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 (Amrita University). 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
16NS601	FC	Research Methodology and Statistics	101	2
16MM601	FC	Cell Biology and Human Physiology	400	4
16MM602	FC	Clinical Biochemistry and Proteomics	300	3
16MM603	SC	Microbiology and Immunology	400	4
16MM604	SC	Biochemistry, Cell Culture Lab and Animal Lab	103	4
16HU601	HU	Cultural Education*		P/F
		Total Credits		**17**

*Non-credit Course

Second Semester

Course Code	Type	Course	LTP	Credits
16MM605	SC	Molecular Basis of Disease and Translational Biotechnology	400	4
16MM606	SC	Computational Molecular Biology	202	4
16MM607	SC	Genetic Engineering and Gene Technology	300	3
16MM608	SC	Molecular Diagnostics	300	3
16MM609	SC	Molecular Biology Lab	102	3
		Total Credits		**17**

Third Semester

Course Code	Type	Course	LTP	Credits
16MM610	SC	Stem Cell Biology and Stem Cell Therapy	400	4
16MM611	SC	Pharmacokinetics and Drug Delivery	400	4
16HU602	HU	Technical Writing and Presentation*		P/F
16MM798	P	Dissertation		10
		Total Credits		**18**

*Non-credit Course

Fourth Semester

Course Code	Type	Course	LTP	Credits
16MM799	P	Dissertation		12
		Total Credits		**12**

List of Courses
Foundation Core

Course Code	Course	L T P	Cr
16NS601	Research Methodology and Statistics	1 0 1	2
16MM601	Cell Biology and Human Physiology	4 0 0	4
16MM602	Clinical Biochemistry and Proteomics	3 0 0	3
			Total credits: 9

Subject Core

Course Code	Course	L T P	Cr
16MM603	Microbiology and Immunology	4 0 0	4
16MM604	Biochemistry, Cell Culture Lab and Animal Lab	1 0 3	4
16MM605	Molecular Basis of Disease and Translational Biotechnology	4 0 0	4
16MM606	Computational Molecular Biology	2 0 2	4
16MM607	Genetic Engineering and Gene Technology	3 0 0	3
16MM608	Molecular Diagnostics	3 0 0	3
16MM609	Molecular Biology Lab	1 0 2	3
16MM610	Stem Cell Biology and Stem Cell Therapy	400	4
16MM611	Pharmacokinetics and Drug Delivery	400	4
			Total credits: 33

Project Work

Course Code	Course	L T P	Credits
16MM 798	Dissertation		10
16MM 799	Dissertation		12
			Total credits: 22

Total credits for course: 64

16NS 601 RESEARCH METHODOLOGY AND STATISTICS 1-0-1-2

Introduction to Biostatistics-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- (a) Differential & Integral Calculus Differentiation – Derivative of a function, Integration as the inverse operation of Differentiation, Methods of Integration. (b) Linear Algebra – Set Theory, Matrix Algebra (i) Set Theory- Sets and their operations. (ii) Matrix Algebra- Special type of Matrices, Determinants.

Study Designs-Prevalence and incidence studies, Case control and Cohort studies, Experimental studies – randomization.

Estimation of Minimum Sample size in Different Designs of Studies and Sampling Methods.

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- Probability: Random experiment, Sample space, Events, Mutually exclusive and exhaustive events, Frequency and classical definition of probability, Axiomatric definition of probability, Addition and multiplication theorems, Conditional probability and independence , Bye's theorem Random Variables and Probability Distributions :- Definition of discrete and continuous random variables, Probability density functions and distribution functions, Standard univariate discrete distributions – Binomial, poisson & Negative Binomial, Standard univariate continuous distributions – Normal, Log normal & Exponential. Sampling distributions – Chi- square distribution and F & 't' distributions. Logic of Statistical Inference- Concept of 'statistic' and 'parameter', Estimators and its properties, point and Interval estimation of parameters, Confidence intervals, concepts of standard error Principles of test of significance, Bayesian Inference Methods.

Methods of tests of Significance 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.

