SPECIAL CENTRE FOR MOLECULAR MEDICINE

One-year M.Sc. (Research) in Molecular Medicine

(in line with NEP-2020)

One-year M.Sc. (Research) in Molecular Medicine

Guidelines and Course Structure

SCMM, JNU proposes to introduce a new academic program, "Master's (Research) in Molecular Medicine" to align its curriculum with the NEP-2020 guidelines.

Eligibility for Admission:

1. Students must have completed one year of the M.Sc. program in Molecular Medicine or allied disciplines after a three-year undergraduate degree course in any branch related to Molecular Medicine as laid out in the JNU admission policy for the M.Sc. in Molecular Medicine Program.

2. The candidates must have obtained at least 75% marks (aggregate) in:

(i) Four-year Undergraduate Program (in Biology, Chemistry, Physics, Mathematics, Veterinary Sciences, Medicine, Biochemistry, Bioinformatics, Biotechnology, Botany, Microbiology, Zoology, Pharmacy, Engineering/Technology or allied subjects)

or

(ii) First/One-year Master's degree program/Post-graduate Diploma in any of the subject areas listed above.

Admission

Admission to the M.Sc. (Research) degree in Molecular Medicine program at SCMM, JNU will be through the national-level entrance examination. Admissions would be made as per JNU policy. Only vacant seats left remaining in the two-year M.Sc. Molecular Medicine program will be offered to students wishing to enroll in the One-Year M.Sc. (Research) degree program in Molecular Medicine.

Curriculum:

A one-year M.Sc. (Research) in Molecular Medicine Program will be run alongside the second-year courses of the M.Sc. Molecular Medicine program at SCMM, JNU. This program will provide an opportunity for students to carry out a high-quality one-year M.Sc.-level research project (Dissertation) along with core courses and choice-based optional courses to provide advanced theoretical knowledge for biotechnology-based research.

Semester III		Semester IV	
Compulsory Courses:		**Compulsory Courses:**	
CM-428N: Dissertation-I: Synopsis writing & Presentation	8 Credits	CM-451: Pharmacology & Therapeutics	3 Credits
CM-431: Biosafety, Bioethics & IPR	2 Credits	CM-453N: Understanding Diseases of National Importance through IKS (Indian Knowledge System)	2 Credits
		CM-454N: Dissertation-II Dissertation Submission & Defense (Viva)	16 Credits
Optional courses (any four):		**Optional courses (any one):**	
CM-422: Cell Adhesion & Signal Transduction	3 Credits	CM-455: Term Paper & Seminar	1 Credit
CM-423: Molecular Basis of Infectious Diseases	3 Credits	CM-456: Critical Review of Research Article & Scientific Writing	1 Credit
CM-424: Molecular Endocrinology And Endocrinopathies	3 Credits		
CM-425: Host-Microbe Relationships in Health & Disease	3 Credits		
CM-426: Proteomics & Metabolomics	3 Credits	**Total = 22 Credits**	
CM-427: Molecular Basis of Metabolic Disorders	3 Credits		
CM-429: Applied Bioinformatics: Genomics and Structural Biology	3 Credits		
CM-430: Stem Cell Biology & Regenerative Medicine	3 Credits		
Total = 22 Credits			
		Total Credits = 44	

COURSE STRUCTURE

SEMESTER I

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: 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 : : Academic Press Inc (2 August 2016). ISBN-10 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, Lubert Stryer, 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, Synopsis writing & Presentation (CM-428N) Credits: 8

Course In-charges: All faculty members

COURSE OBJECTIVES

The objective of this course is to train the students in scientific rigor and in asking the right questions 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. 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
- The students will write the synopsis of the proposed dissertation work after an extensive review of literature and defend the same through a public 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

Course Name: Applied Bioinformatics: Genomics and Structural Biology (CM-429)
Credits: 3

Course In-charge: Dr. Someswar R. Sagurthi and Dr. Sudhir Kumar

COURSE OBJECTIVES

Provide students with fundamental knowledge of bioinformatics tools, databases, and their genomics and structural biology applications; Familiarize students with disease-specific databases and the role of bioinformatics in understanding genetic and protein-related disease mechanisms.
Equip students with essential bioinformatics skills, including sequence alignment, genome assembly, Structure Biology and protein structure prediction.

