Laboratory Press, New York, USA (2014)
7. Evolution, Hall, B. K. and Hallgrimsson, B., Jones and Bartlett Publisher, Sudbury, USA (2006)

Course Name: Molecular Genetics (CM-412) **Credits: 03**

Course In-charge: Dr. Souvik Bhattacharjee

COURSE OBJECTIVES

This course is designed to teach the fundamentals of molecular genetics, including the historical landmark studies that laid the foundation of genetics. Routinely used genetic nomenclature and the various techniques frequently used to identify and characterize the genetic mutations are also covered as a part of the course structure. Overall, this course allows the students to combine the theories of molecular genome organization with the latest practical approaches to identify, decipher and design strategies to correct the genetic abnormalities largely seen in the human population.

COURSE CONTENTS

Unit I: Basic understanding of molecular genetics (12 Lectures)

- Genetic notations, conventions and terminology, internet based genetic data search
- Analysis of mutants (recombination, mapping, linkage, recombination frequency, deletion and complementation)

Unit II: Chromosome organization, duplication and genetic mapping (12 Lectures)

- Nucleic acid hybridization, sequencing and mutagenesis
- Chromosome structure and function, mitosis and meiosis
- Chromosome banding and nomenclature, physical mapping
- Chromosome abnormalities, Aneuploidy and Polyploidy
- Mendelian genetics and Allelic variations

Unit III: Mobile genetic elements and movement of genes (12 Lectures)

- Organization of the bacterial chromosome and conjugation
- Transposons and transducible elements, Single Nucleotide Polymorphism (SNP)
- Phage λ genetics – DNA, gene organization, life cycle, lysogeny, transduction

Unit IV: Human genome, genetic abnormalities, and their detection (12 Lectures)

- Human genome and its organization, the Human Genome Project
- Instability of human genome (mutation, polymorphism and DNA repair)
- Genome projects, identification of human disease genes
- Pathological conditions of genetic abnormalities, genetic testing, DNA fingerprinting.

Learning Outcome

Genetics have undoubtedly become an integral part of biomedical science and clinical practice, with important implications in deciphering disease pathogenesis and progression, identifying diagnostic and prognostic markers, as well as designing better targeted treatments. The exponential growth of our understanding of different genetic concepts is paralleled by a growing list of genetic terminology that can easily intimidate the unfamiliar reader. Rendering genetics incomprehensible to the clinician however, defeats the very essence of genetic research: its utilization for combating disease and improving quality of life. Herein we attempt to correct this notion by presenting the basic genetic concepts along with their usefulness in the clinic. Bringing genetics closer to the clinician will enable its harmonious incorporation into clinical care, thus not only restoring our perception of its simple and elegant nature, but importantly ensuring the maximal benefit for our patients.

Recommended Reading Materials:

1. Molecular Genetics by Stanley R. Maloy, John E. Cronan, and David Freifelder. Boston: Jones and Bartlett Publishers, 1994.
2. Human Molecular Genetics, 2nd ED. By Tom Strachan and Andrew Reed. ISBN-10: 1-85996-202-5.New York : Wiley-Liss, 1999.
3. Lewin's Genes XII - With Access by Joycelyn E. Krebs, Elliott S. Goldstein and Stephen T. Kilpatrick ISBN13: 978-128410449. 12th Edition, 2017
4. Introduction to Genetics: A Molecular Approach by T. A. Brown. ISBN13: 978-0815365099, 2011
5. Genetics: From Genes to Genomes – Access by Leland Hartwell and Michael L. Goldberg ISBN13: 978-1260041156. 6th Edition, 2021

Course Name: Nutrition in human health and disease (CM413N) Credits: 3

Course In-charges: Prof. Shailja Singh and Prof. Chinmay K. Mukhopadhyay

COURSE OBJECTIVES

This course is designed to provide a comprehensive learning about the role of nutrition in human health and diseases. The course will cover the molecular and cellular understanding of the influence of nutrition in health as well as metabolic and infectious diseases. The objective of the course is to help the Master students comprehend the essence of nutrition in maintaining human

health and for the nourishment during various diseases. The student may apply the gained knowledge in their future endeavors.

COURSE CONTENTS

Unit I: Introduction to Nutrition (6 Lectures)

- Basic concepts of nutrition, essential and non-essential nutrients, Macronutrients (proteins, carbohydrates, lipids)
- Measurement of the calorie values of foods, recommended dietary allowances, basal metabolic rate (BMR), Measurement of energy requirements
- Malnutrition, malabsorption and interventional strategies

Unit II: Micronutrients: Vitamins & minerals (12 Lectures)

- Introduction to micronutrients
- Lipid soluble vitamins (A,D,E,K), AND Water soluble vitamins (B complex and C) (Discovery, Structure, Mechanism of action, Role in physiology, Source, RDA, deficiency, toxicity, Interactions with other vitamins and drugs)
- Metals, minerals and trace elements, (Classification, Absorption, Transport & Storage, Role in physiology, Sources & RDA, diseases for deficiency and overload)

Unit III: Functional Foods and Nutraceuticals (7 Lectures)

- Introduction to Functional Foods, Nutraceuticals: Definition, History and Classification, Perceived Effects of Functional Foods
- Probiotics, Prebiotics, Postbiotics and Synbiotics
- Nutraceuticals in diseases
- Nutrigenomics

Unit IV: Nutrition sensing mechanisms (8 Lectures)

- Nutrition sensing and response of cells: Role of mTOR and AMPK pathways
- Micronutrient sensing and response mechanisms in mammalian cells

Unit V: Cellular Nutrient Homeostasis (9 Lectures)

- Molecular physiology of plasma membrane transporters and channels for nutrients
- Intracellular trafficking and compartmentalization of vitamins and their physiologically active forms
- Nutrient homeostasis in cells and during starvation

Unit VI: Dietary management of diseases (6 Lectures)

- Metabolic diseases in context of nutrition (diabetes, obesity, cardiovascular disease and cancer)

- Infectious diseases (malaria, dengue, tuberculosis and covid-19).