Statistical methods in planning and analysis of clinical trials;

Statistical aspects of diagnostic tests.

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 Study Designs, (iii) Practicals in Sampling Theory, (iv) Practicals in Biostatistical Inference, (v) Practicals in Testing of Hypotheses, (vi) Practicals in Nonparametric Methods, (vii) Practicals in Clinical Trials, (viii) Practicals in Multivariate Regression Analysis.

Biosafety

Microbiological risk assessment, Basic laboratories (Biosafety Levels 1-4), Laboratory animal facilities (Biosafety Level 1-4), Biological safety cabinets, Safety equipment, Biosafety

related laboratory techniques, Contingency plans and emergency procedures, Disinfection and sterilization, Biosafety and recombinant DNA technology, Hazardous chemicals, Additional laboratory hazards, Safety checklist

References:

1. Laboratory biosafety manual; Third edition, World Health Organization

TEXT BOOKS/REFERENCES:

1. *Applied Statistical modeling , Byron J T Morgan, 2000, Arnold Publishers.*
2. *Statistical Techniques for data Analysis: J.K. Taylor & Cheryl C, 2004 Chapman & Hall (CRC).*
3. *Data Analysis for SPSS: Manija J. Norusis, 1987.*
4. *Medical Statistics-Principles & Methods: Sundaram KR, Dwivedi SN, Sreenivas V.B Publishers, Delhi, 2009.*
5. *Biostatistics: A Foundation for Analysis in the Health Sciences : Daniel, Wayne W 8th Ed. , 2005.*
6. *An introduction to Medical Statistics: Martin Bland, 2000, Oxford university press.*
7. *Epidemiology – Study, Design & Analysis: Mark Woodward. Chapman & Hall (CRC Series).*

16MM601 CELL BIOLOGY AND HUMAN PHYSIOLOGY 4-0-0-4

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; Energy conversion by mitochondrion: the structure, electron transport chains and proton pumps; 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: characteristics of germ cells; meiosis, primordial germ cells, eggs, sperms.

Human Physiology: The human physiology addressed here pertains to the in depth study and understanding of organ-based physiological processes in the human body during homeostasis. The module covers the relevant overall anatomy of the individual organ system and provides students with an understanding of tissue function and regulation. Emphasis will be laid upon organ-tissue function, while all biological components that regulate function such as hormonal, neural, and other intrinsic regulatory mechanisms will the discussed keeping tissue function as the core. In addition to homeostasis, disruption in function in certain key disease conditions will be discussed to enhance understanding of physiological basis of each organ type. Course content in the first segment of the module will cover the physiology of blood and lymphatic system, followed by function-regulation of the cardiovascular system. The cardiac cycle will be discussed in depth. Gastrointestinal system including the hepato-biliary system along and pancreas physiology will be covered. The second segment of the module will cover functional physiology of the renal-urinary system and the musculoskeletal system. Calcium regulation will be discussed in this context. In the third segment, the pulmonary and the nervous system will be discussed, with emphasis on basis of nerve conduction, action potential generation, functioning of the autonomic nervous system and introduction to the function and processes within various brain regions. The last segment of this module will cover the physiological basis of all the special senses. Reproductive physiology will be discussed as well.

TEXT BOOKS / REFERENCES:

1. *Kim E, Barrett, Susan M, Barman, Scott Boitano, and Heddwen Brooks, "Ganong's Review of Medical Physiology", 24th Edition, McGraw-Hill Medical, 2012*
2. *Gerald Karp, "Cell and Molecular Biology", Fifth Edition, John Wiley, 2008,*
3. *Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P, "Molecular Biology of the Cell", Fifth Edition, Garland Publishing Inc. 2008.*

