

M.TECH - MOLECULAR MEDICINE

This M.Tech. program will provide training in the field of Molecular Medicine. The course is offered by the Division of Molecular Medicine, Amrita Centre for Nanosciences and Molecular Medicine, Amrita Institute of Medical Sciences and Research Centre, Amrita Vishwa Vidyapeetham. Molecular medicine is the study of molecular and cellular phenomena in biological systems that enhances our understanding of human diseases and facilitates discovery research in disease prevention, diagnosis and therapy. Molecular Biology offers new technology tools to probe the living organism, both in diagnostics and therapy. The integration of these two disciplines offers opportunities for many new fundamental insights into the mechanisms of disease and avenues for diagnostics and therapy that could not have been imagined even a decade earlier.

One of the unique strengths of this course is its emphasis on an interdisciplinary approach whereby medical sciences, molecular biology, and nanotechnology areas can be addressed. This is possible because this Centre offers other courses in Nanotechnology and Bio-Nanotechnology. Students will be encouraged to participate in interdisciplinary learning activities, and some of the courses from different programs are jointly offered.

Curriculum First Semester

Course Code	Type	Course	LTP	Credits
18MM601	FC	Cell and Developmental Biology	300	3
18MM602	FC	Basics in Human Physiology and Pathology	400	4
18MM603	FC	Clinical Biochemistry and Proteomics	300	3
18MA613	FC	Statistical Data Analysis	101	2
18MM621	SC	Immunology	300	3
18MM622	SC	Molecular Biology	300	3
18MM623	SC	Biochemistry Lab	101	2
18MM624	SC	Molecular Biology Lab	101	2
18MM625	SC	Cell Culture and Animal Lab	101	2
18HU601	HU	Amrita Values Program *		P/F
18HU602	HU	Career Competency-I *		P/F
		Total Credits		24

* Noncredit course

Second Semester

Course Code	Type	Course	LTP	Credits
18MM626	SC	Molecular Basis of Diseases	200	2
18MM627	SC	Genetic Engineering	300	3
18MM628	SC	Molecular Diagnostics	200	2
18MM629	SC	Pharmacokinetics and Pharmacodynamics	200	2
18MM630	SC	Bioinformatics and Structure based Drug Design	201	3
18MM631	SC	Clinical Microbiology	200	2
18HU603	HU	Career Competency-II	100	1
		Total Credits		15

Third Semester

Course Code	Type	Course	LTP	Credits
18RM601	FC	Ethics in Research and Research Methodology	101	2
18MM632	SC	Stem Cell Biology and Therapy	300	3
18MM798	P	Dissertation		8
		Total Credits		13

Fourth Semester

Course Code	Type	Course	LTP	Credits
18MM799	P	Dissertation		12
		Total Credits		12
		Overall Total Credits		64

FIRST SEMESTER

18MM601

CELL AND DEVELOPMENTAL BIOLOGY

3-0-0-3

Cell Biology: Cell chemistry and biosynthesis: the chemical components of a cell, catalysis and the use of energy by cells, how cells obtain energy from food; Classification and properties of cell: Introduction to different types of cells; Membrane structure: the lipid bilayer, membrane proteins; Membrane transport of small molecules and electrical properties of membranes: principles of membrane transport, active membrane transport, ion channels; Intracellular compartments and protein sorting: compartmentalization of cells, the transport of molecules between the nucleus and cytosol, transport of proteins to different organelle; Intracellular vesicular traffic: molecular mechanisms, transport from the ER through the golgi apparatus, transport from the trans-golgi network to lysosomes, endocytosis, exocytosis; Mechanisms of cell communication: general principles, signaling through GPCRs and enzyme-coupled surface receptors, signaling pathways dependent on regulated proteolysis of latent gene regulatory proteins; Cytoskeleton: self-assembly and dynamic structure of cytoskeletal filaments, molecular motors, cytoskeleton and cell behavior, Cell cycle: an overview, cell cycle control system, control of cell division and cell growth; Apoptosis: cell death, extrinsic and intrinsic pathways; Cell junctions, cell adhesion and extracellular matrix: cadherins and cell-cell adhesion, tight junctions, passageways from cell to cell, integrins and cell-matrix adhesion, extracellular matrix. Germ cells: Primordial germ cells, Meiosis, Eggs, Sperms. Developmental biology: Universal mechanisms of animal development, Development from the perspective of a single cell, The molecular genetics of pattern formation, The patterning of anteroposterior axis, Organogenesis and patterning of appendages, The shaping of the vertebrate body, The mouse development, Neural development.

