M.Sc. MOLECULAR MEDICINE

Molecular medicine is the study of molecular and cellular phenomena in biological systems, molecular aspects of human diseases, the human body's response to diseases, heterogeneity of response and personalized medicine,stem cells, immune response and genetic determinants. The course covers the use of molecular understanding in discovery research in disease prevention, drug development, diagnosis and therapy.

One of the unique strengths of this course is its emphasis on an interdisciplinary approach whereby medical sciences, molecular and biochemical aspects of biology is addressed. All students will be required to conduct a one year thesis research that provides hands-on experience in molecular biology techniques, cell culture, biochemical techniques and genetic analysis.

Curriculum

First Semester

Course Code	Type	Course	LTP	Credits
18MM604	FC	Cell 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
18HU604	HU	Amrita Values Programme	100	1
18HU602	HU	Career Competency-I		P/F
18MM623	SC	Biochemistry Lab	101	2
18MM624	SC	Molecular Biology Lab	101	2
18NS623	SC	Cell Culture and Animal Lab	101	2
		Total Credits		**25**

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
18NS602	SC	Pharmacokinetics and Pharmacodynamics	200	2
18NS606	SC	Bioinformatics and Structure based Drug Design	202	4
18MM636	SC	Clinical Microbiology	300	3
18MM633	SC	Genetics	300	3
18MM634	SC	Neurobiology:Chemical and Architectural Organization of Brain	200	2
18HU603	HU	Career Competency-II	100	1
		Total Credits		**22**

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
18MM635	SC	Organoid Culture And Its Applications In Medicine	200	2
18MM796	P	Dissertation		5
		Total Credits		**12**

Fourth Semester

Course Code	Type	Course	LTP	Credits
18MM797	P	Dissertation		10
		Total Credits		10
		Overall Total Credits		**69**

FIRST SEMESTER

18MM604 **CELLBIOLOGY** **3-0-0-3**

Cell chemistry and biosynthesis: the chemical components of a cell; 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 intracellular compartments; Intracellular vesicular traffic: endocytosis, exocytosis, molecular mechanisms; Cell signaling: general principles, signaling through GPCRs and enzyme-coupled surface receptors; Cytoskeleton: self-assembly and dynamic structure of cytoskeletal filaments, molecular motors; Cell cycle: an overview, cell cycle regulation; 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; Genome: organization of genomes, gene expression and regulation, siRNA and miRNA; Principles and applications of genomic and proteomic tools: DNA electrophoresis, Reverse transcription and real-time PCR, gene sequencing, gene mapping, gene cloning, microarrays, SDS PAGE, ELISA and Western blotting, recombinant DNA technology, gene therapy.

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 modulepertains 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, hepato-biliary 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"9thEdition.,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:

Lehniger 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 ad 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) Practicals in Descriptive Data Analysis Methods, (ii) Practicals in Sampling Theory, (iii) Practicals in Biostatistical Inference, (iv) Practicals in Testing of Hypotheses, (v) Practicals in Nonparametric Methods, (vi) Practicals 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 8thEd. , 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 α β 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'sImmunobiology, 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 Mitochondira 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

18HU604 AMRITA VALUES PROGRAMME 1-0-0-1

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

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, 169pages. John Wiley & Sons Inc., blew 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.

18NS623 CELL CULTURE AND ANIMAL LAB 1-0-1-2

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 animalsandInstitutional 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.

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 Geneitcs 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 Sequencingfor Disease Association,Microarray Approaches to Gene Expression Analysis, Methods for Analysis of DNA Methylation, Other Clinical Diagnostic Technologies:FlowCytometry, MedicalCytogenetics, 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 CytopenicDisorders. 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.

18NS602 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

KatzungB.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, WoltersKluver, 2011

18NS606 BIOINFORMATICS AND STRUCTURE BASED DRUG DESIGN2-0-2-4

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.

Chemoinformatics: 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. Pairwise and multiple sequence

analysis techniques, Sequence alignment studies of protein family to understand its conserved residues including the percentage similarity/identity and its function relationship using BLAST/FASTA and ClustalW software. 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. Basic molecular modeling and optimization techniques, Molecule drawing in ChemDraw.Molecular structure optimization to get the least stable form and other physico-chemical property calculations. Molecular visualization and analysis study using PyMOL 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, 2008.

18MM636 CLINICAL MICROBIOLOGY 3-0-0-3

History of microbiology; general properties of bacteria, bacteriophages, fungus, virus and parasites; Bacterial cell structure: Cell wall and components external to cell wall, Capsules, Slime layer, S-layers, Pilli, Fimbriae, Flagella, cell membrane, cytoplasmic matrix, inclusion bodies, ribosomes, mitochondria, nucleoid, plasmids, endospores; cytoskeleton structure; fungal, viral and parasitic cell structure; clinically important bacteria, fungus, viruses 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); biofilm and quorum sensing; Conjugation; Transduction; Transformation; Restriction and modification enzymes; cloning vectors: plasmid, yeast artificial chromosome; cDNA and genomic DNA library; bacteriocins; Pathogen-associated molecular patterns; Human diseases caused by bacteria, fungus, virus and parasites (Examples: *Staphylococcus, Pneumococcus, Pseudomonas, Chlamydiae, Clostridium, Mycobacterium, Salmonella, Streptococcus, Neisseria, Vibrio, Helicobacter,* Hepatitis, HIV, HPV, Dengue, filaria and Malaria etc); Currently available vaccines.