16MM 602 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: ketogenesis, clinical disorders associated with fatty acid metabolism, lipid transport & storage, cholesterol synthesis, transport, & excretion, clinical issues associated with cholesterol metabolism, metabolism of unsaturated fatty acids & eicosanoids, biosynthesis of membrane lipids and steroids, biosynthesis of amino acids and its metabolism, clinical disorders associated with amino acid metabolism, protein turnover, structures & functions of proteins & enzymes, mechanism of action of enzymes; its kinetics & regulation. Nucleotide biosynthesis, salvage pathways, catabolism of nucleotides and excretion of waste products, overview and integration of metabolism—the provision of metabolic fuels, signal-transduction pathways: an introduction to information metabolism,

special topics-i: metabolism of xenobiotics; special topics-ii: carbohydrates of physiologic significance; special topics-iii: lipids of physiological significance

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. Role of clinical proteomics in identifying molecules important in the diagnosis and pathogenesis of different diseases. Phosphoproteomics and kinome. Biomarker discovery and its significance in diagnostics, therapeutics and drug development.

TEXT BOOKS / REFERENCES:

1. *Harper's, "Illustrated Biochemistry" Sixteenth Edition, McGraw Hill Medical Publishing, July 2009*
2. *Stryer's " Biochemistry" Fifth Edition, W.H.Freeman & Co Ltd, 2002.*
3. *D.L. Nelson and M.M. Cox ,"Lehninger's Principles of Biochemistry",W.H.Freeman, 2005*
4. *D. Voet and J.G. Voet, "Fundamentals of Biochemistry", Wiley, 2008*
5. *Nawin C. Mishra, "Introduction to Proteomics: Principles and Applications" Wiley | 2010 | ISBN: 0471754021 |File type: PDF | 2,1 mb*
6. *Daniel C. Liebler. Introduction to Proteomics: Tools for the New Biology Springer Science & Business Media, 2002.*

16MM603 MICROBIOLOGY AND IMMUNOLOGY 4-0-0-4

Microbiology: Bacteria-fungus-Virus-parasite general information (An overview of Bacterial cell structure: Cell wall and components external to cell wall, 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). Spread and control of diseases; Microbial nutrition and growth: Prokaryotic cell cycle, chromosome replication and partitioning, cytokinesis, growth curve, continuous culture of microorganisms, microbial growth in natural environments; biofilm and quorum sensing. Control of microbes by physical and chemical agents; Molecular mechanism of drug resistance. DNA structure; Replication (Enzymes involved in replication and mechanism); Transcription (structure of mRNA, rRNA, tRNA; enzymes involved in transcription and mechanism); Translation (enzymes involved in translation and mechanism); DNA repair (DNA methylation and DNA repair mechanisms - excision, mismatch, SOS, photoreactivation, recombination repair and glycocylase system). Conjugation; Transduction; Transformation; Transposon (Insertion sequences and composite transposons, phages as transposons, replicative, non-replicative and conservative transposition, mechanism of transposition), Mutation (spontaneous and induced mutations, physical and chemical

mutagenic agents, types of mutation). Bacterial protein secretions; Recombinant DNA technology; Operons: Arabinose operon, lactose and tryptophan operon. Bacteriophages; Human diseases caused by bacteria and virus: pathogenesis of Staphylococcus, Mycobacterium, Salmonella, Streptococcus, Neisseria, Vibrio, Helicobacter, Hepatitis, Dengue, Mycoplasma. Vaccines: New vaccine technology, DNA vaccines, synthetic peptide vaccines, multivalent subunit vaccines, adjuvants and currently available vaccine.

Immunology: Introduction to immunobiology: Cells and organs of the immune system; The components of the immune system, Principles of innate and adaptive immunity, The complement system and innate immunity, Receptors 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, The Generation of Lymphocyte Antigen Receptors: The major histocompatibility complex and its functions, Signaling through Immune System Receptors: Antigen receptor structure and signaling pathways. The Development and Survival of Lymphocytes: Interaction with self-antigens selects some lymphocytes for survival but eliminates others, Survival and maturation of lymphocytes in peripheral lymphoid tissues. The Adaptive Immune Response: Subsets of T cells and T Cell-Mediated Immunity: The Humoral Immune Response; Adaptive Immunity to Infection; The mucosal immune system, Immunological memory. The Immune System in Health and Disease: Failures of Host Defense Mechanisms: Allergy and Hypersensitivity; Manipulation of the Immune Response; Immunology tool box and techniques; Detection, measurement and characterization of antibodies and their use as research and diagnostic tools: affinity chromatography, FACS, RIA, ELISA, Competitive inhibition assay, Hemaggluutination and blood typing., Precipitin reaction, anti-immunoglobulin antibodies, Coombs tests and detection of Rhesus incompatibility, monoclonal antibodies, immunohistochemistry.