TEXT BOOK:

Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P, "Molecular Biology of the Cell", Fifth Edition, Garland Publishing Inc. 2008.

REFERENCE:

Gerald Karp, "Cell and Molecular Biology", Fifth Edition, John Wiley, 2008,

18MM602

BASICS IN HUMAN PHYSIOLOGY AND PATHOLOGY

4-0-0-4

Physiology: This module pertains to the study and understanding of organ-based physiological processes in the human body during homeostasis. The module covers the following topics: Body water and distribution, regulation of water within extracellular, transcellular and intracellular compartments, determination of compartmental fluid volumes, blood and lymphatic system, function-regulation of the cardiovascular system, the cardiac cycle, hepatobiliary system, pancreas physiology, regulation and processes involved in urine formation, the musculoskeletal system and calcium regulation, control of respiration, lung volumes and flow, nervous system – generation of action potential, role of voltage gated ion channels, synapse physiology, and basics of neural networks in brain, special senses, and reproductive physiology. *Pathology:* This module is divided into two segments: The first segment covers the basic pathological processes such as inflammation, compensatory cellular

changes – Hypertrophy, hyperplasia, atrophy and metaplasia, fluid handling disturbances, malignant cellular changes, immunological & metabolic responses, and healing. The second segment covers the study of diseases based on organ systems: Cardiovascular, pulmonary, gastrointestinal, hepato-biliary, renal, musculoskeletal and nervous system disorders. Changes at the level of tissues and cells will be studied within each disease. Conditions such as diabetes, obesity, and hypertension, that are estimated to form the bulk of healthcare load in the next few years, will be given special emphasis. Aetiological and mechanistic basis of these conditions will be discussed in detail.

TEXT BOOK:

Kim E, Barrett, Susan M, Barman, Scott Boitano, and Heddwen Brooks, "Ganong's Review of Medical Physiology", 24th Edition, McGraw-Hill Medical, 2012

Vinay Kumar, Abul Abbas, Jon Aster, "Robbins & Cotran Pathologic Basis of Disease" 9th Edition., Elsevier 2014

REFERENCE:

John E. Hall, "Guyton and Hall Textbook of Medical Physiology", 13e Elsevier, 2015

18MM603 CLINICAL BIOCHEMISTRY AND PROTEOMICS 3-0-0-3

Clinical Biochemistry: Biochemistry & Medicine, how cells can respond to changes in biochemical environments, key organic molecules used by living systems, bioenergetics: the role of ATP, biologic oxidation, glycolysis & the oxidation of pyruvate, clinical significance of glycolytic pathway, the citric acid cycle, metabolism of glycogen, gluconeogenesis, the Calvin cycle and the pentose phosphate pathway, control of the blood glucose and associated clinical diseases, the respiratory chain & oxidative phosphorylation, biosynthesis of fatty acids, oxidation of fatty acids: Structures & function of proteins & enzymes, mechanism of action of enzymes and its regulation.

Proteomics: What is proteome and proteomics, how it is different from genomics, different types of proteomics, significance of sample preparation in proteomics, significance of choosing different methods for proteome analysis, different methods used for proteomic analysis, principles of mass spectroscopy, how proteins are identified using mass spectrometry, Protein fragmentation; Peptide enrichment and separation; Ionization and its Importance; Time of Flight, MS/MS analysis, Peptide fragmentation and peptide sequencing, Identification of proteins using search engines/programs, Accuracy of these identified proteins with respect to protein identity, significance of mass spectrometry in clinics, clinical proteomics and examples of clinical proteomics.

TEXT BOOKS:

1. Fundamentals of Biochemistry: Life at the Molecular Level Kindle Edition by Donald Voet (Author), Judith G. Voet (Author), Charlotte W. Pratt (Author) 5th edition 2016

2. Nawin C. Mishra, "Introduction to Proteomics: Principles and Applications" Wiley, 2010, ISBN: 0471754021

REFERENCE:

Lehninger Principles of biochemistry 7th Edition (2017), Publisher: WH Freeman, Authors Michael Cox, David L. Nelson.