Learning Outcome:

Appropriate nutrition is fundamental in maintaining health and avoiding diseases. Students will have a comprehensive knowledge in understanding the role of nutrition in health and diseases at the molecular and cellular levels. They will also gain knowledge about the role of functional foods and nutraceuticals in maintaining health, and dietary management in metabolic and infectious diseases.

Recommended Reading Materials:

1. Functional Food and Human Health, Eds. Vibha Rani and Umesh C. S. Yadav, 2018. Springer Singapore, DOI: https://doi.org/10.1007/978-981-13-1123-9.
2. Food, Nutrition and Health by Shashi Goyal & Pooja Gupta, 2012. S Chand publication.
2. Textbook of Nutrition in Health and Disease by Kaveri Chakrabarty and A. S. Chakrabarty, 2019, Springer
3. Biochemical, Physiological and Molecular aspects of Human Nutrition Editors: Martha H. Stipanuk, Marie A. Caudill, 4th edition, 2018. Saunders publication; Elsevier Health Sciences

Course Name: Immunology (CM-414) **Credits: 3**

Course In-charges: Dr. Vijay P. S. Rawat and Dr. Dipankar Ghosh

COURSE OBJECTIVES

This course aims to develop high level proficiency on modern immunology and expose students to cutting edge translational research on immunology in context of molecular medicine. The course is designed for students who have limited knowledge of human immune system as well as those with institutional training on immunology at graduate level. Towards this, the course is broadly grouped in two units teaching non-clonal and clonal immune system, with each units emphasizing on translational components of knowledge specific to national interest.

COURSE CONTENTS

Unit I. Introduction to the immune system (5 lectures)

- Brief History of Immunology The concept of host defense and the evolution of immune system The components of the human immune system. The scope of immunology in molecular medicine

Unit II: The non-clonal immune system/Innate Immunity (15 lectures)

- The non-clonal immune system and the innate immune paradigm. The ligands of the innate immune system (PAMPs & DAMPs) The receptors of the innate immune system (PRRs & Inflammasomes) Major Signaling Mediators & Pathways of Innate Immunity (NF-kB, MAP kinases, AP-1)
  - Introduction to Cytokines and Alarmins
  - The Effectors of Innate Immunity

- The cells of the Innate Immunity
- Innate Immune homeostasis, tolerance and the microbiota
- Inflammation and Sepsis

Unit III. The clonal immune system/ Adaptive Immunity (18 lectures)

- Evolution of Adaptive Immunity: (Evolution and cross talk between innate immunity to adaptive immunity. Components of Adaptive Immunity, Appearance of RAG proteins, antigen recognitions
- Antigen processing and presentation: Type of MHCs, antigen recognition, different classes of antigens. MHC class I antigen presentation, MHC class II antigen presentation. recognition of various types of antigens
- T cell activation : signals and molecules required for T cell activation, T cell proliferation, growth factors, T cell Anergy
- T cell types and antigen recognitionCD8+ T cells, CD4+T cells, TcRαβ and TcRϒδ T cells, NKT cells, how CD4, CD8, TCRϒδ and NKT cells recognize antigens
- TCR structure and signaling
- T cell differentiation: Th1, Th2, Th17, Treg, and Tm cell types. Factors required for differentiation, functional differences, cross regulations, transcription regulations, physiological significance. T cell development: Thymus selection, stage specific markers, function of RAGs.
- Th1 and Th2 immune response
- Humoral Immunity: B cell differentiation, B cell maturation
- Antibody structure: H and L chain, Fab and Fc region, Function of each types of antibodies, Antibody diversification: Fab diversification, VDJ recombination, affinity maturation
- Antibody classes and class switching: Ig subtypes, Genetics of class switching, physiological relevance of class switching
- Cytokines of the Immune System

Unit IV: Immunity & diseases (3 lectures)

- Infection and Immunity: Viral pathogens, Intracellular pathogens, Extracellular pathogens, Parasites, and Fungal pathogens.
- Hypersensitivity
- Autoimmunity
- Sepsis and cytokine storm

Unit V: Applied Immunology (3 lectures)

- Vaccines
- Biosimilars
- Adjuvant

Exams and Quiz: **(4 classes)**

Learning Outcome:

1. Demonstrate the ability to comprehend the importance of regulation of immune function, with reference to disease states which result when regulation is defective.
2. Demonstrate an ability to critically evaluate current theories of immunological function and processes.

Recommended Reading Materials:

1. Murphy, K., Travers, P., Walport, M., & Janeway, C. Janeway's immune biology. Ninth Edition Garland Science, Taylor and Francis Group, New York, 2017
2. Jenni Punt, Sharon Stranford, Patricia Jones, Judy Owen Kuby Immunology, Eighth Edition. Macmillan LearningPublishers,2023

Course Name : Bioinformatics & Computational Biology (CM 415) **Credits: 3**

Course In-charge: Dr. Vijay P. S. Rawat

COURSE OBJECTIVES

Bioinformatics & Computational Biology is an emerging scientific discipline and interdisciplinary field of research. This course is designed with an aim to provide the students deep insight into the fundamentals of Bioinformatics and Computational Biology so that they develop analytical skills to solve biological problems, identify new biomarkers and predict new molecules for the disease treatment and prognosis. This course will help the students to learn different biological databases, sequence analysis, protein and RNA structural analysis, genomics, phylogenetics, analysis of high-throughput data, machine learning methods etc.

COURSE CONTENTS

Unit I: Introduction to biological databases and their usage **(10 lectures)**

- Basic concepts of bioinformatics
- Primary, Secondary and Specialized biological data bases
- Big Data analysis and application to biological problems
- Online biological databases (NCBI: Gene, Nucleotide, Protein, GEO, SNP, OMIM. EMBL-EBI. Expacy: UniProtKB/Swiss-Port, STRING and Cancer Cell Line Encyclopedia (CCLE) etc. and their features,
- Extraction of data from online biological databases.