TEXT BOOKS / REFERENCES:

1. Presscott, harley and Klein's Microbiology, 7th edition, McGraw Hill Companies.
2. Alcamo's fundamentals of Microbiology, Jeffery C Pommerville, 9th edition, Jones and bartlett Publishers.
3. Ken Murphy, Paul Travers, Mark Walport, "Janeway's Immunobiology", 7th edition, Garland science publishing, 2007.
4. Immunology, I. Roitt, 7th edition, Mosby Inc.

16MM 604 BIOCHEMISTRY, CELL CULTURE LAB AND ANIMAL LAB

1-0-3-4

- 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.
- Cell culture techniques – mammalian cell culture, MTT assay, Live-dead cell assay;
- Animal handling techniques – animal feed, gavage, injection, ethical treatment of animals, Institutional Animal Ethics Committee

TEXT BOOKS / REFERENCES:

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.*
3. *D. C. Wharton and R. E. McCarty Experiments and Methods in Biochemistry, 350 pages. Macmillan Co., New York.*
4. *R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th ed. 2010. Wiley-Blackwell.*
5. *CPCSEA Guidelines for Laboratory Animal Facility,2004.*
6. *Guide for the Care and use of Laboratory Animals – 8th Edition, 2011, The National Academic Press.*

16MM 605 MOLECULAR BASIS OF DISEASE AND TRANSLATIONAL BIOTECHNOLOGY 4-0-0-4

Concepts of Molecular Medicine and its significance in Translational Biotechnology. Overview of Molecular aspects of cellular functions. Molecular Mechanisms involved in cell Maintenance, Proliferation, Cell injury and Cell death. Risk factors in diseases; Cancer, Neurodegenerative disorders, Autoimmunity and Inherited genetic disorders. Molecular mechanisms that contribute to Cancer development. Exploitation of the existing cellular machinery in Cancer. Signal transduction and Cancer. Role of Genetic Alterations and Mutations in diseases. Significance of Personalized Medicine. What is Personalized Medicine? Significance of EGFR-PI3 kinase and p53 pathway in Cancer. Tumor suppressors and its control on the signaling pathways. Warburg effect; Cell cycle and integration with major molecular pathways including apoptotic pathways in diseases; Nutrient sensing and Energy Metabolism in cell survival and Cancer. Total influence of deregulated molecular pathways in a cell towards transformation into cancerous cell. Capture of the molecular events during disease using Clinical Biochemistry and Clinical Proteomics. Detection and identification of molecules significant in normal versus 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.

Post-translational modifications in cellular function. Phosphorylation, Glycosylation, Acetylation and Methylation in diseases. The Kinome and the Glycome. Identification of post-translational modifications and their Translational significance in Diagnosis and Therapy with examples from Kinome and Glycome. Neurodegenerative disorders; Role of Protein Management and Axonal Transport in Neurodegenerative diseases. Immune system and the role of Immune Dysfunction in diseases. Autoimmunity. Molecular basis of Autoimmunity. Molecular basis of Inherited Genetic disorders. Acute and Chronic inflammation; Tissue renewal and repair: Regeneration, healing and fibrosis; Hemodynamic disorders; tissue degeneration. Infectious diseases and its mechanism. What is Translational Medicine and how it is achieved? Drug target identifications and how they are translated into clinics. How biomarkers are translated for diagnosis and prognosis and their examples.