18MA613**STATISTICAL DATA ANALYSIS****1-0-1-2**

Introduction to Statistics-Need for Statistical Methods in Medicine, Public Health, Biology, Biotechnology & Nano Sciences –Their uses and Misuses, Types of Variables, Data collection Methods, Population and Sample.

Basics of Mathematics- Calculus and Matrix Algebra.

Descriptive Data Analysis Methods-Statistical Tables, Diagrams & Graphs, Measures of Averages, Measures of Dispersion, Correlation Analysis Methods, Regression Analysis Methods.

Theory of probability and Standard Distributions - Binomial, poisson & Negative Binomial, Standard univariate continuous distributions – Normal, Log normal & Exponential. Sampling distributions – Chi- square distribution and F & ‘t’ distributions.

Tests of Significance of Statistical Hypotheses- Concept of Statistical Hypotheses –Null and Alternative hypotheses, Type I and Type II errors, Significance level, Critical region and Power of a test , P- value and its interpretation; Large and Small Sample Test – Normal test, Student’s ‘t’ test, Chi-square tests, Analysis of variance & Non parametric methods.

Nonparametric methods-Non-parametric methods for estimation, Methods for tests of significance for the independent and correlated samples, Nonparametric Methods for more than two populations.

Multivariate analysis Methods- Principles of Multivariate analysis, Multivariate regression analysis, Multivariate logistic regression analysis.

Practicals- (Statistical Software to be used: SPSS & SAS): (i) Practical in Descriptive Data Analysis Methods, (ii) Practical in Sampling Theory, (iii) Practical in Biostatistical Inference, (iv) Practical in Testing of Hypotheses, (v) Practical in Nonparametric Methods, (vi) Practical in Multivariate Regression Analysis.

TEXT BOOK:

1. Statistical Techniques for data Analysis: J.K. Taylor & Cheryl C, 2004 Chapman & Hall (CRC).

REFERENCE:

Biostatistics: A Foundation for Analysis in the Health Sciences: Daniel, Wayne W 8th Ed. , 2005.

18MM621**IMMUNOLOGY****3-0-0-3**

Basic concepts in immunology: Cells and organs of the immune system, Principles of innate and adaptive immunity, The effector mechanisms of immunity, The complement system and innate immunity. The induced responses of innate immunity; Pattern recognition by cells of the innate immune system, Induced innate responses to infection.

Antigen Recognition by B-cell and T-cell Receptors: The structure of a typical antibody molecule, The interaction of the antibody molecule with specific antigen, Antigen recognition by T cells. Antigen presentation to T lymphocytes: The generation of $\alpha \beta$ T-cell receptor ligands, The major histocompatibility complex and its function, Generation of ligands for unconventional T-cell subsets. Development of B and T lymphocytes: Development of B lymphocytes, Development of T lymphocytes, Positive and negative selection of T cells.

T cell mediated Immunity: Development and function of secondary lymphoid organs, Priming of naive T cells by pathogen-activated dendritic cells, General properties of effector T cells and their cytokines, T-cell-mediated cytotoxicity.

The humoral immune response: B-cell activation by antigen and helper T cells, The distributions and functions of immunoglobulin classes, The destruction of antibody-coated pathogens via Fc receptors.

Integrated dynamics of innate and adaptive immunity: Integration of innate and adaptive immunity in response to specific types of pathogens, Effector T cells augment the effector functions of innate immune cells, Immunological memory.

Manipulation of the immune response: Treatment of unwanted immune responses, Using the immune response to attack tumors, Fighting infectious diseases with vaccination.

Modulating the immune system through nanotechnology: Nanoparticles and the immune system, Nanoscale immune activation, Nanotechnology in vaccination, Nanoparticle-based vaccine carriers, Nanotechnology and immunosuppression, Nanoparticles as vehicles for immunosuppressants.

TEXT BOOK:

Janeway's Immunobiology, Ken Murphy, Paul Travers, Mark Walport, 9th edition, Garland science publishing, 2007.

REFERENCE:

Cellular and Molecular Immunology, Abul K Abbas, Andrew H. Lichtman, Shiv Pillai 9th edition 2017.