Unit II: Analysis of DNA, RNA and protein sequences **(12 lectures)**

- Small and long non-coding RNA analysis tools, promoter identification tools

- The principles of miRNA target prediction tools and the distribution of its frequency in existing tools
- Next generation RNA/DNA sequencing analysis and alignment tools.
- Pattern recognition, GC skew
- Differential gene expression analysis. Pathways analysis, Gene Set Enrichment Analysis (GSEA) and Heatmap tools and GWAS
- Post-translational modification (PTM) analysis tools.

Unit III: Phylogeny (6 lectures)

- Construction of Phylogenetic trees and evolutionary analysis
- Design and application of PHYLIP (Phylogeny Inference Package) software

Unit IV: Introduction to Biostatistics and Basic principles of testing of hypothesis (10 lectures)

- Hypothesis, sampling methods (Random and non-random)
- t-test, Chi square, Annova (one way/ two-way, multiple analysis), correlation and regression analysis, Tukey's test and post-hoc analysis
- Parametric and non-parametric tests, FDR tests

Unit V: Primer and RNAi designing tools (10 lectures)

- Primer: PCR (DNA and RNA), qRT-PCR (DNA-RNA), ChIP-qPCR
- miRNA detection and quantification(stem loop primers, NGS)
- siRNA design
- shRNA design

Learning Outcome:

After completing this course, the students will gain an understanding of the bioinformatics challenges and their solutions in the analysis of different large biological data sets, next generation sequencing analysis. They will be able to analyse the proteins, their interactions, modification and function. Student will be able to identify and analyse the disease associated pathways, aberrantly expressed genes, splice variants and disease markers and their possible role in the prognosis, diagnosis and treatment of diseases. Students will be also able to identify new drug targets. They can become an entrepreneur by opening start ups. Students can give us answers to fundamental biological questions important to fields such as Cell Biology, Human diseases and Medical science.

Recommended Reading Materials:

1. Luscombe, N. M., Greenbaum, D., & Gerstein, M. (2001). What is bioinformatics? An introduction and overview. *Yearbook of medical informatics*, (1), 83–99.
2. Searls D. B. (2000). Bioinformatics tools for whole genomes. *Annual review of genomics and human genetics*, *1*, 251–279. https://doi.org/10.1146/annurev.genom.1.1.251
3. Vamathevan, Jessica and Apweiler, Rolf and Birney, Ewan.(2019). Biomolecular Data Resources: Bioinformatics Infrastructure for Biomedical Data Science. *Annual Review of Biomedical Data Science,* Vol. 2, pp. 199-222.
4. Puntervoll, P., Linding, R., Gemünd, C., Chabanis-Davidson, S., Mattingsdal, M., Cameron, S., Martin, D. M., Ausiello, G., Brannetti, B., Costantini, A., Ferrè, F., Maselli, V., Via, A., Cesareni, G., Diella, F., Superti-Furga, G., Wyrwicz, L., Ramu, C., McGuigan, C., Gudavalli, R., Gibson, T. J. (2003). ELM server: A new resource for investigating short functional sites in modular eukaryotic proteins. *Nucleic acids research*, *31*(13), 3625–3630. https://doi.org/10.1093/nar/gkg545
5. Stein L. D. (2003). Integrating biological databases. *Nature reviews. Genetics*, *4*(5), 337–345. https://doi.org/10.1038/nrg1065
6. Mangan, M. E., Williams, J. M., Lathe, S. M., Karolchik, D., & Lathe, W. C., 3rd (2008). UCSC genome browser: deep support for molecular biomedical research. *Biotechnology annual review*, *14*, 63–108. https://doi.org/10.1016/S1387-2656(08)00003-3
7. Andreas D. Baxevanis, Gary D. Bader, David S. Wishart, (2020). Bioinformatics (4th ed.). John Wiley & Sons.

Course Name: Lab Practical (Molecular Biology & Cell Biology) (CM-416N) Credits: 6

Course In-charges: Prof. Chinmay K. Mukhopadhyay, Dr. Souvik Bhattacharjee,

Dr. Shailja Singh, Prof. Rakesh K. Tyagi and Dr. Saima Aijaz

COURSE OBJECTIVES

This course is designed to develop and inculcate the basic laboratory skills in the students in the areas of Molecular Biology and Cell biology. The students will be able to comprehend the principle behind various methods and techniques in these areas and also learn them through performing or hands on experimentation. On the successful completion of the course the student will be able to execute the learnt laboratory skill sets independently or with minimal supervision and the same will be helpful in their dissertation work, Ph.D. thesis work and beyond in their academic and research career.

COURSE CONTENTS:

Unit I: Molecular Biology:

Course In-charge: Prof. Chinmay K. Mukhopadhyay, Dr. Souvik Bhattacharjee, & Prof. Shailja Singh

- Isolation and characterization of plasmid DNA and genomic DNA from *E.coli*

- RNA preparation and analysis
- Principles of agarose gel electrophoresis
- Restriction enzymes, their activity, and important parameters for digestion of DNA and analysis
- Concept of primer designing for PCR amplification.
- Setting of PCR reaction, analysis of amplification product
- Ligation and cloning of any gene of interest in *E. coli* cloning and expression vectors.
- Transformation of *E. coli*, evaluation of transformants and preparation of glycerol stocks
- Transfection of DNA
- Recombinant protein expression in *E. coli*
- SDS-PAGE analysis of protein expression
- Western blotting

Unit II: Cell Biology:

Course In-charge: Prof. Rakesh K. Tyagi and Dr. Saima Aijaz

- Introduction to mammalian cell culture, types of cultures, primary and immortalized cells.
- Introduction to contamination and Biosafety.
- Preparation of complete growth media (cell culture media, medium additives, animal sera).
- Principles of cell culture devices and surfaces.
- Cell growth and propagation.
- Cryopreservation: freeze medium, equipment, procedure and cell revival.
- Subculture of cells (monolayer and suspension cells), passage number.
- Cell counting and viability.
- Cell fixation protocols for processing samples for imaging.
- Immunofluorescence assays to label cytoskeleton proteins and few organelles.
- Principles of cell imaging, microscopic examination of cultures.
- Transfection, expression and imaging of GFP/RFP tagged experimental protein in living cells cell.