COURSE CONTENTS

Unit I: Advanced Bioinformatics Databases (10 Lectures)

- Genomic Databases: UCSC Genome Browser, Human Gene Mutation Database (HGMD), OMIM (Online Mendelian Inheritance in Man), Mycobrowser and ViperDB
- Protein function annotation Databases: STRING, Prosite and BioGRID
- Functional Annotation and Ontologies: Gene Ontology (GO) and InterPro and SNPdb
- Small molecule Databases: Pubchem, Drugbank, ChEMBL and ZINC database

Unit II: Algorithms and Sequence Analysis (10 Lectures)

- Sequence Alignment: identity, similarity, homology, orthologs, paralogs & xenologs)
- Scoring matrices: PAM & BLOSUM (permissible replacements, similarity score)- gap penalties (linear & affine gap penalties).
- Global alignment - Needleman and Wunch algorithm with illustration
- Local alignment- Smith and Waterman algorithm with illustration
- BLAST and FASTA algorithm: Variants, ktup, identification of HSP, statistical significance

Unit III: Structural Biology (10 Lectures)

- Fundamental principles of X-ray diffraction
- Protein overexpression, purification and crystallization
- Model building and validation
- Basic principles of NMR and CryoEM for structural analysis

Unit IV: Hands-on training: Data Retrieval and Sequence Analysis (10 Lectures)

- Sequence format conversion using Readseq tool: FASTA, PIR, FastQ, BAM, and SAM
- Dot matrix comparison of sequences using graphs and dot matcher tool, Global alignment- Emboss Needle, Local alignment- Emboss Water
- Heuristics database search tools: BLAST and FASTA
- Prediction of genes in prokaryotic and eukaryotic genomes, ORF Finder and Genscan, Prediction of SSRs in DNA sequence (SSRit)
- Compute physical and chemical parameters of protein using Protparam tool

Unit V: Hands-on training: Structure prediction and Molecular Modelling (8 Lectures)

- Prediction of secondary structures of proteins
- Chou-Fasman method, GOR IV method, and Psipred
- Tertiary structure prediction by homology model building, Threading and *ab initio* methods
- Structure annotation and Active site prediction
- Virtual Screening and Docking

Learning Outcome

This course covers applied bioinformatics, focusing on databases, algorithms, sequence analysis, structure prediction, and molecular modelling. Key topics include genomic and protein databases, sequence alignment, structure prediction, and annotation. Hands-on training includes data retrieval, gene prediction, physical/chemical protein analysis, and structure modelling. The course integrates practical training in bioinformatics for research**.**

Recommended Reading Materials:

1. Introduction to bioinformatics by Aurther M lesk
2. Developing informatics computer skills by Cynthia Gibas, Per Jambeck
3. Chemoinformatics: a textbook by Johann Gasteiger
4. Bioinformatics second edition by David M mount
5. Essential bioinformatics by Jin Xiong
6. Bioinformatics computing by Bryan Bergeron
7. Bioinformatics: Concepts, skills & applications by R.S. Rastogi
8. Bioinformatics: methods and applications genomics, proteomics and drug discovery by S.C. Rastogi, Parag Rastogi, Namita Mendiratta
9. Bioinformatics and functional genomics (third edition) by Jonathan Pevsner
10. Data mining in Bioinformatics, Jason T. L Wang, Zaki, Toivonen and Dennis Shasha

Course Name: Stem Cell Biology & Regenerative Medicine (CM-430) Credits: 3

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

Course Objectives:

This course is designed to provide postgraduate students with a comprehensive understanding of the biological, molecular, and functional properties of stem cells. It aims to elucidate the defining features of various stem cell types—including embryonic, adult, and induced pluripotent stem cells—and their roles in development, tissue homeostasis, and regeneration. Emphasis is placed on the regulatory mechanisms governing self-renewal, pluripotency, and lineage commitment, with a detailed focus on coding and noncoding regulators, epigenetic and transcriptional control. The course also introduces students to the methodologies employed in stem cell research, including reprogramming techniques and functional assays. Finally, it explores translational aspects by examining current and emerging clinical applications of stem cells in treating hematological, neurological, cardiovascular, and autoimmune diseases**.**

COURSE CONTENTS

Unit I: Introduction to Stem Cell Biology (6 Lectures)

- Characteristics of a stem cell: Self-renewal, Types of Stem Cells. Comparison of ESCs, iPSCs and ASCs.
- Totipotency, Pluripotency, and Multipotency
- Sources of Mammalian ESCs and Extraembryonic Tissues
- Stem cell regulation

Unit II: Pluripotency and Reprogramming (7 Lectures)

- Defining Features of Pluripotent Stem Cells
- Principles of Reprogramming
- Experimental design to test pluripotency, Teratoma formation assay, Embryoid body formation and chimera formation
- Cellular Features Sustaining Pluripotency:
- Comparison of Pluripotent Stem Cells and Strategies for Obtaining Them:
- Somatic Cell Reprogramming to iPSCs: cells while bypassing the ethical concerns associated with the use of embryos.

