Syllabus

(Revised on 29-6-2009)

M.Sc.
in
Biomedical Sciences

(Four Semester Course)

Dr. B.R. Ambedkar Center for Biomedical Research
University of Delhi, Delhi-110 007

Master of Science
Biomedical Science

TWO YEAR FULL TIME PROGRAMME

Rules, Regulations and Course Contents

Dr. B.R. Ambedkar Center for Biomedical Research
(Faculty of Science)
University of Delhi
Delhi-110 007

University of Delhi
Examination Branch

Date: **30th June, 2009**
Course: **M.Sc. in Biomedical Science**

Check List of New Course Evaluation for AC Consideration

S.No.	Parameters	Status
1	Affiliation	
2	Programme Structure	
3	Codification of Papers	
4	Scheme of Examinations	
5	Pass Percentage	
6	Promotion Criteria	
7	Division Criteria	
8	Span Period	
9	Attendance Requirements	
10	Course content for each paper along with reading list	

MASTER OF SCIENCE
(Biomedical Science)

TWO YEAR FULL TIME PROGRAMME

AFFILIATION

The proposed programme shall be governed by the Dr. B.R. Ambedkar Center for Biomedical Research, Faculty of Science, University of Delhi, Delhi-110 007.

PROGRAMME STRUCTURE

The M.Sc. Programme is divided into two parts as under, each part will consist of two Semester as given below.

		Semester – Odd	**Semester-Even**
Part I	First Year	Semester – I	Semester – II
Part II	Second Year	Semester – III	Semester – IV

Each semester would consist of five papers and one practical through Semester I and II (Part I) and semester III. Semester IV (Part II) would comprise of Optional Papers from which each student has to select two papers and undertake Dissertation work. Selection of papers in Semester IV would be based on merit (performance in the Part I Examinations), choice and other specific guidelines as outlined below. It is mandatory for each student to complete a Dissertation, assigned at the end of 2nd Semester and complete at the end of 4th Semester. It would comprise of bench work.

The schedule of papers prescribed for various semesters shall be as follows:

CLASSIFICATION OF PAPERS

Part I: Semester – I

S.No.	Code	Subject	Maximum Marks	Credits
1	MBS 101	Organic Chemistry-I	100	4
2	MBS 102	Biochemistry	100	4
3	MBS 103	Cell Biology	100	4
4	MBS 104	Medical Microbiology	100	4
5	MBS 105	Genetics	100	4
6	MBS 106	Practicals	100	4
		Total	600	24

Part I: Semester – II

S.No.	Code	Subject	Maximum Marks	Credits
1	MBS 201	Organic Chemistry-II	100	4
2	MBS 202	Molecular Biology and Biotechnology	100	4
3	MBS 203	Application of Statistics & Mathematics for Biology	100	4
4	MBS 204	Immunology	100	4
5	MBS 205	Human Physiology-I	100	4
6	MBS 206	Practicals	100	4
		Total	600	24

Part II: Semester – III

S.No.	Code	Subject	Maximum Marks	Credits
1	MBS 301	Human Physiology-II	100	4
2	MBS 302	Principles of Medicinal Chemistry	100	4
3	MBS 303	Analytical and Biomedical Techniques & Instrumentation	100	4
4	MBS 304	Molecular Oncology	100	4
5	MBS 305	Toxicology & Pharmacology	100	4
6	MBS 306	Practicals	100	4
		Total	600	24

Part II: Semester – IV

1	MBS 401	Dissertation	400	16
2	MBS 402	Genome Biology (Compulsory)	100	4
3	MBS	Special Paper I (Optional)	100	4
		Total	600	24

Special Papers* being offered (based on choice cum merit basis)

1	MBS 403	Concepts in drug discovery and mechanism	**Interdisciplinary**	Chemistry
2	MBS 404	Advanced Medicinal Chemistry	**Interdisciplinary**	Chemistry
3	MBS 405	Radiation Biology	**Interdisciplinary**	Zoology
4	MBS 406	Topics in Clinical Research		
5	MBS 407	Advanced Toxicology & Pharmacology		
6	MBS 408	Advanced Immunology	**Interdisciplinary**	Zoology

SCHEME OF EXAMINATION

1. English shall be the medium of instruction and examination.
2. Examinations shall be conducted at the end of each semester as per the Academic Calendar notified by the University of Delhi.
3. Each course will carry 100 marks and will have two components: Internal assessment (25 marks) and end of semester examination (75 marks)

Theory

i.	**Internal Assessment**	**30 marks**
a.	Attendance	05 marks
b.	Test / Assignments	25 marks
ii.	**End of semester examination**	**70 marks**
End Semester Examination (Practicals)		**100 marks**

4. The system of evaluation shall be as follows:

4.1 Internal assessment will be broadly based on attendance in theory (5 marks), assignments and tests in the theory component (20 marks). These criteria are tentative and could be modified by the faculty members associated with teaching of a paper based on guidelines approved by the academic council.

4.2 The scheme of evaluation for dissertation shall be as follows:

4.2.1 Dissertation will formally begin from end of Semester II and will consist of bench work.

4.2.2 Dissertation work will consist of internal evaluation by the concerned supervisor based on general performance, written assignments, student seminar, in-class examination during the duration of the dissertation (100 marks), Project work (200 marks) and viva-voce (100 marks) the last two being evaluated by a board comprising of all teachers in the Department and /or external experts.

5. Examinations for courses shall be conducted only in the respective odd and even Semester as per the Scheme of Examinations. Regular as well as Ex-students shall be permitted to appear / re-appear / improve in courses of Odd Semesters only at the end of Odd Semesters and courses of Even-Semesters only at the end of Even Semesters.

PASS PERCENTAGE

Minimum marks for passing the examination in each semester shall be 40% in each paper and 45% in aggregate of a semester.

However, a candidate who has secured the minimum marks to pass in each paper but has not secured the minimum marks to pass in aggregate may reappear in any of the paper/s of his choice in the concerned semester in order to be able to secure the minimum marks prescribed to pass the semester in aggregate.

No student would be allowed to avail of more than two chances to pass a paper inclusive of the first attempt.

PROMOTION CRITERIA

Semester to Semester: Students shall be required to fulfill the Part to part Promotion Criteria. Within the same part, students shall be promoted from a semester to the next semester, provided she/he has passed at least three out of the five theory examinations of the current semester. However passing in practical is mandatory for promotion from one semester to next. There shall not be any repeat/improvement allowed for practical examination.

Part I to Part II: Admission to Part II of the programme shall be open to only those students who have successfully passed at least 6 theory papers out of papers offered for the Part I courses comprising of Semester-I and Semester-II taken together and two practical papers. However, she/he will have to clear the remaining papers while studying in Part-II of the programme.

DIVISION CRITERIA

Successful candidates will be classified on the basis of combined results of Part-I and Part-II examinations as follows:

Candidates securing 60% and above	:	I Division
Candidates securing between 50% and 59.99%	:	II Division
All others between 40-49.99%	:	Pass

QUALIFYING PAPERS

None

SPAN PERIOD

No students shall be admitted as a candidate for the examination for any of the Parts/Semesters after the lapse of four years from the date of admission to the Part-I/Semester-I of the M.Sc. in Biomedical Programme.

ATTENDANCE REQUIREMENT

No student shall be considered to have pursued a regular course of study unless he/she is certified by the Head /Director of the Dr. B.R. Ambedkar Center for Biomedical Research, University of Delhi, to have attended 75% of the total number of lectures and seminars conducted in each semester, during his/her course of study. Provided that he/she fulfils other conditions, the Head/Director, Dr. B.R. Ambedkar Center for Biomedical Research may permit a student to the next Semester who falls short of the required percentage of attendance by not more than 10% of the lectures and seminars conducted during the Semester.

COURSE CONTENT FOR EACH COURSE

Is Enclosed.

LIST OF READINGS

The latest editions of each book will be referred to the class. List is enclosed at the end of each paper.

MBS 101: Organic Chemistry – I

Reactive Intermediates in Organic Reactions
Carbocations, carbanions, Free Radicals their stability and applications to biological systems, benzynes, carbenes, radical cations and radical anions; their generations and reactions exemplified with suitable case study leading to C-C bond formation.

Stereochemistry of Organic Compounds
The definition of the following terms with suitable examples; Elementary treatment of symmetric elements, Chirality, prochirality; (enantiomer, epimer,diastereomer). Absolute and relative configuration; r and s notation; enantiotopic and diastereotopic faces, endo and exo faces, Regioselective, enantioselective, stereoselective and stereospecific reactions, Confirmation of 2,3 dibromomutane, E & z notations, Cyclohexane diols.

Mechanism and stereochemistry of following reactions
Substitution, elimination and addition reactions; oxidation and reduction, Ester formation and ester hydrolysis, Aromaticity, aromatic and Nucleophilic substitution (with appropriate examples; Woodward Hoffman rules and photocyclization,

Asymmetric synthesis
Cram and Prelog rule, Chiral synthesis (with suitable examples) asymmetric epoxidation.