18MM622

MOLECULAR BIOLOGY

3-0-0-3

Cell and its molecules , DNA : Structure and function, Chromosome and chromatin, Genetic code, wobble hypothesis, RNA and types of RNA basic siRNA and its Dicer, RISC function, shRNA, miRNA and its function, siRNA and miRNA mediated pathways, miRNA and its function on disease, rasiRNA, tasiRNA, nat-siRNA, piRNA, PIWI, Piwi subfamily MIWI, MIWI2, MILI., Proteins and their structure, DNA replication and its regulation(prokaryotes and eukaryotes), Homologous and site specific recombination, DNA repair ,Transcription and its regulation(prokaryotes and eukaryotes) , Translation and its regulation (prokaryotes and eukaryotes),Gene structure, Repeats and clusters , Genome evolution, Gene expression , Gene expression regulations(prokaryotes and eukaryotes),operon, phage strategies , Epigenetics, Methylation ,Histone modifications, Regulation of epigenetics, Regulatory RNAs, Gene regulation in development and evolution, DNA Mutation, Types of mutations, Genetic system of Mitochondria and plastids, Gene recombination, Systems biology, Gene identification, promoter identification, molecular biology techniques : Isolation and Quantification of DNA/RNA,PCR, Reverse transcriptase PCR,,Real Time PCR, Bioinformatics ,SDS PAGE,

2D gel electrophoresis, hybridization (southern, northern and western), sequencing, protein interaction studies.

TEXT BOOK:

Lewin's Essential Genes, Jocelyn E. Krebs, Benjamin Lewin, Elliott S. Goldstein, Stephen T. Kilpatrick, Jones & Bartlett Publishers, 2013 - Science - 847 pages

REFERENCES

Molecular Biology of the Gene, Seventh Edition, James D. Watson, Cold Spring Harbor Laboratory; Tania A. Baker, Massachusetts Institute of Technology; Alexander Gann, Cold Spring Harbor Laboratory; Michael Levine, University of California, Berkeley; Richard Losick, Harvard University, 2013

18MM623

BIOCHEMISTRY LAB

1-0-1-2

Using balances and pipettes, making of solutions of given normality, Knowing pH meters: Preparation of buffers, determination of pKa values and Dissociation constant of a given acid, Titration of amino acids, Spectrophotometry: Determination of concentration of proteins, Recording absorption, Spectra of a given protein and chromophore, Difference spectra, Cell culture and extraction of proteins, Centrifugation and ultracentrifugation, Protein estimation: Lowry, BCA and Bradford methods, Protein fractionation: Salting-in and salting-out, Enzyme assays, Chromatography: Gel filtration; Ion exchange; affinity; high performance liquid chromatography (HPLC), SDS Electrophoresis, western blotting

TEXT BOOKS:

1. D. T. Plummer. *An Introduction to Practical Biochemistry*, 369 pages. McGraw-HiU Book Co. (U.K.) Ltd.
2. S. Chaykin *Biochemistry Laboratory Techniques*, 169 pages. John Wiley & Sons Inc., New York.

18MM624

MOLECULAR BIOLOGY LAB

1-0-1-2

Isolation of chromosomal DNA from Escherichia coli; Agarose gel electrophoresis, Isolation of chromosomal DNA from human blood; Isolation of plasmid DNA from Escherichia coli; Nucleic acid quantification; Polymerase chain reaction (PCR), Restriction digestion, Restriction fragment length polymorphism (RFLP), RNA isolation from Escherichia coli; cDNA synthesis, Reverse Transcriptase PCR, DNA sequencing, Real time PCR.

TEXT BOOK

Joseph Sambrook, David William Russell, Molecular Cloning: A Laboratory Manual, Volume 1-2-3 CSHL Press, 2001.

Cell culture module introduces the students to the basics of cell culture. The course provides students with sufficient knowledge and laboratory skills needed in the academia and industry for carrying out basic cell culture techniques properly and safely. On completion of the course, the student should be able to: account at a general level for the function, maintenance and working of Bio-safety Cabinets (BSC) and be able to work in BSCs with a good sterilisation technique, account for different preventive measures to avoid contamination of cell cultures and how a contaminated cell culture may be treated, account in detail for sterilisation equipment and sterilisation techniques, account for different cell-culture media and important components in the media; be able to apply basic cell-culture techniques, such as cell counting using hemocytometer and harvesting of cells. Explain different factors of significance in the cultivation of cells *in vitro* and be able to maintain cell lines in culture for a longer period of time without contamination.