Unit III: Adult Stem Cells (7 Lectures)

1. Types of Adult Stem Cells and Progenitors:
   - Hematopoietic Stem Cells (HSCs)
   - Neuronal Stem Cells (NSCs)
   - Interstitial Stem Cells:
2. Role of Adult Stem Cells in Tissue Homeostasis.
3. Potency of Adult Stem Cells.

Unit IV: Epigenetic Regulation of Stem Cell Self-Renewal and Differentiation (9 Lectures)

- Role of DNA Methylation: DNA methylation (e.g., methylation of CpG islands) silences gene expression, often repressing genes involved in differentiation.

- Role of DNA Demethylation: Active demethylation (through enzymes like TET proteins) can reactivate genes required for pluripotency or differentiation.
- Histone Activating Marks: Histone acetylation and H3K4me3 (trimethylation of histone H3 on lysine 4) promote open chromatin structure and transcriptional activation.
- Histone Repressive Marks: o H3K27me3 (trimethylation of histone H3 on lysine 27) and H3K9me3 are associated with gene repression and a compact chromatin state.
- Interplay of Epigenetic Hallmarks: o A balance of activating and repressive epigenetic marks dictates whether a gene is expressed or silenced, controlling stem cell fate decisions.

Unit V: Transcriptional Regulation of Stem Cell Self-Renewal and Differentiation (9 Lectures)

- Key transcription factors, regulatory network that maintains the pluripotent state and Differentiation is driven by the activation of lineage-specific transcription factors and the repression of pluripotency genes. Signaling Pathways and Transcriptional Regulation in Stem Cells
  1. Wnt, Notch, and BMP pathways and their downstream effects on transcription.

  2. FGF/ERK signaling and its role in promoting stem cell differentiation.

  3. Hedgehog signaling in stem cell maintenance and differentiation.

- **Post-Transcriptional Regulation in Stem Cells**
  1. The role of microRNAs in regulating pluripotency and differentiation.

  2. RNA-binding proteins and their involvement in post-transcriptional regulation of stem cells.

- **Gene Regulatory Networks in Adult Stem Cells**
  1. Hematopoietic stem cell transcriptional networks Neuronal stem cell transcription factors

  2. Cross-talk between transcriptional and epigenetic regulation during adult stem cell maintenance.

Unit VI: Clinical Applications of Stem Cell Biology (10 Lectures)

- **Cancer Therapy**: Stem cells are used in treatments like **hematopoietic stem cell transplants** for leukemia and lymphoma.
- **Cardiovascular Diseases**: Stem cells (e.g., iPSCs or MSCs) are being explored for regenerating damaged heart tissue after myocardial infarction.

- **Liver Disease**: Stem cells may be used to generate hepatocytes or liver organoids for transplant or disease modeling.

- **Brain and Spinal Cord Injuries**: Neuronal stem cells or iPSC-derived neurons are explored for regenerating damaged nervous tissue.

- **Lung Fibrosis**: MSCs show potential in reducing inflammation and fibrosis in lung diseases.

- **Anemia and Blood Disorders**: HSC transplants are widely used to treat anemia and genetic blood disorders like sickle cell anemia.

- **Autoimmune Diseases**: Stem cells, particularly MSC therapy, are being investigated for modulating the immune system in diseases like multiple sclerosis.

Learning Outcome

By the end of this course, students will have developed a solid conceptual and experimental understanding of stem cell biology. Students will gain insight into the dynamic interplay between transcription factors, signalling pathways, and epigenetic modifications in maintaining stem cell states and directing differentiation. They will also become familiar with experimental approaches used to assess stem cell Self renewal and potency. Furthermore, students will be equipped to evaluate recent advancements in regenerative medicine and stem cell-based therapies, and will be encouraged to analyse primary literature to understand the evolving landscape of stem cell research.