Heterocyclic Chemistry
Structure, synthesis and reactivity of the following heterocycles and their significance in biology and drugs and materials: furan, pyrrole, thiophene, imidazole, oxazole, thiazole, azepine, thiazine, carbazole, indole pyridine, quinoline and isoquinoline, acridine, phenothiazine, pteridine, purines and pyrimidines

Reading List

1 March's advanced organic chemistry: reactions, mechanisms and structure by Jerry March and Michael B. Smith; Ed.6th; Wiley-Interscience; 2007.
2 Advanced organic chemistry: Part A: structure and mechanisms by Francis A. Carey and Richard J. Sundberg; Ed. 5th; Springer; 2008.
3 Asymmetric synthesis: the essentials by Mathias Christmann and Stefan Brase; Wiley-VCH; 2007.
4 Organic chemistry by Thomas N. Sorrell; Ed.2nd; University Sceince Books, 2005
5 Organic chemistry by Robert Thorton Morrison and Robert Neilson Boyd; Ed. 6th; Prentice Hall of India; New Delhi; 2002.
6 Organic chemistry by T. W. Graham Solomons and Craig B. Fryhle; Ed. 9th; Wiley, 2007

MBS 102: BIOCHEMISTRY

Structure Of Protein
Secondary and tertiary structure of protein: a helix, ß sheets, examples of proteins, Ramachandran plot, factors effecting secondary and tertiary structure (disulphide bonds, heat, organic solvents, detergents). Examples of some common structural motifs in proteins.

Separation techniques for proteins: Ion exchange chromatography, dialysis, molecular sieving, polyacrylamide gel electrophoresis (determination of subunits and molecular weight), electrofocussing affinity chromatography.

Structure and function of hemoglobin: Conformational studies, binding of oxygen and its release, oxygen saturation curves. Methods of protein sequencing. Disorder of Amino Acid and protein metabolism

Enzymology
Introduction: General characteristics of enzymes, definition of coenzyme, holoenzyme, prosthetic groups, classification.
Enzyme Kinetics: Substrate, active site, transition state, activation energy, equilibrium constant Km, Vmax, specificity, Michaelis-Menten equation.
Reaction Mechanism: Acid-base catalysis and colvalent catalysis (giving examples). Regulation of enzyme activity: Reversible and irreversible inhibition (non-competitive, uncompetitive) and their effects on Km and Vmax, effect of pH, heat, PMSF and other inhibitors.
Allosteric enzymes: Models to explain their kinetic behaviour.
Problems on enzyme kinetics: Determination of active sites and turnover number.

DNA replication and its regulation
Concept of origin of replication, semiconservative hypothesis.

Mechanism of DNA Replication: Structure and function of DNA polymerases. Role of helicase, primase, gyrase, topoisomerase and other proteins in DNA replication in E.coli. replication of viruses and eukaryotes, initiation of replication, elongation and termination of DNA synthesis. DNA Repair

RNA Synthesis
Transcription in prokaryotes using E-coli as an example, Structure & function of RNA polymerases. Transcription initiation, elongation and termination.

Transcription in eukaryotes–Structure of TFIID, and other transcription factors, enhancers, silencers, insulators, general concept of regulation of transcription (in brief). Post-transcritional modifications, Ribozymes–Structure and mechanism of action.

Translation
Translation in Prokaryotes-initiation: activation of amino acid, role of 30s and 50s ribosomal subunits, initiation factors) shine-dalgarno sequences. Elongation factors, peptidyl transferase termination signal, release factors. Inhibition of protein sunthesis - by antibiotics.

Translation in eukaryotes – recent concept in initiation and termination, regulation of protein synthesis, comparison with prokaryotic system. Post translation modification – Methylation, glycosylation, phosphorylation, acetylation, proteolytic processing, addition of prosthatic groups, disulphide bond etc. protein degradation.

Reading List

1 Harper's biochemistry by Robert K. Murray and Daryl K. Granner and Peter A. Mayes and Victor W. Rodwell; Ed. 25th; McGraw-Hill; 2000.

2 Biochemistry by Donald Voet and Judith G. Voet; Ed. 3rd; Wiley; 2008.
3 Lehninger principles of biochemistry by David L. Nelson and Michael M. Cox; Ed. 5th; W.H. Freeman, 2004.
4 Biochemistry by Christopher K. Mathews and Kensal E. van Holde and Kevin G. Ahern; Ed. 3rd; Prentice Hall, 1999.
5 Textbook of biochemistry with clinical correlations by Thomas M. Devlin; Ed.6th; Wiley-Liss; 2005.
6 Biochemistry by Jeremy M. Berg and John L. Tymoczko and Lubert-Stryer; Ed. 6th; W.H. Freeman, 2008.

MBS 103: CELL BIOLOGY

Biomembranes: Basic structure, lipid and protein composition and their basic functions Transport of molecules across membranes. Passive and active transport across membranes. Factors regulating them, ion chanells, ABC pumps of bacteria.

Organelles of eukaryotic cells – Introduction basic structure and function of various organelles, ER, golgi bodies, chloroplasts, mitochondria endosomes, lysosomes etc. separation and visualization methods of various cell organelles.Muscle & Nerve Cells.

Nucleus and Chromosome Structure
Introduction: Prokaryotic and Eukaryotic genome and its organization, eukaryotic chromosome. Basic structure of DNA; hairpins and cruciform, Z-DNA, triple helix.

DNA Supercoiling: Histones, nonhistone proteins, topoisomerases and telomerase and their functions in chromatin structure. Yeast artificial chromosome.

The Cytoskeleton
Cytoskeleton proteins, Cell motility and shape, protein sorting, Transport of proteins. Microfilaments and actin filaments

ECM Proteins and Cell Adhesion
Cell-cell interaction, Cell junctions, Adhesion proteins, Cell matrix interaction, Integrins, Functional role of adhesion proteins.

Eukaryotic Cell Cycle
Cell cycle and its control: Loss of cell regulation by viral infection, checkpoints in cell cycle regulation.

Cell to Cell Signaling
Cell surface receptors, G-protein mediated signaling, camp, receptors tyrosine kinases, second messengers.

Cell death
Apoptosis, Necrosis, Proapoptotic and Antiapoptotic proteins and mechanism of action Autophagy**,** Senescence, Cell death mechanisms in health and diseases.

Cell Differentiation

Cellular Stress Response
Stress response proteins and pathways, Post translational modifications in stress response, General responses to hyperthermia nutritional deprivation and other stressors.

Reading List

1. Molecular biology of the cell by Bruce, Alberts and Alexander Johnson and Julian Lewis, and Martin Raff; Ed. 5th; Garland Science; 2008.
2. Molecular biology of the cell: the problem book by John Wilson and Tim Hunt; Ed. 5th; Garland Science; 2008.
3. Molecular cell biology by Harvey Lodish and Arnold Berk, Chris A. Kaiser, and Monty Krieger; Ed. 6th; W H Freeman and Company; New York; 2008.
4. Cell: molecular approach by Geoffrey M. Cooper and Robert E. Hausman; Ed. 4th; ASM Press; 2007.
5. Cell biology by Thomas D. Pollard and William C. Earnshaw; Ed. 2nd; Saunders; 2008.

MBS 104 : MEDICAL MICROBIOLOGY

Bacteriology
Introduction, Taxonomy, nomenclature and identification of bacteria, Reproduction and growth, Organization and ultrastructure of micro-organisms and various antibiotics, Antimicrobial used in clinical practical, Normal human flora, Pathogenesis and virulence factors of bacteria, Human diseases caused by bacteria in the following: Respiratory tract infections, Urinary tract infections, Genital tract infections, Gastrointestinal tract infections, Blood stream and CNS infections. Epidemiology of bacterial diseases.

Parasitology
Classification of parasitic protozoa. Cellular organization of parasitic protozoa. Epidemiology of parasitic infections. Immunology and immunopathology of parasitic infections, Control of parasites and parasitic infections. Common parasitic disease: Trypanosomiasis, Leishmaniasis, Malaria, Opportunistic parasitic infections, Helminths.

Medical Mycology
Classification, Cryptococcosis, Candidiasis, Blastomycosis, Histoplasmosis, Coccidiomycosis, Phycomycosis.

Clinical Virology
The structure, components and classification of viruses. Viral multiplication cycle, effect of virus infection on the host cell, cytopathic effects, inhibition of host cell cytopathic effects, inhibition of host macromolecular biosynthesis, changes in regulation of gene expression. Genetics of animal viruses. History, epidemiology, diagnosis, clinical features, treatment and prevention of small pox, herpes, adenoviruses, arboviruses, picornaviruses, myxoviruses.

Reading List

1 Microbiology by Lansing M. Prescott and John P. Harley and Donald Klein; Ed. 6th; McGraw-Hill Science, 2004.
2 Color ATLAS and textbook of diagnostic microbiology by Elmer W Koneman and Stephen D Allen and William M Janda and Paul C Schreckenberger and Washington C Winn; Ed. 6th; Lippincott Williams & Wilkins, 2005.
3 Medical microbiology: a guide to microbial infections: pathogenesis, immunity, laboratory diagnosis and control by David Greenwood and Richard C. B. Slack and John F. Peuthere, ed. 17th Ed. Churchill Livingstone; 2007.
4 Essentials of diagnostic microbiology by Lisa Anne Shimeld and Anne T. Rodgers; Delmar Publishers, 1999.
5 Medical Microbiology by Geo. Brooks and Karen C. Carroll and Janet Butel and Stephen Morse; Ed. 24th; McGraw-Hill Medical, 2007.
6 Topley and Wilson's Microbiology and Microbial Infections by Leslie Collier and Albert Balows and Max Sussman; Ed. 9th; 6-Volume Set; A Hodder Arnold Publication, 2000.

MBS 105: GENETICS

SECTION A

Introduction to the Science of Genetics
Genetic terminology Impact of Genetics on other disciplines.

Mendelian Genetics
Mendelian Laws of inheritance, its application in animal Genetics, analysis of results of Genetic crosses by various methods.

Chromosomal basis of inheritance and data analysis
Sex chromosomes in grasshopper, maize and co-linearity of genes on chromosomes, Non-disjunction in Drosophila and its role in deciphering chromosomal basis of inheritance. Analysis of patterns of inheritance, Punnett square, statistical methods.

Deviations from Mendelian Genetics I
Codominance, incomplete dominance, RFLP markers, gene interactions, multiple alleles.