Contents-The course starts with theory i.e. basic lecture about a general lay out of a cell culture lab, physical environment needed for the cell culture, growth media and its composition, Biosafety cabinets (BSC), its use in cell culture and how to work in a BSC, contamination during cell culture and how to control it, culturing and splitting of cell lines, cryopreservation of cells and cell viability assays. After qualifying the Biosafety examination, students start working in the cell culture lab. The laboratory work starts in small groups. In the practical laboratory work, the students will have hands-on experience in counting, harvesting, culturing and maintaining cell lines.

Animal handling techniques – animal feed, gavage, different routes of injection, ethical treatment of animals and Institutional Animal Ethics Committee policies.

TEXT BOOK:

R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th ed. 2010. Wiley-Blackwell.

REFERENCE:

1. CPCSEA Guidelines for Laboratory Animal Facility, 2004.

2. *Guide for the Care and use of Laboratory Animals – 8th Edition, 2011, The National Academic Press.*

Culture – definition and scope. Values and culture, cultural freedom

Culture and Education

Culture of Research – creativity and responsibility in research

Spirituality and Culture – spirituality as a way of life, spirituality and religion

Culture and women – gender oppression, motherhood

Culture and the Media

Culture and Politics – national values and political harmony

Philosophy and Culture, epistemology

SECOND SEMESTER

18MM626

MOLECULAR BASIS OF DISEASES

2-0-0-2

Concepts of molecular basis of disease and its significance in translational medicine. Molecular mechanisms involved in cell maintenance, proliferation, cell injury and cell death. Molecular basis of radiation effects on cells. The roles of oncogenes, tumour suppressors in tumor initiation, progression and treatment. Risk factors in Neurodegenerative disorders, Autoimmunity and inherited genetic disorders. Telomeres shortening, genome stability and ageing. Cell lines and animal models to study human diseases.

Detection and identification of molecules significant in normal and disease situations, utility of identified molecules as biomarkers related to disease. Translational importance of the identified biomarkers in the diagnosis, prognosis and identification of drug targets leading to development of diagnostics and therapeutics.

TEXT BOOK:

William B Coleman, Gregory Tsongalis, Molecular Pathology – The Molecular Basis of Human Disease, Academic Press, 2018

18MM627

GENETIC ENGINEERING

3-0-0-3

Genetic engineering, Restriction enzymes, Classification, Nomenclature, Activity, Restriction mapping of DNA Molecular cloning, Vectors: plasmids, phages and cosmids, Cloning strategies: PCR, TAcloning, Gateway cloning etc, Construction of genomic libraries, Expression systems: bacterial, yeast, insect, mammalian, plant, Transfer of gene techniques: Transformation, transfection and transduction, Expression of cloned DNA and its analysis, Application of recombinant DNA technology, DNA manipulation and analysis, (eg: production of insulin), r-DNA vaccines, Gene therapy, RNA technology for Genetics, SiRNA technology and mechanisms, RNAi functions and experimental strategy, Transgenics versus Geneics and its applications, Generation of Gene targeting mice, FLOXED, FRT, LoxP strategy, advantages of knockout and knock in mice, Targeted technology (insertion, deletion), Gene editing via CRISPR CAS9 technology, Gene targeting in embryonic stem cells, Targeted disruption for conventional inactivation of mouse genes, Generation of gene targeting mice, Tissue specific promoter, target gene and chimeras, Genomic analysis of gene expression-methods and analysis, Gene expression analysis by Micro array and Real Time PCR (QPCR), Next generation Sequencing, CLIP technology, Chromatography, Genetic counseling; Ethics and Genetic disorders prevention. Introduction to synthetic biology: SLIC, Infusion, BioBRICK systems, Large genome assembly, bioengineering fundamentals.

TEXT BOOKS:

Principles of Gene Manipulation ,Sandy B. Primrose, Richard Twyman, Bob Old, Wiley, 08-Feb-2002.