Learning Outcome:

This course will allow the students to gain hands-on experience in modern techniques of cell and molecular biology. This knowledge will help them in their future career in research or in biotechnology industries.

Recommended Reading Material:

1. Principles and techniques of practical biochemistry. Ed Keith Wilson and John Walker. Cambridge University Press. 2010
2. Sambrook, J., Fritsch, E. R., & Maniatis, T. Molecular Cloning: A Laboratory Manual (2nd ed.). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, 1989 .
3. Fasman, G.D. Practical Handbook of Biochemistry and Molecular Biology. CRC Press, Taylor and Francis Group, UK.1989

SEMESTER III

Course Name: Free radicals and metals in biology and diseases (CM-421) Credits: 3

Course In-charge: Prof. Chinmay K. Mukhopadhyay

Chemistry and biology of Reactive Oxygen Species (ROS); Reactive nitrogen species (RON) including H2S, their roles in physiology and innate immunity and detection in vivo and in vitro; transition metals in oxidative processes; mechanisms of lipid, protein and DNA oxidation; antioxidants- small molecules (like thiols) and enzymes; involvement of oxidative processes in ageing, cancer and atherosclerosis and infectious diseases; metal ions in gene regulation, Iron in human diseases-anaemia, thalassemia, primary and secondary hemochromatosis, hemophilia; metals in immunity; Menkes' and Wilson's disease: Genetic disorders of copper transport; metals and free radicals in Parkinson's, Alzeihmer's and other neurodegenerative diseases.

Recommended Reading Material:

1. Selected topics from methods in enzymology
2. Selected reviews in Biochemistry, Pharmacology (Annual reviews) as recommended by the course co-ordinator.

Course name: Cell Adhesion and Signal Transduction (CM 422) Credits: 3

Course In-charge: Dr. Saima Aijaz

COURSE OBJECTIVES:

This course is designed to make students understand the principles of cell adhesion, different types of cell-cell and cell-extracellular adhesion molecules, the signaling pathways mediated by cell adhesion that regulate cell proliferation, differentiation and gene expression as well as the diseases that arise due to defects in cell adhesion.

COURSE CONTENTS:

Unit I: Introduction to cell adhesion (8 lectures)

- Principles of cell adhesion, differential adhesion hypothesis

- Single cell adhesion through intercellular adhesion molecules (ICAMs), neural cell adhesion molecule (NCAM), vascular cell adhesion molecules (VCAMs) and Platelet endothelial cell adhesion molecules(PECAM).
- Single cell adhesion through selectins, cadherin and integrins

Unit II: Epithelial cell-cell junctions and diseases (12 lectures)

- Tight junctions: composition, functions, signaling pathways regulating gene expression (ZO-1 pathway), cell proliferation (through Rho GTPases) and differentiation, diseases associated with tight junctions.
- Adherens junctions and desmosomes: composition, functions, role of β-catenin signaling in proliferation, diseases associated with adherens junctions and desmosomes.
- Gap junctions: composition, functions and associated diseases.

Unit III: Endothelial cell adhesion (12 lectures)

- Composition of endothelial junctions, FGF/VEGF signaling, functions of endothelia and associated diseases (including neovascularization)
- Blood-retina barrier: structure, function, role of angiopoietins and Tie-2 signaling in diabetic retinopathy.
- Blood-brain barrier: structure-function relationships, defects in neurodegenerative diseases-Alzheimer's disease, multiple sclerosis, paralysis and brain infections.

Unit IV: Cell-extracellular matrix adhesion (8 lectures)

- Composition of the extracellular matrix
- Focal adhesions and hemi-desmosomes: structure, functions and associated diseases.
- Integrins: structure-function, signaling pathways and associated diseases.

Unit V: Epithelial-Mesenchymal Transition (EMT) (6 lectures)

- Introduction: Definitions and types of EMT
- Reversible EMT in embryonic development, wound healing and tissue remodeling, role of TGF-β signaling in EMT.
- Irreversible EMT: loss of cell adhesion in tumor formation, invasion and metastasis, tumor microenvironment.

Unit VI: **Strategies to reverse loss of cell adhesion (2 lectures)**

- Principles of cellular therapy

- Cell based therapies for specific diseases.

Learning Outcome:

The students will learn the concepts of cell adhesion which regulate cell proliferation, differentiation, tumor invasion and metastasis. This knowledge will help them to identify new therapeutic targets.

Recommended Reading Material:

1. Cell Adhesion (Frontiers in Molecular Biology, Edited by Mary C Beckerle. Publisher: Oxford University Press.ISBN-10:0199638713, 2002
2. New Cell Adhesion Research, , Edited by Patrick Nott and Matthew Temple, Publisher: Nova Science Pub Inc. ISBN-10:1606923781, 2009
3. Adhesion Molecules, by Victor R. Preedy, Publisher: CRC Press. ISBN: 9781138117891, 2017
4. Physical Basis of Cell-Cell Adhesion., by Pierre Bongrand, Publisher: CRC Press; 1st edition. ISBN-10:1315896478, 2017.

Course Name: Molecular basis of Infectious Diseases (CM 423) **Credits: 3**

Course In-charges: Prof. Suman K .Dhar and Dr. Souvik Bhattacharjee

COURSE OBJECTIVES

The Molecular Basis of Infectious Diseases course has been designed to provide *in-depth* knowledge of molecular and cellular aspects of pathogens and their respective hosts. This leads them towards understanding of the disease biology and strategies for identification of new targets for drug development. The course also allows the students to get acquainted with the *state-of-the-art* techniques developed for detection, diagnosis, and therapeutic intervention for the infectious diseases with special emphasis to the diseases of developing countries. The course also involves training of students for developing good presentation skills.

COURSE CONTENTS

Unit I: Principles of Infectious Diseases **(10 lectures)**

- Epidemiology and global distribution of infectious diseases
- General principles of human host-microbe interactions and establishment of the disease
- Infection and host manipulation strategies for common pathogens, like bacteria, viruses, fungi, and parasites, with special emphasis for those prevalent in the developing countries

Unit II: Molecular basis of bacterial pathogenesis **(10 lectures)**

- Role of virulence factors and adhesins in establishment of infection.