Mutation and mutational analysis
Spontaneous occurrence of mutations in bacteria Lederberg and Lederberg experiment, Types of mutations i.e. point mutations, deletions, rearrangements, insertions, dynamic mutations (repeat expansions) with appropriate examples, Chromosomal anomalies. Mutation mapping suing balancers, Clb technique in Drosophila.

Linkage as a deviation from Mendelian Genetics
Recombination, Gene mapping using Drosophila as an example, experiments demonstrating physical basis of recombination, crossing over. Gene mapping using special systems, yeast and Neurospora.

Bacterial genetics
Transformation, Conjugation, genetic map construction in *E.coli*. Phage genetics, fine structure of rII region, work of Seymour Benzer.

Genetic Variation
Transposition and its application in genetic studies. Extra chromosomal inheritance, chloroplast and mitochondrial inheritance, mitochondrial mutations in yeast, human genetic disorders related to mitochondrial inheritance.

Deviations from Mendelian Genetics II
Genomic imprinting in mice, understanding molecular basis of epigenetic inheritance, human disorders related to imprinting, Prader Willi and Angelmen syndrome, Molecular basis of Epigenetic regulation in H19 and Igf2 region, histone modification marks, Position effect variegation.

Genetic control mechanisms and generation of cellular asymmetry
The lambda phage control of lytic and lysogenic phase, molecular basis of regulatory mechanisms in phage lambda. Mating type switching in *Saccharomyces cerevisiae.*

Sex determination in Drosophila and humans
Chromosomal basis to genetic basis, genetics of dosage compensation in Drosophila. X inactivation and its molecular basis in humans.

Introduction to developmental genetics
Early embryonic development in Drosophila. Maternal inheritance, genetic basis of axis determination, regulatory cascade in development in Drosophila, Homeotic genes.

Introduction to human Genetics
Pedigree analysis and basic inheritance patterns in humans.

SECTION B

POPULATION GENETICS

Definition, aim and scope of population genetics, population structure, factors maintaining population boundaries, effective breeding size, gene pool. The Hardy-Weinberg Law and its application, factors affecting the Hardy-Weinberg equilibrium. Human polymorphism (transient and balanced), relationship between sickle cell polymorphism and malaria, other ploymorphisms that may be an adaptation to malaria eg. G6PD deficiency. Duffy blood groups, thalassemia and haptoglobins. X linked polymorphism (G6PD and colour blindness). Incompatibility Selection. Non-random mating, inbreeding and its consequences. Migration and Genetics, types of migration, models to study genetic effects of migration, gene flow, effects of gene flow, admixture and natural selection, calculation of admixture.

Reading List

1. Principles of genetics by D. Peter Snustad and Michael J. Simmons; Ed.5th; John Wiley & Sons Ltd; 2008.
2. Principles of genetics by Eldon John Gardner and Michael J. Simmons and D. Peter Snustad Ed.8th; John Wiley; 2005.
3. Introduction to genetic analysis by Anthony J.F. Griffiths and Susan R. Wessler and Richard C. Lewontin and Sean B. Carroll; Ed.9th; W. H. Freeman,2008.
4. An Introduction to Genetic Analysis by Anthony J.F. Griffiths; Susan R. Wessler; Richard C. Lewontin; William M. Gelbart; David T. Suzuki and Jeffrey H. Miller; W. H. Freeman, 2004.
5. Developmental biology by Scott F. Gillbert; Ed.8th; Sinauer Associates; 2006.
6. Genes by Benjamin Lewin; Ed.9th; Jones and Bartlett Publishers; 2006.

MBS-201: ORGANIC CHEMISTRY-II

Bio-organic Chemistry
Aminoacids, peptides and Proteins structure and Functions. Formation of Peptide Bonds. Activation and Protecting groups and peptide bond formation, protein degradation and sequencing of amino acids,DNA and RNA bases, nucleosides and nucleotides, formation of N- and C- glycosides, phosphodiesters, conformation and configuration of 5-carbon and 6-carbon sugars, maltose, sucrose and lactose, glucosylamine, neuraminic and muramic acids.

Synthetic macromolecules and Polymers in Biology
Building of macromolecules and molecular frameworks and their biomedical applications. Synthetic strategies for artificial systems that mimic biological entities, applications of supramolecular principles to molecular diagnosis, therapeutic applications of supramolecular chemistry. Nanotechnology and its applications in drug delivery and the potential for synthetic peptides to form antibiotic tubes

Mechanisms in Biological Chemistry
Active methylene groups, aldol and retroaldol reactions, schiff bases and enamine reactions, nitrogen, phosphorous and sulfur ylides, Umpolung reaction, Michael addition, Polymer supported organic reactions, phase transfer catalysis, Equivalence of these reactions in biological systems

Enzyme systems
Enzyme classifications, EC number, Inhibitors, Mechanism of Enzymes. Mechanism of coenzyme catalysis: Coenzyme A, NAD^+ and NADPH, FMN and FAD, biotin, pyridoxal, TPP, lipoic acid, tetrahydrofolate, ascorbic acid, cyanocobalamine and cytochrome P-450.

Hammett and Taft Equation
Steric and Solvent effects Role of pH, reaction media on certain reactions.

Reading List

1 March's advanced organic chemistry: reactions, mechanisms and structure by Jerry March and Michael B. Smith; Ed.6th; Wiley-Interscience; 2007.
2 Advanced organic chemistry: Part A: structure and mechanisms by Francis A. Carey and Richard J. Sundberg; Ed. 5th; Springer; 2008.
3 Organic chemistry by Thomas N. Sorrell; Ed.2nd; University Sceince Books, 2005
4 Organic chemistry by Robert Thorton Morrison and Robert Neilson Boyd; Ed. 6th; Prentice Hall of India; New Delhi; 2002.
5 Organic chemistry by T. W. Graham Solomons and Craig B. Fryhle; Ed. 9th; Wiley, 2007
6 Modern methods of organic synthesis by W. Carruthers and Iain Coldham; Ed. 4th; Cambridge University Press; London; 2005.
7 Introduction to General, Organic and Biochemistry by Frederick A. Bettelheim, William H. Brown, Mary K. Campbell, Shawn O. Farrell; Ed.9th; Brooks Cole, 2009.
8 Biological and Pharmaceutical Nanomaterials: Nanotechnologies for the Life Sciences by Challa S. S. R. Kumar; Ed.1st; Wiley-VCH, 2006.

MBS 202: MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Regulation of gene expression in Prokaryotes
Coordinated control of clustered genes-operon model, with example of inducible systems like Lac–Operon. Arabinose operon and repressible systems like Trp operon. Role of cyclic AMP.

Role of repressors and activators of transcription in regulation of phage-lytic and lysogeic pathways, lambda repressor.

Regulation of Gene expression in Eukaryotes
Introduction-Organization of genes in eukaryotic DNA; Repetitive DNA sequences, Activators, enhancers. Modular structure of transactivators, repressor complexes, mechanism of their function in gene regulation.

Post transcriptional regulation of transcription regulators by methylation, acetylation, hormones and protein-protein interactions.

Methods used to study protein-protein interactions (yeast two hybrid and co-Immunoprecipitation) and protein-DNA interactions (EMSA and DNA footprinting)

Diseases linked with gene expression.

Chromatin remodeling
Role of various remodeling proteins such as NURF, ACF, CHRAC, SWI-SNF and locus control regions in gene regulation.

Oncogenes
Retroviral and cellular oncogenes, their function and mechanism of action in regulating cell growth and development (using P53 and Ras protein as example).

Recombinant DNA technology and Biotechnology
Types of Restriction endonucleases and how to make restriction maps. Other enzymes used in genetic engineering such as S1 nuclease, polynuceotide kinase, mung bean nuclease etc. Vectors - cloning and expression vectors, prokaryotic and eukaryotic cloning vectors, yeast vectors, shuttle vectors, YAC & BAC. Principles of selection of specific cloned DNA - blue white selection, insertional inactivation, antibiotic markers used in prokaryotic and eukaryotic cloning. Detection and identification of cloned DNA sequences, methods of sequencing of DNA. Application and principles of Polymerase Chain Reaction, RT-PCR, RFLP analysis, real time PCR. Mutagenesis – different methods used to generate mutants (deletion and point mutations). Application of recombinant DNA technology: DNA fingerprinting, gene therapy, diagnostics. Bio-safety and ethics for recombinant DNA technology.

Reading List

1 Gene VIII by Benjamin Lewin Ed.7th; Oxford; 2008.
2 Molecular cell biology by Harvey Lodish and Arnold Berk, Chris A. Kaiser, and Monty Krieger; Ed.6th; W H Freeman and Company; New York; 2008
3 Cell: a molecular approach by Geoffrey M. Cooper; Ed.3rd; ASM Press; 2004

MBS 203: APPLICATION OF STATISTICS AND MATHEMATICS FOR BIOLOGY

Bio-Statistics
Introduction to Mean, mode, median, mean deviation, Standard deviation, coefficient of variation.

Correlation (Karl Passions, Co-efficient of correlation, Rank correlation) and Regression analysis, Regression equations, taking suitable examples from biological data.

Probability: Theorems on probability, Binomial and normal distribution .

Methods of Sampling of biological data and analysis using 't' and 'Z' and 'F' tests of significance for small and large samples.

Bio-Mathematics
Functions, Limits and continuity, differentiation and integration, Maxima & Minima and their use in biological problems.

Differential Equations, separable variables, homogeneous, exact and linear equations of second order, application of differential equations of Biochemistry.

Matrices and determinants, characteristic roots and characteristic equations, Caley Hamilton theorem.