TEXT BOOKS / REFERENCES:

1. *Richard N. Mitchell, Vinay Kumar, Abul K. Abbas, Nelson Fausto ,"Pathological Basis of Disease", Elsevier Saunders, 2005.*
2. *Goodman and Gilman's, "The Pharmacological Basis of Therapeutics" McGraw-Hill Professional; Tenth edition, 2001.*
3. *Rang and Dale, "Clinical Pharmacology", Churchill Livingstone, 2007.*
4. *R. J. Trent, "Molecular Medicine: An Introductory Text", Academic Press, 2005.*

16MM 606 COMPUTATIONAL MOLECULAR BIOLOGY 2-0-2-4

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.

COMPUTATIONAL BIOTECHNOLOGY LAB:

- 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.

TEXT BOOKS / REFERENCES:

1. *P. Clote and R. Backofen "Computational Molecular Biology- An Introduction" (2000), ISBN- 978-0-471-87252-8*
2. *Carl Branden and John Tooze "Introduction to Protein Structure" , Garland Science; 2 edition (17 Dec 1998), ISBN-13: 978-0815323051*
3. *Mount D W, "Bioinformatics Sequence and Genome Analysis", Cbs Publishers & Distributors (2003), ISBN: 8123909985*
4. *S. Mitra and T. Acharya, "Data Mining: Multimedia, Soft Computing, and Bioinformatics", New York: John Wiley, ISBN 0-471-46054-0, 2003*
5. *Andrew RL and Gillet VJ "Introduction to Chemoinformatics", Springer PUBLISHER | ISBN / ASIN:1402062907, 2007.*

16MM 607 GENETIC ENGINEERING AND GENE TECHNOLOGY 3-0-0-3

Overview: The cell, organelles, macromolecules and atoms, cellular organelles, Chromosomes, Genetics, genes, Gene structure: Exon, Intron, Coding and Non-coding, structure of gene, Gene expression, Mutation and DNA repair, Repetitive DNA in human genome; Centromeres and telomeres, Epigenetics and its role, Epigenetics in disease (rett syndrome), Epigenetic errors, Epigenetic modification, DNA methylation in mammals, Histone modifications, rDNA technology and its application, Genetic engineering, Restriction and modification in bacteria, Restriction enzymes, Classification, Nomenclature, Activity, Restriction mapping of DNA Molecular cloning, Vectors: plasmids, phages and cosmids, Cloning strategies Construction of genomic libraries, cDNA clones, Preparation of DNA probes, Expression of cloned DNA, Application of recombinant DNA technology, DNA manipulation and analysis, production of insulin, r-DNA vaccines, Gene therapy, RNA technology for Genetics, SiRNA technology and mechanisms, RNAi functions and experimental strategy, basic siRNA and its Dicer, RISC function, shRNA, miRNA and its function, siRNA and miRNA mediated pathways, miRNA and its mer function on disease, rasiRNA, tasiRNA, nat-siRNA, piRNA, PIWI, Piwi subfamily MIWI, MIWI2, MILI, Transplantation laws, Allogenic, Xenogenic, Autograft, Isograft, Xenograft, mouse models in genetic diseases, effect of novel inhibitors against mouse xenograft models, Transgenics versus Geneitcs and its applications, Gene technology, Gene construct, Generation of Gene targeting mice, FLOXED, FRT, LoxP strategy, advantages of knockout and knock in mice, Targeted technology (insertion, deletion), 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, Human sickle cell anemia, Trait, Sickling disorder, Sickle cell hemoglobin, Genetic mutation techniques and advantages, SSCP (single strand conformation polymorphism), HA (heteroduplex analysis), CCM (chemical cleavage of mismatch), CSGE (conformation sensitive gel electrophoresis), DGGE (denaturing gradient gel electrophoresis), DHPLC (denaturing HPLC), PTT (protein truncation test), direct sequencing, Next Generation sequencing, MLPA (Multiplex Ligation-dependent Probe Amplification) mutations for genetic analysis and its application, Microarray for Genetic disorder, Genomic analysis of gene expression, RNA seq, DNA spotting microarray, slide based and affymetric array, affymetrix GeneChpis, ChIP-chip, Gene expression analysis by Micro array and Real Time PCR (QPCR), Genetic counseling; Ethics and Genetic disorders prevention.