- Functional involvement of pathogenicity island, protein and DNA secretion systems in pathogenicity and disease.
- Modulation of the host signalling system in response to the infection

Unit III: Molecular and cellular basis of viral infections (8 lectures)

- Key examples of RNA and DNA viruses pathogenic to humans (including Hepatitis C Virus/HCV, Ebola virus, SARS, influenza, Human Herpes virus/HSV).
- Molecular biology of tumorigenic viruses
- Mechanisms of viral carcinogenesis

Unit IV: Molecular parasitology: (12 lectures)

- The molecular aspects of parasite biology including the life cycle stages in the different hosts.
- Genetics and biochemistry of parasites and their unique metabolic pathways (with primary focus on the Kinetoplast and Apicomplexan parasites such as *Plasmodium, Toxoplasma, Leishmania etc.*)
- Mechanisms of pathogenesis, including signalling pathways, parasite adaptations for survival within the host.
- Grand challenges for drug and vaccine development and disease control in infectious diseases

Unit V: Research Presentation (8 lectures)

- Each student presents a research paper on the broad areas of Molecular Basis of Infectious Diseases.
- The presenter will highlight the concept of the paper as well as emphasize on the future applications derived from the paper.
- The presentation will be evaluated by the course-coordinators with extensive discussions and suggestions to improve and the interpretations, slide preparation and presentation skills.

Learning Outcome:

This course will help the students to understand the Molecular basis of Infectious Diseases for a wide range of pathogens that may include but not limited to virus, bacteria, fungi, protozoan parasites. This will enable them to think regarding intervention processes using appropriate targets leading to effective vaccines and medicines against emerging diseases in the long run.

Recommended Reading Material

1. Bacterial Pathogenesis: A Molecular Approach: Brenda A. Wilson, Malcolm Winkler, Brian T. Ho. Publisher: ASM Press; 4thedition (2019)

2. Molecular Diagnostics of Infectious Diseases. By Harald H. Kesslar. ASIN:B0138MB64K, Publisher: De Gruyter; 3rd edition (2014).
3. Medical Microbiology: An Introduction to Infectious Diseases. By John C. Sherris, Kenneth J Ryan et al. Publisher: Appleton & Lange; 4th edition (2004)

Course: Name: Molecular Endocrinology & Endocrinopathies (CM 424) Credits: 3
Course In-charge: Prof. Rakesh K. Tyagi

COURSE OBJECTIVES

This course is designed to develop the competence in the basic concepts of hormone and of endocrine system and the functioning of extracellular and intracellular receptors. Students will learn to appreciate how alterations, deviations or malfunctioning in endocrine system and hormone target sites contribute to the normal life processes and onset of endocrine diseases. On successful completion of the course, the student will be able to comprehend the basics and general advances in endocrinology, endocrine related diseases, receptor biology and therapeutics.

COURSE CONTENTS

Unit I: Principles of Endocrinology (12 lectures)

- Introduction to basic endocrinology: historical perspective and milestones.
- Endocrine glands, their secretions and functions
- Classifications of hormones: Peptide and protein hormones, steroid hormones, Amino acid derivatives etc.
- Overview of cellular patterns of secretion; feedback mechanism of hormone regulation.

Unit II: Hormones and receptors (12 lectures)

- Extracellular and intracellular receptors (structure, function of these receptors)
- Receptor-ligand interactions (hormone, ligand, agonist, antagonist etc)
- Steroid hormones and steroid receptors
- Nuclear receptors superfamily
- Co-activators and co-regulators and their structural features

Unit III: Molecular basis of endocrinopathies (14 lectures)

- Endocrine and metabolic disorders (examples-thyroid, pituitary etc)
- Breast and prostate cancers, anti-hormone therapy
- Small molecule modulators as therapeutic ligands
- Selective Nuclear Receptor Modulators (SNuRMs) and Selective Nuclear Receptor Modulators (SNuRDs)
- Environmental endocrinology, endocrine disruptors and their potential health implications

Unit IV: Special topics in endocrine health and disease (10 lectures)

- Menopause and andropause
- Ageing and sex steroids (expand)
- Hormone replacement therapy: benefits and risks
- Topical term papers, projects and quiz

Learning Outcome:

Upon successfully completing the course, the student will be able to comprehend the basics and general advances in endocrinology, endocrine-related diseases, receptor biology, and therapeutics.

Recommended Reading Material

1. Introduction to Endocrinology (2009) by Chandra S Negi, PHI Learning Pvt. Ltd, Delhi, India
2. Molecular Endocrinology (2004) 3rd ed. by Franklyn F. Bolander Jr, Elsevier Academic Press.
3. Principles of Endocrinology and Hormone Action (2018) Antonino Belfiore and Derek LeRoith (Editors) Springer International Publishing AG, Switzerland.
4. The Nuclear Receptor Facts Book (2002) by Vincent Laudet and Hinrich Gronemeyer, Academic Press, London, UK.

Course Name: Host-Microbe Relationships in Health and Disease (CM 425) Credits: 3

Coordinators: Prof. Shailja Singh and Dr. Souvik Bhattacharjee

COURSE OBJECTIVES

This course focuses on fundamental aspects of host-pathogen relationships and covers the biological mechanisms of pathogenesis and the development of disease following infection. Also included are extensive discussions on the progressive development of therapeutic potential and their unique targeting approaches. Finally, the emergence of drug-resistance in pathogens will be evaluated, including the designing of counter strategies of drug designing. 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.

COURSE CONTENTS

Unit I: Evolutionary origin of pathogens and development of host infection strategies.

(10 lectures)

- Basic introduction to different pathogens'(viruses, bacteria, fungi and parasites) origin and their respective hosts
- Life cycle of the pathogen life cycle and their uniqueness

- Genetic architecture of the pathogens including genome structure and gene expression, antigenic variability
- Epidemiology, population genetics and evolution

Unit II: Genetic, cellular and molecular mechanisms of host selection and pathogenesis.

(10 lectures)

- 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, including manipulation and reprogramming of the intracellular host environment.
- Pathogen molecules that mediate interactions with host, and the role these interactions play in host recognition and modulation and disease progression.