Reading List

1 Basic statistics by A. L. Nagar and R. K. Das; 2nd Ed.; Oxford; 2002.
2 Biostatistics: a manual of statistical methods for use in health, nutrition and anthropology by K. Visweswara Rao; Jaypee Borthers, 1996.
3 Introductory statistics by Prem S. Mann; 5th Ed.; John Wiley; 2003.
4 Biostatistics: a foundation for analysis in the health sciences by Wayne W. Daniel; 8th Ed.; John Wiley; 2005.
5 John E. Freund's mathematical statistics with application by Irwin Miller and Marylees Miller; Ed.7th; Pearson; 2006.
6 Essential Mathematical Biology by Nicholas F. Britton; Ed.1st; Springer; 2004.
7 Differential Calculus by Shanti Narayan ; Ed. 30th; S. Chand & Co Ltd; 2005.

MBS 204 : IMMUNOLOGY

Introduction to Immune System
Innate and acquired Immunity, Active and passive Immunity

Lymphoid System
Lymphoid Tissue: Primary or Secondary, Primary Lymphoid Organs, Secondary Lymphoid organs, Lymphocyte Traffic

Cells involved in the Immune Response
Lymphocytes, Mononuclear Phagocyte, Antigen- presenting cells, Polymorphs and mast cells, Cluster designation Ag specific receptors (comparison of Human and Mouse Lineages)

Antibody Generation, structure and Function
Humoral immunity, Clonal Selection Theory, Immnoglobulins, Antibody Structure and Function, Antibody Effector Mechanism, Antibody Receptors, Antibody Diversity, Immunogolubin Gene Recombination**,** Effect of Somatic Mutations or the Antibody Diversity, Ab Class switching, Antibody Responses in vivo, Enhanced Secondary Responses Isotype switching, Affinity Maturation Development of Memory

Major Histocompatibility Complex
Structure of MHC Class I Molecules, Structure of MHC Class II Molecules, Genomic Organisation of the MHC locus in Mice and Humans, Ontogeny and T-cell Receptors, Genomic Organization of TCR Locus

Antigen Recognition and Presentation
Structure and assembly of MHC molecules/Peptide Complexes. Antigen Processing and Presentation of T-lymphocytes (CD4+ and CD8+)

Complement System
Nomenclature of classical Complement, Alternative Activation of pathway, Biological Effects of Complement

Cytokines Network
Molecular basis of t- cell activation, Cytokine production from T_H1 and T_H2 CD4+ T-cells, Structure and function of various cytokines, cytokine receptors

Cell Mediated Immune Response
T -Cell independent Defence Mechanisms, T- Cell dependent Defence Mechanisms, Cell Mediated Cytotoxicity, Role of Macrophages in Immune Response

Regulation of Immune Response
Role of Antigen, Antigen Presenting Cell, Antibody, Lymphocytes, Idiotypic Modulation of Response, Neuroendocrine Modulation of Responses, Genetic control of Immune Response.

Cell Migration and Adhesion
Patterns of Cell Migration, Structure and function of various adhesion Molecules, Mechanism of Cell Migration and their involvement in disease

Immunopathology
Rh- blood groupings, Autoimmune Diseases, Immuno deficiencies, Genetic disorders congenital and acquired, Hypersensitivity Reactions (type I and type IV), Role of 1gE, Mast cells, Genetic Allergic Response, Tumors

Immune Tolerance
Self Tolerance, Transplantation and Rejection.

Antigen Antibody Interaction

Immunological Techniques
Haemagglutination, Direct/Indirect Immunoflorescence, Isolation of pure antibodies, Hybridoma Technology for Mab Production, Assays for Complement

Gene Targeting: Knock out and Transgenic Animals.

Tumor Immunology

FACS

Vaccines

Reading List

1 Kuby Immunology by Thomas Kindt and Richard A. Goldsby and Barbara A. Osborne; Ed. 6th; W.H. Freeman and Company, New York; 2007.
2 Cellular and molecular immunology by Abul K. Abbas and Andrew H. Lichtman and Shiv Pillai; Ed. 6th; Saunders, 2007.
3 Immunology; Ed.7th by David Male and Jonathan Brastoff and David B. Both and Ivan Roitt; Mosby Elsevier; 2006.
4 Immuno biology: the immune system in health and disease by Charles A. Janeway and Paul Travers and Mark Walport and Mark J. Shlomchik; 7th Ed; Garland Science; 2008.
5 Immunology of infection diseases by Stefan H. E. Kaufmann and Alan Sher and Rafi Ahmed; ASM Press, Washington; 2002.
6 Essentials of immunology & serology by Jacqueline H. Stanley; DELMAR; Australia; 2002.

MBS 205: HUMAN PHYSIOLOGY

Membrane physiology, nerve and muscle
Organization and functional systems of the cell with refers to nerve and muscle cells. Transport of ions and molecules through cell membrane: diffusion and active transport. Membrane potentials and action potentials: Resting membrane potential of nerves. Nerve action potential. Excitation and Contraction of skeletal muscle: Physiologic anatomy of skeletal muscle. Molecular mechanisms of muscle contraction. Energetics of muscle contraction. Excitation of skeletal muscle. Neuromuscular transmission and excitation-contraction coupling.

Blood physiology
Blood cells, and blood clotting, red blood cells. Blood groups, transfusion, tissue and organ transplantation. Resistance of body to infection. Leukocytes, granulocytes, monocyte-macrophage system and inflammation. Hemostasis and blood coagulation.

Heart and circulation
Physiology of cardiac muscle. Cardiac cycle, Regulation of heart pumping, Rhythmical excitation of heart, Control of excitation and conduction in heart, Characteristics of normal electrocardiogram, Cardiac arrhythmias, Physical characteristics and basic theory of circulation, Vascular distensibility and functions of arterial and venous systems, Microcirculation and lymphatic system, Capillary fluid exchange, interstitial fluid and lymph flow, Local control of blood flow by tissues and humoral regulation, Nervous regulation of circulation, Cardiac output, venous return and their regulation, Heart sounds, dynamics of valvular and congenital heart defects, Cardiac failure and circulatory shock.

Respiration
Pulmonary ventilation: mechanisms of pulmonary ventilation, pulmonary volumes and capacities, alveolar ventilation. Functions of respiratory passageways. Pulmonary circulation, pulmonary edema and pleural fluid. Physical principles of gas exchange, Diffusion of gases through respiratory membrane, Transport of oxygen and carbon dioxide in blood and body fluids. Regulation of respiration: respiratory center, peripheral chemoreceptor system, central chemoreceptor system and their regulatory function.

Gastrointestinal physiology
General principles of gastrointestinal function - motility, nervous control, and blood circulation, Transport and mixing of food in the alimentary tract, Ingestion of food. Motor functions of stomach. Movements of small intestine. Movements of colon. Secretary functions of alimentary tract: Secretion of saliva, Gastric secretion, Pancreatic secretion, Secretion of bile by liver, Secretions of small and large intestine. Digestion and absorption in gastrointestinal tract: Digestion of various foods, Absorption in small intestine.

Kidneys and body fluids
Body fluid compartments: Basic principles of osmosis and osmotic pressure: Extracellular and intracellular fluids. Interstitial fluid and edema. Urine formation by kidneys: Glomerular filtration, renal blood flow and their control, Functions of kidneys in homeostasis, Determinants of glomerular filtration rate, Renal blood flow, Tubular processing of glomerular filtrate, Reabsorption and secretion by renal tubules. Reabsorption and secretion along different parts of nephron, Regulation of tubular reabsorption.

Regulation of extracellular fluid osmolarity and sodium concentration. Role of thirst in controlling extracellular fluid osmolarity and sodium concentration. Integration of renal mechanisms for control of blood volume and extracellular fluid volume. Renal regulation of potassium, calcium, phosphate and magnesium. Regulation of acid-base balance.

Reading List

1 Textbook of medical physiology by Arthur C. Guyton and John E. Hall; Ed.11th; Saunders; 2005.
2 Review of medical physiology by William F. Ganong; Ed. 22nd; McGraw Hill; 2005.
3 Essential medical physiology by Leonard R. Johnson and Ed. 3rd; ELSEVIER; 2003.
4 Principles of anatomy and physiology by Gerard J. Tortora and Bryan Derrickson; Ed.1th; John Wiley; 2006. With (Brief atlas of the skeleton surface anatomy, and selected medical images)
5 Best and Taylor's physiological basis of medical practice by John B. West; 12th; B I Waverly Pvt Ltd.; New Delhi; 1990.
6 Medical Physiology: A cellular and molecular approach by Walter F. Boron and Emile L. Boulpaep; Saunders; 2003.
7 Physiology by Robert M. Berne and Matthew N. Levy; Mosby; 1998.

MBS 301: ADVANCE HUMAN PHYSIOLOGY

Sensory Physiology
Central nervous system synapses. Some special characteristics of synaptic transmission, Sensory receptors. Neuronal circuits for processing information. Somatic sensations: Tactile and position senses. Sensory pathways for transmission of somatic signals into the central nervous system. Transmission in dorsal column – medial lemniscal system. Pain, headache, and thermal sensations: Pain receptors and their stimulation, Dual transmission of pain signals into the central nervous system. Referred and visceral pain. Eye: Optics of vision, Receptor and neural function of retina, Photochemistry of vision, Color vision, Neural function of retina. Central neurophysiology of vision, Organization and function of visual cortex. Hearing: Tympanic membrane and ossicular system, Cochlea, Central auditory mechanisms, Vestibular sensations and maintenance of equilibrium. The chemical senses - taste and smell.