Recommended Reading Materials:

1. Essentials of Stem Cell Biology, by Robert Lanza, Anthony Atala, eBook ISBN: 9780128214015. Elsevier. 4th Edition, Year, 2021.

2. Molecular Biology of the Cell, by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter. eBook ISBN: 9781315735368. 6th Edition. Year, 2015.

3. Stem Cells: Scientific Progress and Future Research Directions by Irving L. Weissman, Michael F. Clarke, Richard C. Mulligan. National Institutes of Health (NIH). Year, 2001.

4. Induced pluripotent stem cells: past, present, and future, by Takahashi K., Yamanaka S. Nature Reviews Molecular Cell Biology. Volume 10, Pages 678–684. Year, 2009.

5. Epigenetic regulation of stem cell fate by Victoria V. Lunyak1,and Michael G. Rosenfeld . Human Molecular Genetics. Volume 17, Pages 28–36. Year, 2008.

6. Stem cells in regenerative medicine: science, regulation and business strategies. Trounson A., McDonald C. by Nature Reviews Drug Discovery. Volume 14, Pages 97–111. Year, 2015.

Course Name: Biosafety, Bioethics & IPR (CM-431) Credits: 2

Course In-charge: Prof. Shailja Singh & Prof. Umesh C. S. Yadav

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 (10 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 (10 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 (12 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.

SEMESTER II

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

Course In-charge: Dr. Someswar R Sagurthi, Dr. Sudhir Kumar

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 systems.

COURSE CONTENTS

Unit I: An Introductory Drug Design Overview (10 lectures)

- Drug design (Ligand design, Peptide design), Drug receptor interactions theories
- Receptor occupation and response relationships
- Receptor Characterization
- Receptors and specificity and biased agonism
- Structure-Activity Relationships in drug design & discovery

Unit II: Pharmacokinetics & Pharmacodynamics of drugs (10 lectures)

- Effective dose determination
- Lethal dose determinations, Therapeutic Index
- Efficacy vs Potency of Drug
- Routes of drug administration
- Absorption, distribution, excretion & clearance of drug

Unit III: Drug Metabolism, Drug–Drug Interactions, Toxicology of Drugs (10 lectures)

- Biotransformation of Drugs, Phase I and Phase II transformations
- 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 IV: Different Class of drugs (10 lectures)

- Small molecules as drugs e.g. Anticancer, Antibiotics, Antidiabetic, Cardiovascular disease
- Peptide Therapeutics (GLP-1 agonists for diabetes).
- Monoclonal Antibodies, Immuno-therapeutics
- Natural products isolated from Medicinal Plants and approved as drugs

Unit V: Clinical Pharmacogenomics & Pharmacogenetics (8 lectures)

- Precision & Personalized medicine
- Dose modification based on clinical pharmacogenomics
- Pharmacogenomic-guided dosing for warfarin
- Integration of AI in pharmacogenomics to predict individual drug responses

Learning outcome

Students will gain insights into drug design, drug-receptor interactions, metabolism, and mechanisms of action. They will develop skills to identify novel drug targets, design small molecules, biologics, and vaccines. This knowledge prepares them for academia, pharmaceuticals, or entrepreneurship careers, enabling them to contribute to affordable drug development and global healthcare. They will gain knowledge in addressing unmet drug discovery and development needs.

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-Smith and J. K. Aronson, Oxford University Press, 3rd Edition 2002.

3. Organic Chemistry of drug design and drug action, R.B. Silverman, Academic Press, 2ndEdition 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, 6thEdition, 2017

Course Name: Understanding Diseases of National Importance through IKS (Indian Knowledge System) (CM-453N) Credits: 2

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 Dissertation Submission & Defense (Viva) (CM-454N)

Credits: 16

Course In-charges: All Faculties of SCMM guiding the students' dissertations

COURSE OBJECTIVES

The objective of this course is to train the students to 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 the 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 a general audience.

COURSE CONTENTS

- Completing the research work proposed in the Synopsis, write the dissertation, present their work in a public presentation and defend it.

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

Course Name: Term Paper & Seminar (CM-455) **Credits: 1**

Course In-charges: All Faculties of SCMM

COURSE CONTENTS

- Term paper writing and Seminar presentations by the students on the topics related to different diseases as assigned.

Learning Outcome

Students will learn the scientific writing and seminar presentation skills.