Unit III: Classification of the strategies harnessed by the pathogen to evade the host/vector defense mechanisms (14 lectures)

1. Epidemiology and global distribution of infectious diseases.
2. General principles of human host-microbe interactions and establishment of the disease.
3. Infection and host manipulation strategies for common pathogens, like bacteria, viruses, fungi, and parasites, with special emphasis for those prevalent in the developing countries.

Unit IV: Evaluation of the merits and limitations of the experimental approaches used to address the host-pathogen interaction: (14 lectures)

- Vaccine and therapeutic intervention strategies developed for different pathogens
- Mechanism of action of approved drugs and those in the pipeline
- Genetic approaches for pathogen manipulations using CRISPR-Cas9 and knockout approaches for their attenuation
- Consequence of emergence of drug resistance and their global implications
- Current techniques for rational drug design and their applications.

Learning Outcome:

The course addresses basic concepts in interactions between humans and microbes. It provides multidisciplinary insights on the host-microbe interaction with a focus on the link between underlying molecular changes that ultimately impacts the disease.

Recommended Reading Material

1. Host-Microbe Interactions, 1st Edition - August 1, 2016: Editors: Michael San Francisco, Brian San Francisco. Hardcover ISBN: 9780128093856. eBook ISBN: 9780128096178.

2. Host-Pathogen Interactions: Methods and Protocols. (2018). Editors: Carlos Medina, Francisco Javier López-Baena. ISBN: 978-1-4939-7604-1.

3. Host-Microbe Interactions: Volume 142 (Progress in Molecular Biology and Translational Science). Editors: Michael San Francisco (Editor), Brian San Francisco (Editor). Publisher : : 10-ISBN .(2016August 2)Academic Press Inc 012809385.

Course Name: -Proteomics & Metabolomics (CM 426) Credits: 3

Course In-charge: Dr. Dipankar Ghosh

COURSE OBJECTIVES

Omics is a rapidly evolving, multi-disciplinary, and emerging field that encompasses genomics, transcriptomics, proteomics, and metabolomics. These domains, either independently or combined, allow systems level understanding of biology. The course will introduce the principles of these technologies; their advantages and limitations in perspectives of their domains. The emphasis will be on proteomics, metabolomics – the two domains of systems biology that often play fundamental role understanding the translational and post-translational biology of the genome for accelerated discoveries in health and disease.

COURSE CONTENTS

Unit I. Basic Concepts (5 lectures)

- The central dogma. Basic structure of DNA, RNA and proteins.
- Principles of biological information and information flow.

Unit II. Principles of Proteomics and Metabolomics-I (12 lectures)

- Introduction to protein structures and functions.
- Protein post-translational modifications.
- Introduction to Proteomics – history, types of proteomics and their applications.
- Introduction to Metabolomics – basic metabolic pathways; targeted and untargeted analysis.

Unit III. Principles of Proteomics and Metabolomics-II (25 lectures)

- Separations technologies in proteomics and metabolomics.
- Introduction to mass spectrometry – History, principles, mechanisms of ionization, types of mass analyzers and applications.
- Introduction to NMR – History, principles of biological NMR and applications.
- Introduction to systems biology and integration of omics information.

Unit IV. Applications of Proteomics & Metabolomics (6 lectures)

- Human protein atlas and protein annotations.
- Major open-access resources, Case studies, Sample preparations, data interpretations and troubleshooting.

Learning Outcome:

After completing the course the student will be able to: • account for essential aspects of the techniques used in proteomics and metabolomics • perform simple metabolomic and proteomic experiments • prepare samples for preparation metabolomics and proteomics • analyse and interpret metabolomic and proteomic data • apply those methods to solve unfamiliar problems • new drug targets may be identified in different diseases.

Recommended Reading Material:

1. NEW DEVELOPMENTS IN MASS SPECTROMETRY (Series) ; Title- Processing Metabolomics and Proteomics Data with Open Software: A Practical Guide Edited by Robert Winkler, 2020 DOI: https://doi.org/10.1039/9781788019880 , Royal Society of Chemistry.
2. Proteomic and Metabolomic Approaches to Biomarker Discovery, Edited by: Haleem J. Issaq and Timothy D. VeenstraBook • Second Edition • 2020 DOI : https://doi.org/10.1016/C2018-0-03967-5 , Academic Press,
3. Mass Spectrometry: Principles and Applications by Edmond de Hoffmann, Vincent Stroobant. Publisher: Wiley-Interscience; 3rd edition (2007)

Course Name: Molecular Basis of Metabolic Disorders (CM 427) Credits: 3

Course In-charges: Prof. Chinmay K. Mukhopadhyay and Prof. Umesh C. S. Yadav

COURSE OBJECTIVES

Molecular Basis of Metabolic Disorder course is designed with an aim to provide the students deep insight into the metabolic diseases at the molecular and cellular levels. Understanding these mechanisms will help them to comprehend the molecular basis of specific disease mechanism and enable them to ask questions for unraveling new biomarkers and therapeutic targets for various metabolic diseases including obesity, diabetes, heart complications, kidney and liver diseases. The objective of the course is to help the Master students comprehend mechanisms of pathogenesis related to metabolic diseases and apply the gained knowledge in their future endeavors.

COURSE CONTENTS

Unit I: Introduction to metabolic disorders (8 lectures)

- Metabolic disorders, role of life style, mechanism, markers and diagnosis
- Inflammation- definition and types; history of inflammation, Mechanism of inflammation – initiation, progression and resolution, inflammatory diseases.
- Anemia of Inflammation or anemia of chronic diseases

Unit II: Molecular Basis of Metabolic Diseases (14 lectures)

- History of obesity research, etiology of obesity, Body Mass Index (BMI),types of adipose tissues, molecular mechanism of obesity, Leptin and obesity, Metaflammation, therapeutic approaches.