Nervous system: motor and integrative neurophysiology
Motor functions of spinal cord. Spinal cord reflexes. Muscle sensory receptors - muscle spindles and Golgi tendon organs and their roles in muscle control, Flexor reflexes and withdrawal reflexes, Reflexes of posture and locomotion. Cortical and brain stem control of motor function: Motor cortex and corticospinal tract, Role of brain stem in controlling motor function. Cerebellum, basal ganglia and motor control. Integration of all parts of total motor control system. Cerebral Cortex: intellectual functions of brain, learning and memory. Physiologic anatomy of cerebral cortex. Functions of specific cortical areas, Association areas. Function of brain in communication - language input and output. Function of corpus callosum and anterior commissure. Thoughts, consciousness and memory. Behavioral and motivational mechanisms of brain. Limbic system and hypothalamus. Activating-driving systems of brain. Functional anatomy and functions of limbic system and hypothalamus. States of brain activity. Sleep. Slow-wave sleep. REM sleep. Basic theories of sleep. Brain waves. Origin in brain of brain waves (EEG). Epilepsy, Psychotic behavior and dementia - roles of specific neurotransmitter systems.

Metabolism and Temperature Regulation
Metabolism of carbohydrates and formation of adenosine triphosphate. Lipid metabolism. Dietary balances, regulation of feeding, obesity and starvation. Vitamins and minerals. Energetics and metabolic rate. Body temperature, temperature regulation and fever.

Endocrine glands & Hormones
Endocrine glands & Hormones, Pituitary: Structure and function, Hypothalamic control of pituitary glands. Thyroid structure, function of parathyroid hormones. Adernal Cortex, Structure and function of its hormones; Adrenal Medullar; function of its hormones. Pancreas: Function of its hormones.

Environmental Physiology
High altitude, space and Deep Sea Diving Physiology: Effect of low oxygen pressure on the body, Effects of Acceleratory forces on the body in aviation and space physiology, Effect of High partial pressure of gases on the body.

Reading List

1 Textbook of medical physiology by Arthur C. Guyton and John E. Hall; Ed.11th; Saunders; 2005.
2 Review of medical physiology by William F. Ganong; Ed. 22nd; McGraw Hill; 2005.
3 Essential medical physiology by Leonard R. Johnson and Ed. 3rd; ELSEVIER; 2003.
4 Principles of anatomy and physiology by Gerard J. Tortora and Bryan Derrickson; Ed.1th; John Wiley; 2006. With (Brief atlas of the skeleton surface anatomy, and selected medical images) and
5 Best and Taylor's physiological basis of medical practice by John B. West; 12th; B I Waverly Pvt. Ltd.; New Delhi; 1990.
6 Medical physiology: a cellular and molecular approach by Walter F. Boron and Emile L. Boulpaep; Saunders; 2003.
7 Physiology by Robert M. Berne and Matthew N. Levy; Mosby; 1998.

MBS 302: PRINCIPLES OF MEDICINAL CHEMISTRY

Role of Medicinal Chemistry in discovery of drugs

Drug Design
Discovery of lead compound, lead modification, conventional drug screening, structural modification, bioisosteres, structure activity relationship, Quantitative structure activity relationships, introduction to molecular modeling and molecular graphics, pharmacophore descriptors

Receptors
Chemical nature of receptors, Neurotransmitters and their receptors, Receptor modulation and mimics, Receptor sites, Drug receptor interactions, active transport, affinity and efficacy, antagonism, partial antagonism, inverse agonism, allosteric binding sites Chirality and receptor binding, Signal transduction and second messenger systems, classification of receptors and receptor subtypes.

Introduction of various classes of drugs based on their interaction with target site. Drugs interacting with receptors, enzymes, DNA, carbohydrates etc with suitable examples.

Structure activity relationship illustrated with examples from Sulphonamides, β-lactams, Quinolones, Nucleosides and Alkaloids.

Drug Metabolism
Biotransformations and their mechanisms, Phase I and Phase II metabolism, Oxidation, Reduction, Hydrolysis, Deamination and Conjugation (GSH, Sulfate, Glucuronide and Amino acids), Role of non-specific enzymes: Oxidases, Mono-oxygenases, Di-oxygenases and Peroxidases: Biotransformations illustrated by suitable examples of commonly used drugs, Chirality and drug metabolism.

Enzyme Inhibition
Reversible and irreversible, Adverse drug reactions, Drugs acting on cell wall, Fungal membrane and Nuclear membrane, Drugs inhibiting protein synthesis.

Reading List

1 Organic chemistry of drug design and drug action by Richard B. Silverman; Ed. 2nd; ELSEVIER; 2004.
2 Foye's Principles of Medicinal Chemistry by Thomas L Lemke and David A Williams; Ed. 6th; Lippincott Williams & Wilkins; 2007.
3 Medicinal chemistry: principles and practice by Frank D. King; Ed. 2nd; The Royal Society of Chemistry; 2002.
4 Introduction to medicinal chemistry by Graham L. Patrick; Ed. 3rd; Oxford; 2006.
5 Chemical aspects of drug delivery systems by D. R. Karsa and R. A. Stephenson; The Royal Society of Chemistry; 1996.

MBS 303: ANALYTICAL & BIOMEDICAL TECHNIQUES AND INSTRUMENTATION

Introduction
Principles of Instrumental Analysis, Types of Instrumental Methods to be covered in the course. Selecting an analytical method and developing a new Analytical Technique.

Separation Methods
An introduction to chromatographic separation, Gas Chromatography, High Pressure Liquid Chromatography and FPLC, Supercritical fluid chromatography

Mass Spectrometry
Explanation of mass Spectrometry. Forming charged particles: Electron impact (EI) and Chemical Ionization(CI), Fast Atom Bombardment (FAB), Field Desorption (FD), Electrospray Ionization, Matrix Assisted Laser Desorption Ionization (MALDI). Mass Analyzers: Magnetic sector mass spectrometers, Double focusing mass spectrometers, Quadrupole pole mass spectrometers, ion cyclotron resonance, Time of Flight mass analyzers. Combine the mass spectrometer with Gas Chromatography (GC/MS) and with liquid chromatography (LC/MS). Applications of mass spectrometry in Biomedical field.

Nuclear Magnetic Resonance Spectroscopy
Theory of NMR: Quantum description, Classical description – Processional motion, Larmour frequency, Relaxation processes, T1 and T2 and their measurement. Fourier Transform NMR: Pulsed excitation, FID, Types of NMR Spectra – Wild line and high resolution spectra. NMR Spectrometers: Instrumentation. Environmental Effects: Types, Chemical shift theory, Magnetic anisotropy, Spin–spin splitting, first order and second order spectra, Double Resonance Techniques, Proton on heteroatom. Application of proton NMR: Identification of compounds. 13C NMR: Proton decoupling: Broad band, off-resonance, Pulsed decoupling, NOE, application to structure determination. Magnetic Resonance Imaging: The concept of MRI, Application in Muscle Physiology, functional mapping of brain. Other nuclei : 31P, 19F, 23Na, 15N

Optical Methods and their applications in Biomedical Sciences
Ultraviolet / Visible molecular absorption spectroscopy, Fluorescence and Phosphorescence, Infrared, CD and ORD

Miscellaneous
Confocal Microscopy: Applications in Cell Biology, Electron Microscopy, Tracer Techniques in Biology: tumor diagnosis and imaging, infectious diseases such as tuberculosis, Flow Cytometry, Mangetic Assisted Cell Sorting

Reading List

1 Spectrometric identification of organic compounds by Robert M. Silverstein and Francis X. Webster; Ed. 6th; John Wiley; 1997.
2 Principles of instrumental analysis by Douglas Skoog and F. James Holler and Timothy A. Nieman; Ed. 5th; Saunders; 1998.
3 Contemporary instrumental analysis by Kenneth A. Rubinson and Judith F. Rubinson; Prentice Hall 2000.
4 Organic spectroscopy by William Kemp; Ed. 3rd; Palgrave; 1991.
5 Basic one and two dimensional NMR spectroscopy by Horst Friebolin; Ed.3rd; Wiley-VCH; 1998.
6 NMR and its applications to living systems by David G. Gadian; Ed. 2nd; Oxford; 1995.
7 Structure determination of organic compounds: tables of spectral data by E. Pretsch and P. Buhlmann and C. Affolter; Springer; 2005.
8 MRI principles by Donald G. Mitchell; W S Saunders; 1999.
9 HPLC: a practical user's guide; Ed.2nd by Marvin C. McMaster; Wiley-Interscience; 2007.

MBS 304: MOLECULAR ONCOLOGY (Interdisciplinary)

The Cancer Problem
Epidemiology, Environmental carcinogens and risk factors, life style, changing patterns, the Indian scenario.

Mechanisms of Carcinogenesis
Various theories, multi-step and multistage processes, Initiation, Promotion and Progression. Role of DNA damage, repair and mutations by physicochemical agents and viruses, interaction of various agents. Differentiation: hyperplasia and precancerous lesions. Strategies of chemoprevention.

Tumor types and leukemia
Benign and malignant tumors, localized and metastatic disease, Schemes of classification, WHO classification, staging and grading, degree of malignancy. Classification of leukemia, types of chromosomal translocations.

Tumor Immunology
Immune suppression and role of immune survelliance in growth of tumors. Tumor specific antigens and immune response. Modulation of immune response and immunotherapy, cancer vaccines.

Modulation of the Eukaryotic Cell Cycle and cell death in cancer
Cell cycle and its control: Mechanism of deregulation of cell cycle during cancer. Apoptosis, Necrosis, Proapoptotic and Antiapoptotic proteins and mechanism of action.

Cell Interactions in Development of cancer
Cell-cell interaction, integrins, invasions, invasions by cancerous cells. Angiogenesis, Neoarrgiogenesis, Stem Cell Differentiation, Morphogens

Experimental Model Systems in Cancer Research
Microbial Models, Primary Cell Cultures, Established Cell Lines, Organ Cell Cultures, Spheroids.