TEXT BOOKS:

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

18MM633 GENETICS 3-0-0-3

Overview of genetics: Relationship between genes and traits, Fields and science of genetics, Patterns of inheritance: Mendelian inheritance, Law of segregation, Law of independent assortment, Studying inheritance patterns in humans, Chromosome transmission during cell division and sexual reproduction: General features of chromosomes, Cell division, Mitosis and cytokinesis, Meiosis, Sexual reproduction, The chromosome theory of inheritance and sex chromosomes, Extensions of Mendelian inheritance: Overview of simple inheritance patterns, Dominant and recessive alleles, Environmental effects on gene expression, Incomplete dominance, overdominance and codominance, X-linked inheritance, Sex-influenced and sex-

limited inheritance, Lethal alleles, Pleiotropy, Gene interactions, Non-Mendelian inheritance: Maternal effect, Epigenetic inheritance: dosage compensation and genomic imprinting, Extranuclear inheritance, Genetic linkage and mapping in eukaryotes: Overview of linkage, Relationship between linkage and crossing over, Genetic mapping in animals and haploid eukaryotes, Mitotic recombination, Variation in chromosome structure and number: Changes in chromosome structure: an overview, Deletions and duplications, Inversions and translocations, Changes in chromosome number: an overview, Variation in number of chromosomes within a set and in the number of sets of chromosomes, Chromosome organization and molecular structure: Organization sites along eukaryotic chromosomes, Sizes of eukaryotic genomes and repetitive sequences, Structure of eukaryotic chromosomes in nondividing cells and during cell division, Gene regulation in eukaryotes: Epigenetics: Epigenetics and development, Paramutation, Epigenetics and environmental agents, Medical genetics and cancer: Inheritance patterns of genetic diseases, Genetic basis of cancer, Personalized medicine, Developmental genetics: Vertebrate development and sex determination in animals, Population Genetics: Genes in populations and the Hardy-Weinberg equation, Overview of microevolution, Natural selection, Genetic drift, Migration, Nonrandom mating, Sources of new genetic variation, Complex and quantitative traits: Overview of complex and quantitative traits, Polygenic inheritance, Heritability, Selective breeding, Evolutionary genetics: Origin of species, Phylogenetic trees, Molecular evolution.

TEXT BOOKS:

Genetics: Analysis and Principles, 6th edition, Robert Brooker, McGraw-Hill Professional publishers, 2017.

REFERENCE

Principles of genetics, 8th edition, Gardner, Simmons, Snustad, Wiley, 2006.

18MM634 NEUROBIOLOGY: CHEMICAL AND ARCHITECTURAL ORGANIZATION OF BRAIN 2-0-0-2

Introduction: Concept of neurobiology; Levels of neural organization. Neurons and Glia.Importance of neuronal polarity and Axonal integrity.Molecular and architectural organization of neuron and oligodendrocytes and its role in impulse conduction.Importance of myelin and myelination. Electrical properties of membrane; Membrane potential; Ion channels; Properties of axons and dendrites; Action potential; Synapse; Synaptic potential and integration; Directly and indirectly gated neurotransmitter receptors; Secretion, Axonal transport, vesicle trafficking and regulation; Neuronal growth, survival and development; Glia biology, role of astrocytes, oligodendrocytes and their concerted action in supporting neuronal function, myelin biology. Different levels of brain organization. Diseases affecting the nervous system.

TEXT BOOK:

Principles of Neural Science, Fifth Edition (Principles of Neural Science (Kandel) 2012 McGraw-Hill Education / Medical by Eric Kandel and James Schwartz

REFERENCES:

Basic Neurochemistry: Principles of Molecular, Cellular, and Medical Neurobiology by Scott Brady and George Siegel (2011)

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

18MM635 ORGANOID CULTURE AND ITS APPLICATIONS IN MEDICINE 2-0-0-2

Mini organs – organoids: Basics of organoid development, experimental strategies, essential reagents and choice of 3D matrices, technical challenges; Characterization of organoids – marker screening, immunostaining and imaging of organoids, genomic profiling of organoids;
In vitro models of development and disease using cerebral, liver, intestinal, pancreas and salivary gland organoids. Applications of organoids – in cancer research, tissue regeneration and development, personalised drug testing, ethics of organoidbiobanks.
3D bioprinting: Basics and importance of 3D printing of living cells for medical applications,choice of bio-inks, current advances and challenges in 3D bioprinting.

TEXT BOOK:

Jamie Davies and Melanie Lawrence, Organoids and Mini Organs, Academic Press, 2018