Recommended Reading materials:

1. Papers relevant for topics on different diseases.

Course Name: Critical Review of Research Article & Scientific Writing (CM-456) Credits: 1
Course In-charges: All Faculties of SCMM

COURSE CONTENTS

- Students will be assigned the recent research articles to critically review and analyze the same as per the scientific rigour.
- The session on scientific writing will be held for their training and skill development from time to time.

Learning Outcome

Students will learn critical analysis of research papers and learn the skill set of scientific writings.

Recommended Reading materials:

1. Papers relevant for topics on different diseases

SEMESTER III

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:

5. Cell Adhesion (Frontiers in Molecular Biology, Edited by Mary C Beckerle. Publisher: Oxford University Press.ISBN-10:0199638713, 2002
6. New Cell Adhesion Research, , Edited by Patrick Nott and Matthew Temple, Publisher: Nova Science Pub Inc. ISBN-10:1606923781, 2009
7. Adhesion Molecules, by Victor R. Preedy, Publisher: CRC Press. ISBN: 9781138117891, 2017
8. 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: 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

4. Bacterial Pathogenesis: A Molecular Approach: Brenda A. Wilson, Malcolm Winkler, Brian T. Ho. Publisher: ASM Press; 4thedition (2019)
5. Molecular Diagnostics of Infectious Diseases. By Harald H. Kesslar. ASIN:B0138MB64K, Publisher: De Gruyter; 3rd edition (2014).
6. 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

5. Introduction to Endocrinology (2009) by Chandra S Negi, PHI Learning Pvt. Ltd, Delhi, India
6. Molecular Endocrinology (2004) 3rd ed. by Franklyn F. Bolander Jr, Elsevier Academic Press.
7. Principles of Endocrinology and Hormone Action (2018) Antonino Belfiore and Derek LeRoith (Editors) Springer International Publishing AG, Switzerland.
8. 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)

4. Epidemiology and global distribution of infectious diseases.
5. General principles of human host-microbe interactions and establishment of the disease.
6. 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

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

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

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

4. 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.
5. 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,
6. 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

5. Selected topics from Annual Reviews, Nature Reviews, New England Journal of Medicine, Lancet
6. Victor W. Rodwell, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil; Harper's Illustrated Biochemistry. 31st Ed. McGraw Hill, 2018.
7. Jeremy M. Berg, Lubert Stryer, John Tymoczko, Gregory Gatto, Biochemistry (9th Edition), WH Freeman, 2019.
8. 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, Synopsis writing & Presentation (CM-428N) Credits: 8

Course In-charges: All faculty members

COURSE OBJECTIVES

The objective of this course is to train the students in scientific rigor and in asking the right questions 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. 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
- The students will write the synopsis of the proposed dissertation work after an extensive review of literature and defend the same through a public 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:

2. Literature related to the proposed research topic

Course Name: Applied Bioinformatics: Genomics and Structural Biology (CM-429)
Credits: 3

Course In-charge: Dr. Someswar R. Sagurthi and Dr. Sudhir Kumar

COURSE OBJECTIVES

Provide students with fundamental knowledge of bioinformatics tools, databases, and their genomics and structural biology applications; Familiarize students with disease-specific databases and the role of bioinformatics in understanding genetic and protein-related disease mechanisms.
Equip students with essential bioinformatics skills, including sequence alignment, genome assembly, Structure Biology and protein structure prediction.

COURSE CONTENTS

Unit I: Advanced Bioinformatics Databases (10 Lectures)

- Genomic Databases: UCSC Genome Browser, Human Gene Mutation Database (HGMD), OMIM (Online Mendelian Inheritance in Man), Mycobrowser and ViperDB
- Protein function annotation Databases: STRING, Prosite and BioGRID
- Functional Annotation and Ontologies: Gene Ontology (GO) and InterPro and SNPdb
- Small molecule Databases: Pubchem, Drugbank, ChEMBL and ZINC database

Unit II: Algorithms and Sequence Analysis (10 Lectures)

- Sequence Alignment: identity, similarity, homology, orthologs, paralogs & xenologs)
- Scoring matrices: PAM & BLOSUM (permissible replacements, similarity score)- gap penalties (linear & affine gap penalties).
- Global alignment - Needleman and Wunch algorithm with illustration
- Local alignment- Smith and Waterman algorithm with illustration
- BLAST and FASTA algorithm: Variants, ktup, identification of HSP, statistical significance

Unit III: Structural Biology (10 Lectures)