TEXT BOOKS / REFERENCES:

1. *T. Strachan and A. Read Human's "Molecular Genetics "Garland Science/Taylor & Francis Group; Third edition, 2003.*
2. *M. Levitan's "Textbook of Human Genetics" Oxford University Press, USA; Second edition 1977.*
3. *Lewin's Genes X by Jocelyn E. Krebs, Elliotts S. Goldstein, Stephen T. Kilpatrick. Jones & Bartlett Learning, USA; Ed. 10, 2009.*
4. *Jacqueline N. Crawley, What's wrong with my mouse? Behavioral phenotying of Transgeneics and Knockout mice, 2nd edition, Wiley, 2007.*
5. *siRNA and miRNA Gene Silencing, from bench to bedside, series methods in Moelcular biology vol 487, Sioud, Mouldy (Ed). Springer, 2009, XIV, 474p*

16MM 608 MOLECULAR DIAGNOSTICS 3-0-0-3

Introduction : An Historical Perspective on the Clinical Diagnostic Laboratory.Basic Molecular Biology: An Overview of Nucleic Acid Chemistry, Structure, and Function: The Foundations of Molecular Biology,Extraction of Nucleic Acids, 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 Amplified Nucleic Acid Testing, Electrophoretic Methods for Mutation Detection and DNA Sequencing,Single-Nucleotide Polymorphisms: Testing DNA Variation 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, Immunohishemistry, 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: An Overview of Molecular Genetics, Genetic Basis of Neurologic and Neuromuscular Diseases, Molecular Mechanisms of Endocrine Disorders,Molecular Pathogenesis of Cardiovascular Disease, Molecular Diagnostics in Coagulation, Cystic Fibrosis,Prenatal Genotyping for Identification of Fetuses at Risk for Immune Cytopenic Disorders,Personalized Medicine,Applications of Molecular Diagnostics for Human Cancers ,Molecular Pathogenesis of Human Cancer, Application of Molecular

Diagnostics to Hereditary Nonpolyposis Colorectal Cancer, Molecular Genetic Applications to the Diagnosis of Lymphoma ,Molecular Genetic Abnormalities in Acute and Chronic Leukemias, Applications of Molecular Diagnostics for Infectious Diseases:Molecular Testing for Chlamydia trachomatis and Neisseria gonorrhoeae,Human Papillomavirus, Applications of Molecular Diagnostics for Identity-Based Testing: HLA Typing Using Molecular Methods , Molecular Analysis for Forensic Casework and Parentage Testing , Molecular Assessment of Bone Marrow Transplant Engraftment , The Use of DNA-Based Identity Testing for Specimen Identification .Issues for the Clinical Molecular Pathology Laboratory:Genetic Counseling Considerations in Molecular Diagnosis , Ethical, Social, and Legal Issues Related to Molecular Genetic Testing

TEXT BOOKS / REFERENCES:

1. *Buckingham and Flaw's, "Molecular Diagnostics: Fundamentals, Methods and Clinical Applications", F.A. Davis Company; First edition , 2007.*
2. *Molecular Diagnostics: For the Clinical Laboratorian / Edition 2 William B. Coleman (Editor), Gregory J. Tsongalis (Editor) Publisher: Springer-Verlag New York, LLC.*

16MM 609 MOLECULAR BIOLOGY LAB 1-0-2-3

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 BOOKS / REFERENCES:

1. *Joseph Sambrook, David William Russell, Molecular Cloning: A Laboratory Manual, Volume 1-2-3 CSHL Press, 2001.*
2. *Terence A. Brown, Essential Molecular Biology: A Practical Approach, Volume 1 Oxford University Press, 2000.*
3. *Udo Reischl; Molecular Diagnostics of infectious diseases; Humana Press.*
4. *Adrian J Harwood, Methods in Molecular Biology; Protocols for gene analysis.*
5. *Frederick M Ausubel, Roger Brent, Robert D Moore, J G Seidman, John A smith, Kevin Struhl; Current protocols in Molecular Biology, John Wiley and Sons, Inc (Volume 1-4).*