18MM628

MOLECULAR DIAGNOSTICS

2-0-0-2

Introduction: An Historical Perspective on the Clinical Diagnostic Laboratory. Basic Molecular Biology: Nucleic Acid Blotting Techniques: Theory and Practice, The Polymerase Chain Reaction. Bioinformatics: Computer-Based Approaches to Genetic Analysis. Molecular Diagnostic Technologies: PCR-Based Methods for Mutation Detection, Alternative Methods for Mutation Detection and DNA Sequencing for Disease Association, Microarray Approaches to Gene Expression Analysis, Methods for Analysis of DNA Methylation, Other Clinical Diagnostic Technologies: Flow Cytometry, Medical Cytogenetics, Fluorescence In Situ Hybridization, Immunohistochemistry, Laser Capture Microdissection (FFPE).

Quality Assurance in the Molecular Diagnostics Laboratory: Framework for Quality Assurance in Molecular Diagnostics, Verification of Molecular Assays, Standards and Standardization of Molecular Diagnostics, Laboratory-Developed Tests in Molecular Diagnostics.

Applications of Molecular Diagnostics for Genetic Diseases, Molecular diagnostics of Coagulation, Cystic Fibrosis; Prenatal Genotyping for Identification of Fetuses at Risk for Immune Cytopenic Disorders. Applications of Molecular Diagnostics for Human Cancers. Applications of Molecular Diagnostics for Infectious Diseases, for Identity-Based Testing: HLA Typing Using Molecular Methods. Molecular Analysis for Forensic Casework and Parentage Testing, Molecular Assessment of Bone Marrow Transplant Engraftment. Personalized Medicine., Genetic Counseling Considerations in Molecular Diagnosis, Ethical, Social, and Legal Issues Related to Molecular Genetic Testing.

TEXT BOOK:

Molecular Diagnostics: For the Clinical Laboratorian / Edition 2 William B. Coleman (Editor), Gregory J. Tsongalis (Editor) Publisher: Springer-Verlag New York, LLC.

REFERENCES:

Buckingham and Flaw's, "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications", F.A. Davis Company; First edition , 2007.

18MM629 PHARMACOKINETICS AND PHARMACODYNAMICS 2-0-0-2

Nature of drugs, drug-body interactions, permeation of drugs, drug groups, macromolecular nature of drug receptors, drug concentration and response, drug distribution and elimination of single and multiple drugs in single and multi-compartment models, derivation of relationships between various pharmacokinetic parameters like clearance, volume of distribution, elimination rate constant, half-life etc. Fundamental principles guiding absorption, distribution, metabolism and elimination of drug molecules, basics of population pharmacokinetics, pharmacogenomics, and single-gene pharmacokinetic disorder. Pharmacodynamic concepts related to affinity and efficacy of drug molecules, drug binding, receptor actions, transport proteins, enzyme action, ion channel function and extrusion mechanisms using specific drugs – acetaminophen, warfarin, certain antibiotics, and anti-malignant drugs. Mechanism of action of selected drugs will be discussed.

TEXT BOOK

Katzung B.G., Masters S.B., Trevor A.J., "Basic and Clinical Pharmacology", 13th Edition, McGraw Hill, 2014

REFERENCE:

Malcolm Rowland, Thomas Tozer, "Clinical Pharmacokinetics and Pharmacodynamics, Concepts and Applications", 4th Edition, WoltersKluwer, 2011

18MM630 BIOINFORMATICS AND STRUCTURE BASED DRUG DESIGN 2-0-1-3

Introduction to Concept of Genomics, Proteomics and Bioinformatics; Databases on web: Genome, Proteome and Molecular biology; Sequence alignment: Near-optimal sequence alignment; Global pair wise sequence alignment; Multiple sequence alignment; Genome rearrangement; Evolutionary Bioinformatics: Phylogenetic tree construction and analysis. Different methods used for protein evolution; Protein Modeling: Protein structure prediction and analysis, Protein visualization software, Protein dynamics and Protein structure validation tools.

Cheminformatics: Basic idea of molecule design, Visualization and generation of 2D and 3D molecular structures, Chemical databases and its implications, Pharmacophore model, Virtual screening, Ligand based and structure-based molecular design; Commands and Languages: Basic Unix and Linux commands, Extensible markup language and its use in Bioinformatics; Sequence similarity and database search: Pattern recognition and matching; Quantitative and probabilistic pattern matching; Sequence pattern databases, Spectral pattern matching, String matching algorithm.