- Fundamental principles of X-ray diffraction
- Protein overexpression, purification and crystallization
- Model building and validation
- Basic principles of NMR and CryoEM for structural analysis

Unit IV: Hands-on training: Data Retrieval and Sequence Analysis (10 Lectures)

- Sequence format conversion using Readseq tool: FASTA, PIR, FastQ, BAM, and SAM
- Dot matrix comparison of sequences using graphs and dot matcher tool, Global alignment- Emboss Needle, Local alignment- Emboss Water
- Heuristics database search tools: BLAST and FASTA
- Prediction of genes in prokaryotic and eukaryotic genomes, ORF Finder and Genscan, Prediction of SSRs in DNA sequence (SSRit)
- Compute physical and chemical parameters of protein using Protparam tool

Unit V: Hands-on training: Structure prediction and Molecular Modelling (8 Lectures)

- Prediction of secondary structures of proteins
- Chou-Fasman method, GOR IV method, and Psipred
- Tertiary structure prediction by homology model building, Threading and *ab initio* methods
- Structure annotation and Active site prediction
- Virtual Screening and Docking

Learning Outcome

This course covers applied bioinformatics, focusing on databases, algorithms, sequence analysis, structure prediction, and molecular modelling. Key topics include genomic and protein databases, sequence alignment, structure prediction, and annotation. Hands-on training includes data retrieval, gene prediction, physical/chemical protein analysis, and structure modelling. The course integrates practical training in bioinformatics for research**.**

Recommended Reading Materials:

1. Introduction to bioinformatics by Aurther M lesk
2. Developing informatics computer skills by Cynthia Gibas, Per Jambeck
3. Chemoinformatics: a textbook by Johann Gasteiger
4. Bioinformatics second edition by David M mount
5. Essential bioinformatics by Jin Xiong
6. Bioinformatics computing by Bryan Bergeron
7. Bioinformatics: Concepts, skills & applications by R.S. Rastogi
8. Bioinformatics: methods and applications genomics, proteomics and drug discovery by S.C. Rastogi, Parag Rastogi, Namita Mendiratta
9. Bioinformatics and functional genomics (third edition) by Jonathan Pevsner
10. Data mining in Bioinformatics, Jason T. L Wang, Zaki, Toivonen and Dennis Shasha

Course Name: Stem Cell Biology & Regenerative Medicine (CM-430) Credits: 3

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

Course Objectives:

This course is designed to provide postgraduate students with a comprehensive understanding of the biological, molecular, and functional properties of stem cells. It aims to elucidate the defining features of various stem cell types—including embryonic, adult, and induced pluripotent stem cells—and their roles in development, tissue homeostasis, and regeneration. Emphasis is placed on the regulatory mechanisms governing self-renewal, pluripotency, and lineage commitment, with a detailed focus on coding and noncoding regulators, epigenetic and transcriptional control. The course also introduces students to the methodologies employed in stem cell research, including reprogramming techniques and functional assays. Finally, it explores translational aspects by examining current and emerging clinical applications of stem cells in treating hematological, neurological, cardiovascular, and autoimmune diseases**.**

COURSE CONTENTS

Unit I: Introduction to Stem Cell Biology (6 Lectures)

- Characteristics of a stem cell: Self-renewal, Types of Stem Cells. Comparison of ESCs, iPSCs and ASCs.
- Totipotency, Pluripotency, and Multipotency
- Sources of Mammalian ESCs and Extraembryonic Tissues
- Stem cell regulation

Unit II: Pluripotency and Reprogramming (7 Lectures)

- Defining Features of Pluripotent Stem Cells
- Principles of Reprogramming
- Experimental design to test pluripotency, Teratoma formation assay, Embryoid body formation and chimera formation
- Cellular Features Sustaining Pluripotency:
- Comparison of Pluripotent Stem Cells and Strategies for Obtaining Them:
- Somatic Cell Reprogramming to iPSCs: cells while bypassing the ethical concerns associated with the use of embryos.

Unit III: Adult Stem Cells (7 Lectures)

1. Types of Adult Stem Cells and Progenitors:
   - Hematopoietic Stem Cells (HSCs)
   - Neuronal Stem Cells (NSCs)
   - Interstitial Stem Cells:
2. Role of Adult Stem Cells in Tissue Homeostasis.
3. Potency of Adult Stem Cells.