- Cardiovascular diseases (CVDs) – link with obesity, major components of CVDs including Atherosclerosis, Endothelial dysfunction, Heart failure, Cardiomyopathy, Hypertension will be discussed such as diagnosis, mechanism of disease development, potential therapeutic approaches.
- Fatty Liver diseases- Natural history and progression, prevalence and pathophysiology, Role of adipose tissue and insulin resistance, two hits and multiple parallel hits hypothesis of disease progression, role of oxidative stress and inflammation.
- Chronic Kidney disease, definition and stages, causes and risk factors, clinical manifestations, pathology, detection and management.

Unit III: Molecular mechanism of hyperglycemia, insulin resistance and diabetes (8 lectures)

- Insulin dependent and insulin independent diabetes
- Mechanisms of hyperglycemia and insulin resistance
- Adipokines and insulin resistance

Unit IV: Inborn diseases of metabolism (6 lectures)

- Definitions and introduction to Inborn errors of Metabolism (IEM), Clinical manifestations, classifications, preventions and treatments.
- Lysosomal storage disorders, introduction and history, sub-categories of the disease, biochemical and cellular bases of the disorders, advancement in enzyme replacement therapies.
- Metabolic bone diseases, bone cells and remodeling processes, role of hormones, understanding the diseases from clinical examples, osteoporosis, hypercalcemia, Paget's disease, measurements of bone mineral density.

Unit V: Role of Reactive Oxygen Species (ROS) and Reactive Nitrogen Species (RNS) in metabolic diseases (6 lectures)

- Introduction to oxidative stress, free radicals, ROS and antioxidants, roles in metabolic disorders.
- Introduction to RNS and roles in metabolic disorders.
- Red-ox in signaling pathways

Unit VI: Model organisms to study metabolic disorders (6 lectures)

- Model organisms such as Zebrafish, C. elegans, Drosophila, Rat/Mouse, humanized animals etc. to understand the mechanisms of metabolic diseases including neurodegenerative diseases.

Learning Outcome:

Students will be able to develop insight about the metabolic diseases at the molecular and cellular levels after completion of this course. They will be able to understand the molecular basis of

specific disease mechanisms, learn about new biomarkers, therapeutic targets and drug development regarding diseases like obesity, diabetes, cardiovascular, kidney, liver diseases, and diseases of inborn errors. The knowledge gained will help the students to build their future academic and research career in the stream of metabolic diseases mainly contributing to the morbidity and mortality in any population.

Recommended Reading Material

1. Selected topics from Annual Reviews, Nature Reviews, New England Journal of Medicine, Lancet
2. Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil; Harper's Illustrated Biochemistry. 31st Ed. McGraw Hill, 2018.
3. Jeremy M. Berg, LubertStryer, John Tymoczko, Gregory Gatto, Biochemistry (9th Edition), WH Freeman, 2019.
4. Bray George A., A Guide to Obesity and the Metabolic Syndrome, Origins and Treatments. Taylor & Francis Inc. ISBN: 9781439814574, 9781439814574, 2011.

Course Name: Dissertation–I, Presentation (CM-428) **Credits: 4**

Course In-charges: All the faculty members

COURSE OBJECTIVES

The objective of this course is to train the students about the scientific rigor and asking the right question to investigate. They will be able to read and comprehend the literature, frame the hypothesis around a pertinent question and formulate the objective to test their hypothesis using accurate methodology. The students will write the synopsis of the proposed dissertation work after an extensive review of literature and defend the same. By the end of dissertation part -I the students will be able to learn the basics of research proposal writing in the form of synopsis, perform some preliminary experiments and defend the synopsis in front of the centre assessment committee which will be evaluated.

COURSE CONTENTS

- Synopsis writing and presentation

Learning Outcome: This course will help students to learn how to design a project, write the synopsis and make a presentation.

Recommended Reading Material:

1. Literature related to the proposed research topic

SEMESTER IV

Course Name: Pharmacology and Therapeutics (CM 451) **Credits: 3**

Course In-charge: Prof. Vibha Tandon

COURSE OBJECTIVES

This enables the students to get a broad idea on Pharmacology and different therapeutics against human diseases, its related terms and concepts of designing of drugs and the biological effects. The topics are framed to enhance the student's knowledge in various areas of drug action in biological system.

COURSE CONTENTS

Unit I: An Introductory Overview **(5 lectures)**

- Drug design, Drug receptor interactions theories, Occupation theory, rate theory, Macromolecule perturbation theory
- Receptor occupation and response relationships, sparereceptors, silent receptors
- Receptor characterization methods
- Receptors and specificity

Unit II: Structure Activity Relationships in drug design & discovery **(5 lectures)**

- Pharmacophore Identification
- Quantitative structure activity relationship for biological activity of compounds
- Design and dose response relation of Agonist, Antagonist, Partial Agonist, Inverse Agonist

Unit III: Efficacy of Drug **(5 lectures)**

- Effective dose determination
- Lethal dose determinations, Therapeutic Index
- Efficacy vs Potency of Drug

Unit IV: Pharmacokinetics & Pharmacodynamics of drugs **(8 lectures)**

- Routes of drug administration
- Absorption, distribution, excretion & clearance of drug
- Monophasic and biphasic compartment analysis of drug distribution
- Bioavailability, plasma protein binding, volume of distribution, Half-life of drug
- Effect of drug on human body and hematopoietic system

Unit V: Drug Metabolism, Drug–Drug Interactions, Toxicology of Drugs **(8 lectures)**

- Biotransformation of Drugs, Phase I and Phase II transformations
- Enzymes responsible for biotransformations
- Microsomal and Non-microsomal mechanisms of drug metabolism
- Single dose and repeat dose toxicity studies; Factors influencing such studies such as species, sex, size, route, dose level; data evaluation and regulatory requirements.

- Design and organization of phase-I to phase-IV clinical studies.