16MM 610 STEM CELL BIOLOGY AND STEM CELL THERAPY 4-0-0-4

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: haematopoietic 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, iPS. The reprogramming problem; studies of clones; pluripotent stem cells in animal models of disease; in vitro differentiation of pluripotent stem cells. Molecular pathways of pluripotency. Stem cell microenvironment: Stem cell niche and signaling, Engineered *invitro* platforms. Stem cells and cloning. Stem cells and Gene Therapy: Signalling pathway involved in self-renewal and differentiation of stem cells. Stem Cell Genetics: Reprogramming, Epigenetics & karyotype. Genetically corrected stem cells and their use for gene therapy. Identifying and isolating stem cells. Stem cell based therapy: Drug screening and Transplantation. 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. Haematological malignancies and stem cells. Side population cells in flow cytometry, Induced pluripotent stem cells, its derivation and applications. Direct reprogramming and Transdifferentiation. Regulatory and ethical issues of stem cell research in India. Stem cell therapy for various diseases (neurodegenerative, retinal, leukemia, heart).

TEXT BOOKS/REFERENCES

1. Robert Lanza, "Essentials of Stem cell Biology", Elsevier, 2006
2. Daniel R. Marshak, Richard L. Gardner and David Gottlieb, "stem cell Biology", Cold spring Harbour Laboratory Press, 2001

16MM 611 PHARMACOKINETICS AND DRUG DELIVERY 4-0-0-4

Clinical Pharmacokinetics and Dynamics: Overview of pharmacology and a drug, how drugs act-general principles, protein targets for drug binding, drug receptors, drug specificity, drug-receptor interaction, competitive antagonism, partial agonists and the concepts of efficacy, drug antagonism and synergism, desensitization, quantitative aspects of drug-receptor interaction, binding reaction, binding when more than one drug is present, how drug act-molecular aspects, targets for drug action, receptors, ion channels, enzymes, transport proteins, receptor proteins, isolation and cloning of receptors, molecular structure of receptors, ion channels as drug targets, control receptor expression, how drugs act-cellular aspects-regulation of intracellular calcium, calcium entry mechanism, calcium extrusion mechanism, calcium release mechanism, excitation, resting cell, muscle contraction, release of chemical mediators, epithelial transport, cell proliferation, apoptosis, regeneration, host defense in view of drug action, methods and measurements in pharmacology, bioassays, animal models of diseases, pharmacological studies in human, clinical trials, drug absorption and distribution, physical process underlying drug disposition, movement of drug across cell barrier, binding of drugs to plasma proteins, drug absorption and routes of administration, distribution of drugs in the body, special drug delivery system, drug metabolism and elimination, pharmacokinetics, drug elimination expressed as clearance, single compartment model, multi-

compartment model, population kinetics, pharmacogenetics, pharmacogenomics, single-gene pharmacokinetic disorder, pharmacogenomic tests.

Nanomedicine Development: Methods of preparation of drug nanoparticles, Structures of drug nanoparticles, Lipid based pharmaceutical nanoparticles, Targeted, non-targeted delivery-Absorption, Bioavailability, Distribution, Elimination; controlled drug release; Transdermal drug delivery; exploiting novel delivery routes using nanoparticles-Nano hydrogels for drug delivery-intelligent, ionic, thermo responsive, biohybrid, imprinted hydrogels.

TEXT BOOKS / REFERENCES:

1. *Rang MP, Dale MM and Ritter JM "Pharmacology" , Churchill Livingston, 1999.*
2. *Lawrence DR and Bennett PN, "Clinical Pharmacology" Churchill Livingstone, 1980.*
3. *Gibaldi, Milo, Marcel Dekker Series, "Biopharmaceutics and Clinical Pharmacokinetics" Publisher: Lea & Febiger; 4th Sub edition (January 1991).*
4. *Shargel, "Applied Biopharmaceutics and Pharmacokinetics", McGraw-Hill Medical; 5th edition (August 19, 2004).*
5. *Rowland and Tozer, "Clinical Pharmacokinetics : Concepts and Applications", Lippincott Williams & Wilkins; Third edition (January 15, 1995).*