Unit IV: Epigenetic Regulation of Stem Cell Self-Renewal and Differentiation (9 Lectures)

- Role of DNA Methylation: DNA methylation (e.g., methylation of CpG islands) silences gene expression, often repressing genes involved in differentiation.
- Role of DNA Demethylation: Active demethylation (through enzymes like TET proteins) can reactivate genes required for pluripotency or differentiation.
- Histone Activating Marks: Histone acetylation and H3K4me3 (trimethylation of histone H3 on lysine 4) promote open chromatin structure and transcriptional activation.
- Histone Repressive Marks: o H3K27me3 (trimethylation of histone H3 on lysine 27) and H3K9me3 are associated with gene repression and a compact chromatin state.
- Interplay of Epigenetic Hallmarks: o A balance of activating and repressive epigenetic marks dictates whether a gene is expressed or silenced, controlling stem cell fate decisions.

Unit V: Transcriptional Regulation of Stem Cell Self-Renewal and Differentiation (9 Lectures)

- Key transcription factors, regulatory network that maintains the pluripotent state and Differentiation is driven by the activation of lineage-specific transcription factors and the repression of pluripotency genes. Signaling Pathways and Transcriptional Regulation in Stem Cells
  1. Wnt, Notch, and BMP pathways and their downstream effects on transcription.

  2. FGF/ERK signaling and its role in promoting stem cell differentiation.

  3. Hedgehog signaling in stem cell maintenance and differentiation.

- **Post-Transcriptional Regulation in Stem Cells**
  1. The role of microRNAs in regulating pluripotency and differentiation.

  2. RNA-binding proteins and their involvement in post-transcriptional regulation of stem cells.

- **Gene Regulatory Networks in Adult Stem Cells**
  1. Hematopoietic stem cell transcriptional networks Neuronal stem cell transcription factors

  2. Cross-talk between transcriptional and epigenetic regulation during adult stem cell maintenance.

Unit VI: Clinical Applications of Stem Cell Biology (10 Lectures)

- **Cancer Therapy**: Stem cells are used in treatments like **hematopoietic stem cell transplants** for leukemia and lymphoma.
- **Cardiovascular Diseases**: Stem cells (e.g., iPSCs or MSCs) are being explored for regenerating damaged heart tissue after myocardial infarction.

- **Liver Disease**: Stem cells may be used to generate hepatocytes or liver organoids for transplant or disease modeling.

- **Brain and Spinal Cord Injuries**: Neuronal stem cells or iPSC-derived neurons are explored for regenerating damaged nervous tissue.
- **Lung Fibrosis**: MSCs show potential in reducing inflammation and fibrosis in lung diseases.
- **Anemia and Blood Disorders**: HSC transplants are widely used to treat anemia and genetic blood disorders like sickle cell anemia.
- **Autoimmune Diseases**: Stem cells, particularly MSC therapy, are being investigated for modulating the immune system in diseases like multiple sclerosis.

Learning Outcome

By the end of this course, students will have developed a solid conceptual and experimental understanding of stem cell biology. Students will gain insight into the dynamic interplay between transcription factors, signalling pathways, and epigenetic modifications in maintaining stem cell states and directing differentiation. They will also become familiar with experimental approaches used to assess stem cell Self renewal and potency. Furthermore, students will be equipped to evaluate recent advancements in regenerative medicine and stem cell-based therapies, and will be encouraged to analyse primary literature to understand the evolving landscape of stem cell research.

Recommended Reading Materials:

1. Essentials of Stem Cell Biology, by Robert Lanza, Anthony Atala, eBook ISBN: 9780128214015. Elsevier. 4th Edition, Year, 2021.

2. Molecular Biology of the Cell, by Bruce Alberts, Alexander Johnson, Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter. eBook ISBN: 9781315735368. 6th Edition. Year, 2015.

3. Stem Cells: Scientific Progress and Future Research Directions by Irving L. Weissman, Michael F. Clarke, Richard C. Mulligan. National Institutes of Health (NIH). Year, 2001.

4. Induced pluripotent stem cells: past, present, and future, by Takahashi K., Yamanaka S. Nature Reviews Molecular Cell Biology. Volume 10, Pages 678–684. Year, 2009.

5. Epigenetic regulation of stem cell fate by Victoria V. Lunyak1,and Michael G. Rosenfeld . Human Molecular Genetics. Volume 17, Pages 28–36. Year, 2008.