Unit VI: Molecular Basis of Therapeutics Microbial Targets (5 lectures)

- Signal Transduction pathways and their role in diseases
- Drug induced check point activation/inhibition
- Antimitotic drugs, Mitotic exit/slippage, Manipulating mitotic checkpoint

Unit VII: Different Class of drugs against common (6 lectures)

- Small molecules as drugs e.g. Anticancer, Antibiotics, Antidiabetic, Cardiovascular disease
- Peptide Therapeutics
- Monoclonal Antibodies, Immuno-therapeutics
- Natural products isolated from Medicinal Plants and approved as drug

Unit VIII: Clinical Pharmacogenomics & Pharmacogenetics (6 lectures)

- Precision & Personalized medicine
- Dose modification based on clinical pharmacogenomics

Learning Outcome:

Students will be able to develop insight about the principles of drug design, drug development against any disease. They will be able to understand the structure of Receptors (drug targets), drug-receptor interactions, drug-drug interactions, metabolism of drugs, effects of drug on human body, mechanism of action of drug. This will help them in designing new small molecules, biologicals, vaccines in future. These students will be also able to identify new drug targets. These students will serve as manpower and future scientists for benefit of mankind globally. The knowledge gained will help the students to build their future academic and research career in the pharmaceutical companies. They can tomorrow become an entrepreneur by opening start-ups. They can develop new API, targets, biological assays to measure the activity of drugs, essential drugs at affordable cost, vaccines, adjuvant which is an unmet need of whole world

Recommended Reading Materials:

1. The Pharmacological Basis of Therapeutics, Louis S. Goodman, Alfred GilmanSr., Edited by Laurence L. Brunton, John, S.L., K. L. Parker, McGraw Hill Education,11th Edition2005.
2. Oxford Text book of Clinical Pharmacology and Drug Therapy, D. G. Grahame-Smithand J. K. Aronson, Oxford University Press, 3rd Edition 2002.
3. Organic Chemistry of drug design and drug action, R.B. Silverman, Academic Press, 2nd Edition 2004.
4. Statistical Methods in Biology, Bailey, M.A., Norman, T.J., Cambridge University Press, 3rd Edition, 1995.
5. A Text book of Drug design and development, Povl. Krogsgaard-Larsen Tommy L. and U Madsen, CRC Press, 2nd Edition, 1996.
6. An introduction to Medicinal Chemistry, Graham Patrick, OUP Oxford, 6th Edition, 2017.

Course Name: Bioethics & IPR (CM452) Credits: 2

Course In-charge: Prof. Shailja Singh

COURSE OBJECTIVES

Within the realm of contemporary science and technology policies, bioethics and Intellectual Property Rights (IPR) hold immense significance. The course is especially crafted to familiarize M.Sc. students with the essential principles of bioethics and IPR in an understandable manner. By underscoring essential elements, this simplified version of the course provides a comprehensive understanding of bioethics and intellectual property, spanning their historical roots to its relevance in today's context. The course is comprises three modules, focusing on the fundamental aspects of bioethics and IPR.

COURSE CONTENTS

Unit I: Understanding the basics of bioethics (8 lectures)

- Ethics & innovation in research: Safe laboratory practices; animal ethics; and, human subject research ethics and regulations.
- Lab safety essentials: Handling laboratory equipment and chemical reagents; fire and electrical safety; disinfection and sterilization; definitions of biosafety levels 1-5; microbiological risk assessment; biosafety and recombinant DNA technology; and, laboratory animal facilities.
- Ethical research guidelines: Ethical use of laboratory animals and human subjects; biosafety guidelines: WHO and Government of India; and, introduction to the JNU Institutional Ethics Review Board (IERB).

Unit II: Understanding the essentials of IPR (8 lectures)

This unit establishes a foundational understanding of intellectual property, with its significance in science and technology.

- Introduction to intellectual property: Definition and importance
- Types of intellectual property: Patents, trademarks, copyrights
- Intellectual property and innovation: Fostering creativity in science and technology

Unit III: Historical development and globalization of IPR (8 lectures)

This unit discovers the evolution of intellectual property laws and their global impact.

- Historical evolution: Key milestones in the development of IPR
- International agreements: Overview of treaties and conventions
- Standardization: Influence on global scientific cooperation

LEARNING OUTCOMES

The students will develop an understanding of bioethics and IPR in the context of contemporary science and technology policies. They will gain a thorough knowledge of bioethics fundamentals, including ethical research guidelines, safe laboratory practices, and animal and human subject ethics. Additionally, the students will acquire an understanding of the essentials of IPR and its role in innovation development.

Recommended Reading materials:

1. Basic Laboratory Methods for Biotechnology (2nd Edition). Publisher: Benjamin Cummings; 2nd Edition 2008.
2. Clinical Ethics: A Practical Approach to Ethical Decisions in Clinical Medicine, Ninth Edition by Albert R. Jonsen; Mark Siegler; William J. Winslade ISBN: 9781260457544. 2022
3. Bioethics Across the Globe by Akira Akabayashi ISBN: 9789811535710, Springer Singapore2020.
4. Manuals of patent office practice and procedure, Publisher: The Office of Controller General of Patents, Designs & Trademarks, Version 3, 2019.

Course Name: Diseases of National Importance (CM453) Credits: 3

Course In-charges: All Faculties of SCMM

Seminar series by medical and clinical specialists and experts on selected diseases of national importance including:

Diabetes, Goiter, hypertension, ischemic heart disease, bronchial asthma, epilepsy, prostate cancer, cervical cancer, breast cancer, lung cancer, gastric and diarrheal diseases, malaria, Tuberculosis.

Learning Outcome:

Students will be familiarized with emerging diseases and the underlying mechanisms of pathogenesis.

Recommended Reading materials:

1. Papers relevant for diseases.

Course Name: Dissertation-II Submission & Viva (CM454) Credits: 8

Course In-charges: All Faculties of SCMM

COURSE OBJECTIVES

The objective of this course is to train the students execute the research work proposed in their synopsis, perform the experiments, collect the data and record it, analyze the results and write the dissertation under the supervision of their guides. The students will be able to perform the experiments with progressively minimum supervision and complete their research work, write dissertation and present the same. By the end of dissertation part -II the students will be able to propose and execute the research work, write the report and present the work in front of general audience.

COURSE CONTENTS

- Completing the research work proposed in the Synopsis, write the dissertation and present their work.

Learning Outcome:

Students will learn to present and defend their dissertation work in an open seminar.

Recommended Reading Material:

1. Literature related to the proposed research topics by the students