Tumor suppressor genes and Viral oncogenes
Mechanisms of P53, Rb, Ras action in normal and transformed cells and viral oncogenes, Role of oncogenes in gene regulation using examples erb, rel, jun-fos, large Tantigen etc.

Growth factor-signalling pathways in cancer
Relationship between oncogene products and growth factors, using example of Src, Wnt, Abl, GAP and growth factors. Effect of viral infection on signal transduction.

Cancer genetics, familial cancers.

Emerging Cancer Therapy
Cellular, tissue and molecular markers, potential targets for Cancer Therapy, Drug Discovery Strategy.

Reading List

1 Genes by Benjamin Lewin Ed. 7th; Oxford; 2000.
2 Principles of Genetics by Eldon J. Gardner and Michael J. Simmons and D. Peter Snustad; Ed. 8th; John Wiley, 2005.
3 Molecular cell biology by Harvey Lodish and Arnold Berk, Chris A. Kaiser, and Monty Krieger; Ed. 6th; W H Freeman and Company; New York; 2008.
4 Principles of molecular oncology by Miguel H. Bronchud and Others; Humana Press; 2000.

MBS 305: TOXICOLOGY & PHARMACOLOGY

Introduction to pharmacology, scope of pharmacology.
Routes of administration of drugs, their advantages and disadvantages. Various processes of absorption of drugs and the factors affecting them;
Adsoption, metabolism, distribution and excretion of drugs.
Pharmacodynamics: General mechanism of drug action and the factors, which modify drug action.

Pharmacological classification of drugs; the discussion of drugs should emphasize the following aspects:

Drugs acting on the central nervous system: Anesthetics, pshychopharmacological agents

Drugs acting on the autonomic nervous system: Cholinergic drugs, anticholinergic drugs, anticholinesterase drugs, Adrenergic drugs and adrenergic receptor blockers, Neuron blockers and ganglion blockers, Neuromuscular blockers, drugs used in myasthenia gravis.

Hormones and hormone antagonists, Drugs acting on the respiratory system- bronchodilators, expectorants and antitussive agents, Drugs acting on the digestive system, Cardiovascular drugs, cardiotonics, antianginal agents, antihypertensive agents, peripheral vasodilators and drugs used in atherosclerosis, coaogulants and anticoaogulants.

Principles of Toxicology

Definition, scope and different branches of toxicology.

A brief review of toxic substances:
Synthetic organic compounds: Chemical additives in food, Chemicals in the work place, Solvents, Pesticides, Cosmetics, Drugs of abuse. Inorganic chemicals: Industrial and chemical environmental inorganic toxicants polluting air/ water/ food. Naturally occurring poisons: Mycotoxins, Bacterial toxins, Plant toxins and Animal toxins.

Types of toxicity and its measurement: Acute, Sub-acute or Chronic and its manifestations. Acute toxicity: Mode of application/ administration/ exposure, in-vitro tests, Dose response relationship, Measurement of TD 50/ TC 50 and LD 50/ LC 50. Subacute and chronic toxicity. Risk and safety analysis: Margin of safety, Therapeutic index, Ideal therapeutic index. Inter-species extrapolation of dose-response data, NOEL, ADI, TLV, WHO standards. Special toxicity studies: Carcinogenecity, teratogenicity, in-vitro mutagenicity tests.

Epidemiology of toxicity: Cohort study, Retrospect study, Case-control study, Cross-sectional study, Confounding.

Pharmacokinetic aspects of toxicants:
Absorption, Distribution, Metabolism and Excretion (ADME) of drugs and chemicals. A general study only. Site of metabolism, Metabolizing enzymes of liver, kidney, lung, GI tract, skin and their role in activation and detoxification of drugs and chemicals. Physiological (route of exposure, species, sex and age), Nutritional and environmental (temperature, altitude and circadian rhythms related) factors affecting metabolism, detoxification and toxic responses of drugs and chemicals.

Organ toxicities
Hepatotoxicity: A brief description of morphological and functional aspects of liver with special reference to hepatotoxicity, various hepatotoxic agents, types of liver injuries- Fatty liver formation, Necrosis, Cholastosis, Hepatitis, Fibrosis, Cirrhosis, Carcinogenesis. Nephrotoxicity: A brief description of morphological and functional aspects of kidney in relation of nephrotoxicity, nephrotoxic agents, Detailed mechanisms of chemical induced nephrotoxicity. Cardiovascular toxicity: A brief description of mechanisms of cardiovascular toxicity and cardiotioxic agents- subcellular and biochemical mechanisms.

Neurotoxicity: A brief description neurotoxic agents and types of neurotoxic effects- Axanopathy, Neropathy, Neuronopathy, Mylenopathy. Broncho-pulmonary (inhalation) toxicity. Gastro-intestinal toxicity. Skin toxicity/ photosensitivity. Tests for evaluation of toxicities in different organs. Therapeutic aspects: General measures and treatment of poisoning cases, Specific antidotes, Agents of first choice, Contraindications.

Reading List

1 Essential of medical pharmacology; 6th Ed. By K.D. Tripathi; Jaypee Brothers; New Delhi; 2008.
2 Goodman & Gilman's the pharmacological basis of therapeutics by Laurence Brunton and John Lazo and Keith Parker; Ed. 11th; McGraw-Hill Professional; 2005.
3 Pharmacology H. P. Rang and M.M. Dale and J.M. Ritter and P.K. Moore; Ed. 5th; Churchill Livingstone, 2003.
4 Integrated Pharmacology: With Student Consult Access by Clive P. Page and M.J. Curtis and M.C. Sutter and M.J. Walker and B.B. Hoffman; Ed. 3rd; Mosby; 2006.
5 Principles of toxicology by Karen E. Stine and Thomas M. Brown; Ed. 2nd; CRC Press; 2006.
6 Lu's basic toxicology: fundamentals, target organs and risk assessment by Frank C. Lu and Sam Kacew; Ed. 5th; Informa Healthcare; 2009.
7 Casarett and Dull's toxicology: the basic science of poisons by Curties D. Klaassen; Ed. 7th; McGraw Hill; New York; 2007.
8 Toxicology by Hans Marquradt and S.G. Schafer and R.D. McClellah and Academic Press; 1999.
9 Principles and practice of toxicology in public health by Ira R. Richards; Jones and Bartlett Publishers; 2007.
10 Handbook of human toxicology by E.J. Massaro; CRC Press; 1997.

MBS 401: DISSERTATION

MBS 402: GENOME BIOLOGY (Interdisciplinary)

Introduction
Overview of Genomics. To highlight how biology is a network of interactions direct and indirect. What is the difference between genetics and genome biology? The transition from reductionist to comprehensive approach in understanding biological systems.

Role of model organisms in genetic studies in the pre-genomic era
E.coli: Mutation analysis through mutant selection and deciphering metabolic pathways. *Saccharomyces cerevisea*: Tetrad analysis, isolation of mutants (e.g. cell cycle mutants) and their characterization. *Caenorhabditis elegans*: Discovery of RNAi/miRNA in developmental context. *Drosophila melanogaster*: from chromosomal basis of inheritance to sharing themes in developmental biology. (Note: students have studied this under Concepts in genetics (II semester), during these lectures the teacher is expected to reflect the integration of regulatory loops shared between Drosophila and humans, to show how this Cinderella of genetics remains relevant in the genomics era). *Mus musculus*: Generation of knockouts and transgenic for tissue expression analysis: Conventions of nomenclature of genes and gene products in different model systems (www.ncbi.nlm.nih.gov).

Pedigree Analysis
Basic concept, Gathering family history, Pedigree symbols and construction of pedigrees, Interpretation of pedigree data.

Patterns of inheritance for monogenic traits
Deviations from the basic pedigree patterns-Variable penetrance and expressivity, pleiotropy, late onset, dominance problems, anticipation, genetic heterogeneity, genomic imprinting and uniparental disomy, spontaneous mutations and X-inactivation (Website: OMIM)

Human Genome and beyond
History, organization and goals of human genome sequence. Tools (Vectors- BAC, PAC, YAC and sequencing techniques) and approaches (Hierarchial and shotgun sequencing used). Outcomes and ethical issues. (For topics 1 and 3 refer to Human Genome Project site also.)

Organization of the Human Genome
General features: Gene density, CpG islands, RNA-encoding genes. Gene clusters, Pseudogenes. Diversity in size and organization of genes. Types of repetitive DNA: LINES, SINES. Genetic markers and their applications

Techniques for Genomics
Cytogenetic techniques (Karyotyping and FISH). Polymorphism screening (Genotyping of SNPs and Microsatellite markers). Expression analysis and proteome analysis

Mapping strategies
Physical Maps (Cytogenetic maps, Radiation hybrids). Genetic Maps (Marshfield and DeCode maps)

Identification of Genetic Basis of Disease
Forward and Reverse Genetics; Top-down and Bottom- up approaches. Parametric and non-parametric approach, TDT, Polymorphism based analysis. Positional and Candidate Gene approaches, Positional-cloning approach [Examples like Huntington disease, Cystic fibrosis, but not restricted to these]. Genotypic and Allelic frequencies. Haplotype construction (using SNPs and/or microsatellites polymorphism data). Introduction to Copy number variation (to be covered through paper presentations)

Genome of model organisms & pathogens & Comparative Genomics
Overview of prokaryotic and eukaryotic genome organization and complexity: *E. coli, Yeast, Drosophila, Mouse, M. tuberculosis* and *Plasmodium*. Conservation and diversity of genomes

Implications of Genome Research:
Diagnosis and screening of Genetic Disorders. Prenatal genotyping for mutations in β- globin gene and sickle cell aneamia. Applications in pharmacogenetics (Genetic polymorphism in drug metabolism genes and their effect on drug metabolism and drug response, toxicity)

Website based analysis and seminars: www.ncbi.nlm.nih.gov, www.ensembl.org, HAPLORE for haplotype construction. Epigenome analysis [Concepts are taught in II semester]

Reading List

1 Human molecular genetics by Tom Strachan and Andrew P. Read; Ed. 3rd; Garland Science; 2004.
2 Vogel and Motulsky's Human Genetics: Problems and Approaches by Michael Speicher and Stylianos E. Antonarakis and Arno G. Motulsky; Ed. 4th; Springer; 2009.
3 Genomics: the science and technology behind the human genome project by Charles R. Cantor and Cassandra L. Smith; Ed. 2nd; John Wiley; 2002.
4 Genetics: From Genes to Genomes by Leland Hartwell, Leroy Hood, Michael L. Goldberg, and Ann E. Reynolds; Ed. 3rd; McGraw Hill Higher Education; 2006.
5 Basic human genetic by Elaine Johnsoen, Mange and Arthur P. Mange; Rastogi Publications; 2005.
6 Molecular and Genetic Analysis of Human Traits by Gustavo Maroni; Ed.1st; Wiley-Blackwell; 2001.
7 Human Genetics: The Molecular Revolution by McConkey; Jones and Bartlett; 1993.
8 Thompson & Thompson Genetics in Medicine by Robert L. Nussbaum and Roderick R. McInnes and Huntington F. Willard; Ed. 6th; Saunders; 2004.