Pharmacy Informatics: Medical databases and clinically relevant drug-drug interactions, Pharmacy information system, Telemedicine and Telehealth.

Lab course work:

Basic linux commands and linux editors, X-windows and linux environment used for learning different linux commands and text editors like vi, xedit etc. Exposure to different useful databases, virtual screening and Data mining, Different biologically important databases were explored. Structural similarity search of drug like molecules were mined from different small molecular databases. Sequence alignment studies of protein family using BLAST software.

TEXT BOOKS:

1. Mount D W, "Bioinformatics Sequence and Genome Analysis", Cbs Publishers & Distributors (2003), ISBN: 8123909985

2. Practical Bioinformatics; Editors: Bujnicki, Janusz M. (Ed.), Series: Nucleic Acids and Molecular Biology, Springer publisher, [10.1007/978-3-540-74268-5](https://doi.org/10.1007/978-3-540-74268-5), 2008.

18MM631**CLINICAL MICROBIOLOGY****2-0-0-2**

History of microbiology; general properties of bacteria, bacteriophages (lytic and lysogenic), fungus, virus and parasites, sterilization, disinfection, control of microbes by physical and chemical agents; culture media, culture methods and growth; mechanism of action of common antimicrobial agents, molecular mechanism of drug resistance, bacterial protein secretions systems; operons (lactose and tryptophan); Human diseases caused by bacteria, fungus, virus and parasites (Example pathogenesis of Staphylococcus, Pneumococcus, Pseudomonas, Chlamydiae, Clostridium, Mycobacterium, Salmonella, Streptococcus, Neisseria, Vibrio,

Helicobacter, Hepatitis, HIV, HPV, Dengue, filaria and Malaria etc); Currently available vaccines.

TEXT BOOK:

Ananthanarayan and Paniker's Text book of Microbiology 9th Edition, Universities Press

THIRD SEMESTER

18RM601 ETHICS IN RESEARCH AND RESEARCH METHODOLOGY 1-0-1-2

Plagiarism, regulatory principles, safety in research, ethics in stem cell research, ethics in clinical research, ethics in nanomaterials based research

Principles of data documentation, protocol development, research questions and hypothesis driven research.

TEXTBOOKS:

1. Research Ethics for Scientists, C. Neal Stewart Jr., Wiley-Backwell Publishers, 2011
2. Ethics in Science, Ethical Misconduct in Scientific Research, John D'Angelo, CRC Press, 2012.

18MM632 STEM CELL BIOLOGY AND THERAPY 3-0-0-3

Introduction to stem cells, basic principles and methodologies, classification of stem cells, major developments in stem cell biology, clinical use of stem cells. History of the origin of stem cells. Molecular mechanisms controlling the cell cycle: stem cell self-renewal and maintenance. Cell proliferation versus cell differentiation. Normal stem cells: hematopoietic stem cells, mesenchymal stem cells, cardiac stem cells. Embryonic stem cells (ESC): difference between mouse and human ESCs, derivation of ESCs, scientific and ethical hindrance to ESC therapy. Tissue Stem Cells, Translational Stem Cell Medicine, Identification and characterization of pluripotent stem cells in animal and humans; sources of pluripotent cells – blastocysts, parthenogenesis, nuclear transfer, iPSCs. Stem cell microenvironment: Stem cell niche and signaling, Stem cells and Gene Therapy: Signaling pathway involved in self-renewal and differentiation of stem cells. Identifying and isolating stem cells. Cancer stem cells: Historical perspective, isolation and characterization of cancer stem cells. Solid cancer stem cells (Breast, Lung, prostate, liver, stomach, Glioma). Targeting cancer stem cells. Hematological malignancies and stem cells. Side population cells in flow cytometry, Induced pluripotent stem cells, its derivation and applications. Regulatory and ethical issues of stem cell research in India. Stem cell therapy for various diseases (neurodegenerative, retinal, leukemia, heart).

TEXT BOOK:

Robert Lanza, "Essentials of Stem cell Biology", Elsevier, 2006

REFERENCE:

Daniel R. Marshak, Richard L. Gardner and David Gottlieb, "Stem cell Biology", Cold spring Harbour Laboratory Press, 2001