6. Stem cells in regenerative medicine: science, regulation and business strategies. Trounson A., McDonald C. by Nature Reviews Drug Discovery. Volume 14, Pages 97–111. Year, 2015.

Course Name: Biosafety, Bioethics & IPR (CM-431, Core) Credits: 2

Course In-charge: Prof. Shailja Singh & Prof. Umesh C. S. Yadav

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 (10 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 (10 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 (12 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:

5. Basic Laboratory Methods for Biotechnology (2nd Edition). Publisher: Benjamin Cummings; 2nd Edition 2008.

6. 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
7. Bioethics Across the Globe by Akira Akabayashi ISBN: 9789811535710, Springer Singapore2020.
8. Manuals of patent office practice and procedure, Publisher: The Office of Controller General of Patents, Designs & Trademarks, Version 3, 2019.

SEMESTER-IV

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

Course In-charge: Dr. Someswar R Sagurthi, Dr. Sudhir Kumar

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 systems.

COURSE CONTENTS

Unit I: An Introductory Drug Design Overview (10 lectures)

- Drug design (Ligand design, Peptide design), Drug receptor interactions theories
- Receptor occupation and response relationships
- Receptor Characterization
- Receptors and specificity and biased agonism
- Structure-Activity Relationships in drug design & discovery

Unit II: Pharmacokinetics & Pharmacodynamics of drugs (10 lectures)

- Effective dose determination
- Lethal dose determinations, Therapeutic Index
- Efficacy vs Potency of Drug
- Routes of drug administration
- Absorption, distribution, excretion & clearance of drug

Unit III: Drug Metabolism, Drug–Drug Interactions, Toxicology of Drugs (10 lectures)

- Biotransformation of Drugs, Phase I and Phase II transformations
- 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 IV: Different Class of drugs (10 lectures)

- Small molecules as drugs e.g. Anticancer, Antibiotics, Antidiabetic, Cardiovascular disease
- Peptide Therapeutics (GLP-1 agonists for diabetes).
- Monoclonal Antibodies, Immuno-therapeutics
- Natural products isolated from Medicinal Plants and approved as drugs

Unit V: Clinical Pharmacogenomics & Pharmacogenetics (8 lectures)

- Precision & Personalized medicine
- Dose modification based on clinical pharmacogenomics
- Pharmacogenomic-guided dosing for warfarin
- Integration of AI in pharmacogenomics to predict individual drug responses

Learning outcome

Students will gain insights into drug design, drug-receptor interactions, metabolism, and mechanisms of action. They will develop skills to identify novel drug targets, design small molecules, biologics, and vaccines. This knowledge prepares them for academia, pharmaceuticals, or entrepreneurship careers, enabling them to contribute to affordable drug development and global healthcare. They will gain knowledge in addressing unmet drug discovery and development needs.

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-Smith and J. K. Aronson, Oxford University Press, 3rd Edition 2002.

3. Organic Chemistry of drug design and drug action, R.B. Silverman, Academic Press, 2ndEdition 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, 6thEdition, 2017

Course Name: Understanding Diseases of National Importance through IKS (Indian Knowledge System) (CM-453N) Credits: 2

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 Dissertation Submission & Defense (Viva) (CM-454N)

Credits: 16

Course In-charges: All Faculties of SCMM guiding the students' dissertations

COURSE OBJECTIVES

The objective of this course is to train the students to 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 a dissertation and present the same. By the end of the 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 a general audience.

COURSE CONTENTS

- Completing the research work proposed in the Synopsis, write the dissertation, present their work in a public presentation and defend it.

Learning Outcome

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

Recommended Reading Material:

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

Course Name: Term Paper & Seminar (CM-455) **Credits: 1**

Course In-charges: All Faculties of SCMM

COURSE CONTENTS

- Term paper writing and Seminar presentations by the students on the topics related to different diseases as assigned.

Learning Outcome

Students will learn the scientific writing and seminar presentation skills.

Recommended Reading materials:

1. Papers relevant for topics on different diseases.

Course Name: Critical Review of Research Article & Scientific Writing (CM-456) Credits: 1
Course In-charges: All Faculties of SCMM

COURSE CONTENTS

- Students will be assigned the recent research articles to critically review and analyze the same as per the scientific rigour.
- The session on scientific writing will be held for their training and skill development from time to time.

Learning Outcome

Students will learn critical analysis of research papers and learn the skill set of scientific writings.

Recommended Reading materials:

1. Papers relevant for topics on different diseases