MBS 403: CONCEPTS IN DRUG DISCOVERY AND MECHANISM (Interdisciplinary)

Existing drugs as lead compounds for new discovery: Case histories to be illustrated with examples from sulfonamides, β-lactams, Quinolones, Nucleosides, Alkaloids etc.

Combinatorial Chemistry: Methodology of combinatorial Synthesis, Parallel synthesis and Combinatorial Library.

Concepts in drug delivery systems., drug delivery devices: implants, minipumps, mechanism of controlled drug release, soluble delivery systems: micro and nano systems, routes of drug delivery systems .

Pharmacogenetics: Population variation in drug metabolism; genetic variability; polymorphism relating to receptors and genes in drug metabolism; molecular markers and Single nucleotide polymorphism as markers for emerging concepts in pharmacogenetics.

Receptor Chemistry and Biology: Chemistry of membrane and intracellular receptors; Isolation and characterization of receptors; Regulation of receptor number and affinity; Receptor cross-talk; Organ Receptors; Non-liganded and constitutive receptor activation; r-DNA receptor bioassays; Desensitization of receptors; Receptors as targets for vaccines and newer drug development.

Student seminar

Reading List

1 Organic chemistry of drug design and drug action by Richard B. Silverman; Ed. 2nd; ELSEVIER; 2004.
2 Combinatorial chemistry and molecular diversity in drug discovery by Eric M. Gorden and James F. Kerwin; Wiley-Liss; 1998.
3 Molecular diversity and combinatorial chemistry: principles and applications by Michael C. Pirrung; ELSEVIER; 2004.
4 Textbook of drug design and discovery by Povl Krogsgaard-Larsen and Kristian Stromgaard and Ulf Madsen; Ed. 4th; CRC; 2009.
5 Nanobiotechnology in molecular diagnostics: current techniques and applications by K.K. Jain, Horizon Bioscience; 2006.
6 Burger's medicinal chemistry and drug discovery by Donald J. Abraham; Ed. 6th; John Wiley; 2003.
7 Polymeric drugs & drug delivery systems by Raphael M. Ottenbrite and Sung Wan Kim; Technomic, 2001.

MBS 404: ADVANCED MEDICINAL CHEMISTRY (Interdisciplinary)

Metal Complexes in Medicine
Chemistry of Metal Species, Biochemistry, SAR. Complexes in Clinical Trial. Metal containing imaging agents

Drugs acting on Novel Targets (examples from past one decade or so)
β-tubulin inhibitors and their mechanism. Kinase inhibitors e.g. AKt inhibitors, discovery of gleevac etc. HIV inhibitors: integrase inhibitors, CCR5 inhibitors etc. New drugs developed for tuberculosis and other infectious diseases. New drugs developed for cardiovascular disease Cholesterol, absorption inhibitors e. g. ezetimibe, glycoprotein inhibitor e.g. abciximab, Renin inhibitors e.g. aliskerin

Drug Discrimination
Subjects, Dose and the parameters, Nature of the stimulus, Stereoselectivity, Specificity, Locus and mechanism of action, Structure activity studies

Role of Biotechnology in Drug Discovery
The impact of biotechnology on small-molecular drug discovery and development. Examples of approved biotechnology based drugs: Monoclonal antibodies, Interferon alpha, Interferon beta, Interferon gamma, Inter leukins, Growth hormones, Antisense nucleotides, Use of Transgenic animal models for drug evaluation

Molecular Modelling and Computer Aided Design of Macro-moleculas for Medical Application.
Basic elements contributing to 3D-structure, Macromolecular structure database: Its constitution and attributes, Sequence Homology and Homology based modeling, Modeling Ligand –Protein association: Docking methods, Molecular Mechanics, Molecular Dynamics.

Students Seminar

Reading List

1 Introduction to Medicinal Chemistry: How drugs act and why by Alex Gningauz and Bruce S. Burnham and Iris H. Hall; Ed. 2nd; Wiley-Interscience; 2007.
2 Chemoinformatics: a textbook by Johann Gasteiger and Thomas Engel; Wiley-VCH; 2003.
3 Molecular modeling: basic principles and applications by Hans-Dieter Holtje and Wolfgang Sippl and Didier Rogan and Gerd Folkers; Ed. 3rd; Wiley-VCH; 2008.
4 Biopharmaceuticals: Biochemistry and Biotechnology by Gary Walsh; Ed. 2nd;Wiley; 2003.
5 Targeted & Controlled Drug Delivery: Novel Carrier Systems by S. P. Vyas, and R.K. Khar; CBS; 2006.

MBS 405: RADIATION BIOLOGY

PART I

Fundamentals of Radiation Physics
Electromagnetic radiation and radioactivity. Radiation sources and radionuclides. Measurement units of exposed and absorbed radiation.

Radiation and Photochemistry
Interaction of radiation with matter, excitation and ionization. Radiochemical events relevant to radiation biology. Dosimetry

Interaction of radiation with Biomolecules
Nucleic acids, proteins, lipids and carbohydrates

Cellular effects of radiation
Effects of Ionizing and non-ionizing radiation on cells, DNA, chromosomes and membrane, cell survival (including biophysical models). Division delay and cell cycle check points. Mutation

DNA repair processes
Various repair pathways and their regulation. Mechanistic and regulatory aspects of DNA repair. Role of DNA repair in aging and genetic diseases

Biology Dosimetry
Micronuclei formation, Chromosome aberration and mutation assays.

Systemic effects of radiation
Acute, delayed and late radiation effects (with particular reference to nervous system, gastrointestinal and hematopoitic syndrome). Carcinogenesis and teratogenesis.

Modification of cellular and systemic response to radiation
Radiosensitization and Radioprotection.

Behavioral Radiation Biology
Effects of radiation on nervous systems (in vitro studies). Effects of low and high doses of radiation on nervous system and behaviour.

Radiation Safety
Biological basis of ICRP recommendations

Radio-ecology and environmental radiation biology
Low dose effects of natural and man made radiation, Ultraviolet radiation and environment.

PART II

Application in Biomedicine

Radiation Medicine
Radiation Therapy, Therapeutic nuclear medicine, Management of radiation injuries

Current Area of Research
Tumor Physiology and Radiation Response, Predictive Assays, Adaptive response, Improvement in Tumor Radiotherapy, Emerging new applications

Others
Low-dose hypersensitivity, Bystander effects, Radiation induced alterations in signal transduction

Reading List

1 Radiobiology for the Radiobiologist by Eric J. Hall and Amato J. Giaccia;Ed. 6th; Lippincott; 2005.
2 Basic Clinical Radiobiology by G. Gorden Steele; Hodder Arnold Publication; 2002.
3 Introduction to Radiobiology by A. Wambersie; Ed. 1st; Taylor & Francis; 2007.
4 Introduction to Radiobiology by A.H.W. Nias; Ed. 2nd; Wiley; 1998.

MBS 406: TOPICS IN CLINICAL RESEARCH

Introduction to Clinical Research
Definition, Scope and Types of Clinical Research, Understanding Epidemiology, (infectious disease, cancer and genetics) Pharmacology and Pharmaceuticals, Good Clinical Practices (GCP), Process of Drug Development and Drug Safety. Introduction to Bioavailability and Bioequivalence.

Methods in Clinical Research and Clinical Trial: Design
Designing of protocol, Pharmaco-epidemiology, Introduction to Quality Assurance and quality control, Good Laboratory Practice (GLP) and Accreditation, Study population and sample size, Medical report writing and publication of results.

Ethics in Clinical Research
Definition and theories of Ethics and Foundation, Independent Ethics Committee, Informed Consent, Integrity in Clinical Research, Conflicts of Interest.

Regulatory Process in Clinical Research
History and Role of Regulations in Clinical Research, US and Indian Regulatory system, EU Regulatory Affairs, Non-Disclosure Agreement, GMP regulations, Patent and Patent laws

Clinical Research and Management
Clinical Study Preparation, Pre-clinical Trials, Clinical trial phase I/II/III/IV, Documentation, Monitoring, Audit and Inspection of trial study, Pharmaco-vigilance, Drug Safety.

Biostatistics and Data Management
Role of Statistics in clinical research, Trial design and analysis, Data management and validation, Consideration of SAE (serious adverse effects), Bioinformatics, software and IT in Clinical Research.

Reading List

1 Ethical and Regulatory Aspects of Clinical Research: Readings and Commentary, Ezekiel J. Emanuel, 1st Ed., The Johns Hopkins University Press; 1 Edition, 2003.
2 The Pharmaceutical Regulatory Process (Drugs and the Pharmaceutical Sciences), Ira R. Berry, 1st Ed., Informa HealthCare, 2004.
3 Fundamentals of Biostatistics, Bernard Rosner, Duxbury Press; 6th Ed., 2005.
4 Epidemiology and Biostatistics: An Introduction to Clinical Research, Bryan Kestenbaum, 1st Ed., Publisher: Springer, 2009.
5 Adaptive Design Methods in Clinical Trials, Shein-Chung Chow, CRC, 2006.
6 Introduction to Randomized Controlled Clinical Trials, 2nd Ed., John N.S. Matthews, CRC, 2006.
7 The Oxford Textbook of Clinical Research Ethics, Ezekiel J. Emanuel, Oxford University press, 2008.

MBS 407: ADVANCED IMMUNOLOGY

Immunoglobulins
Introduction, Overview of Immunoglobulin, V Gene Assembly and recombination, three Immunoglobulin gene Expression, Chromosomal Translocation involving Immunoglobulin loci.

Major Histocompatibility Complex
Detailed Structure and Molecular Interaction of MHC Molecules, Chemistry of peptide, Binding and Presentation, MHC and Transplantation, MHC and Diseases, Pathogen Interface with Antigen Presentation, TCR Genes, Chromosomal Translocations associated with Disease and Molecular Mechanism of T-Cell Activation.

Complement
Complement: Location, Regulation and Activation, Biological Consequences of Complement Activation. Complement as Pathogenic Factor in Disease.

Hybridoma Technology, Utilising Transgenic and Knockout Mice in understanding immune mechanisms, Mucosal Immunity, Aging and Immune Functions, Cytotoxic T-Lymphocytes, Inflammation, Systemic Autoimmunity, Pathogensis of Allergic Diseases, Transplantation Immunology, Tumor Immunology, Immune Response to Infectious Disease-Viral, bacterial and Protozoans, Vaccines, immuno Deficiency Diseases, Immunotherapy, signal Transduction in Innate Immunity, Microbial evasion strategies.

Student Seminar

Reading List

1 Kuby Immunology by Thomas Kindt and Richard A. Goldsby and Barbara A. Osborne; Ed.6th; W.H. Freeman and Company, New York; 2007
2 Cellular and molecular immunology by Abul K. Abbas and Andrew H. Lichtman and Shiv Pillai; Ed. 6th; Sounders; 2007.
3 Immunology; Ed.7th by David Male and Jonathan Brastoff and David B. Both and Ivan Roitt; Mosby Elsevier; 2006.
4 Immuno biology: the immune system in health and disease by Charles A. Janeway and Paul Travers and Mark Walport and Mark J. Shlomchik; Ed. 7th; Garland Science; 2008.
5 Immunology of infection diseases by Stefan H. E. Kaufmann and Alan Sher and Rafi Ahmed; ASM Press, Washington; 2002
6 Essentials of immunology & serology by Jacqueline H. Stanley; DELMAR; Australia; 2002.

MBS 408: ADVANCED TOXICOLOGY & PHARMACOLOGY

Environmental and Pesticide Toxicology
Metallic Pollutants: Mercury, lead, arsenic, cadmium, fluoride; Source, exposure, absorption, target site interactions and health hazards.

Pesticides
Brief classification with examples, residual and non-residual pesticides. Mode of entry and mode of action of pesticides in target and non-target organisms; metabolism of pesticides, phase I and phase II reaction, elimination. Ecotoxicology: Impact of pesticides residues on ecosystems, non-target organisms; Pesticide beioaccoumlation, biomagnification through food chain. Environmental alteration of pesticides - microbial and solar, fate and dissipation of pesticides residue under tropical and temperature conditions.

Pesticide hazards to man
Accidental and occupational exposure, entry through air, food and water, Main routes of entry and factors affecting intake, distribution, biotransformation and elimination dynamics. Residue levels in man: Indian experience Vs developed countries; Residues in tissues and organs – distribution and redistribution; Pregnancy and transfer to fetus. Health hazards: Non–fatal subtle levels, biochemical and physiological effects; Parameters used in carcinogenic risk assessment of pesticide residues; Animal experiments – carcinogenic, teratogenic and mutagenic tests; Organochlorine insecticide residues as carcinogens-parent status Carcinogens – phenoxyherbicides, arsenicals and HCB; Organochloro residue burden in newborn babies in developing countries and potential hazards.
Pharmacokinetics and Pharmacodynamics: General mechanism of drug action and the factors, which modify drug action.

Pharmacological classification of drugs; the discussion of drugs should emphasize the following aspects:

Drugs acting on the central nervous system : General anesthetics, adjunction to anesthesia, intravenous anesthetics. Analgesic and non-steroidal anti-inflammatory drugs, narcotic analgesics, antirheumatic and antigout remedies, sedatives and hypnotics, pshychopharmacological agents, anti-convulsants, analeptics. Centrally acting muscle relaxants and anti-parkinsonism agents, anti-Alzheimer's drugs. Local anesthetics.

Drugs acting on the eye, mydriatics, drugs used in glaucoma. Drugs acting on the respiratory system-bronchodilators, expectorants and antitussive agents. Antacids, histamine and anti-histamines, prostaglandins. Cardiovascular drugs, cardiotonics, antianginal agents, antihypertensive agents, peripheral vasodilators and drugs used in atherosclerosis. Drugs acting on the blood and blood forming organs, haematinics, coagulants and anticoagulants, haemostatics, blood substitutes and plasma expanders. Drugs affecting renal function- diuretics and antidiuretics. Hormones and hormone antagonists- hypoglycemic agents, antithyroid drugs, sex hormones and oral contraceptives, corticosteroids. Drugs acting on the digestive system- carminatives, digestants, bitters, antacids and drugs used in peptic ulcer, purgatives and laxtives, antidiarrhoeals, emetics, antiemetics.

Chemotherapy of microbial diseases, urinary antiseptics, sulfonamides, penicillins, streptomycin, tetracyclines and other antibiotics; antitubercular drugs, antifungal agents, antiviral drugs, antileprotic drugs.

Chemotherapy of protozoal diseases , Drugs used in cancer, Disinfectants and antiseptics.

Reading List

1 Essential of medical pharmacology; 5th Ed. By K.D. Tripathi; Jaypee Brothers; New Delhi; 2003.
2 Goodman & Gilman's the pharmacological basis of therapeutics by Joel G. Hardman and Lee E. Limbird; 9th Ed.; 1995.

3 Pharmacology H. P. Rang and M.M. Dale and J.M. Ritter and P.K. Moore; Ed.5th; Churchill Livingstone, 2003.
4 Integrated pharmacology by Clive P. Page and M.J. Curtis and M.C. Sutter and M.J. Walker and B.B. Hoffman; Mosby; 1997.

5 Principles of toxicology by Karen E. Stine and Thomas M. Brown; Ed.2nd; CRC Press; 2006
6 Lu's basic toxicology: fundamentals, target organs and risk assessment by Frank C. Lu and Sam Kacew; Ed.4th; Taylor & Francis; 2002
7 Casarett and Dull's toxicology: the basic science of poisons by Curties D. Klaassen; Ed.7th; McGraw Hill; New York; 2007
8 Toxicology by Hans Marquradt and S.G. Schafer and R.D. McClellah and Academic Press; 1999
9 Principles and practice of toxicology in public health by Ira R. Richards; Jones and Bartlett Publishers; 2007
10 Handbook of human toxicology by E.J. Massaro; CRC Press; 1997

PRACTICALS

(9 hrs per week)

MBS 106: PRACTICALS

✓ GENETICS

Experiments in Concepts in genetics:

1. Estimation of colony forming units in *E.coli* and its application in isolation of pure mutant strains from mixtures.
2. To set up and analyze results of crosses between mutants and wild type Drosophila to understand Mendelian genetic principles using Drosophila: Dominant and recessive inheritance; sex linked inheritance.
3. Using balancer stock to localize recessive mutations on chromosomes in Drosophila.
4. Preparation of polytene chromosomes and immunostaining for a chromatin interacting protein.
5. Analysis of chromatin organization in mouse tissue for specific sequences through Micrococcal nuclease sensitivity followed by PCR.
6. Detection and analysis of Variable number of tandem repeats (VNTR) in human genome by PCR: mapping the VNTR sequence on the human genome using Bioinformatics tools.

✓ BIOCHEMISTRY

1. Salting in and salting out of proteins.
2. Desalting of proteins by dialysis and Sephadex G-25.
3. Protein estimation by Loorys & Bradford methods.
4. Ion-exchange chromatography.
5. Affinity chromatography for protein purification.
6. To check purity of protein & subunit structure by SDS page & silver staining.
7. Western blot analysis to check special proteins.
8. Isolation of genomic & plasmid DNA.
9. Protein & Nucleic Acid blasts, Clustal W and sequence alignment etc.

✓ MEDICAL MICROBIOLOGY

Bacteriology

1. Preparation and sterilization of different culture media (e.g. Blood agar, chocolate agar, nutrient agar, nutrient broth, Mac Conkey agar) and to obtain pure cultures.
2. To carry out different types of staining such as Gram staining, Acid fast staining, Spore staining, Albert's staining of the given bacterial culture.
3. To determine the antibiotic sensitivity profile of the given microbial culture using Kirby-Bauer method.
4. To carry out the following biochemical tests for given bacterial cultures: Catalase test, Urease set, Indole test, Methyl red test Voges-Prauskauer test, Citrate test, Lysine iron agar, Triple sugar iron, Sugar fermentation tests (glucose, maltose, sucrose).

Mycology

1. To prepare temporary mounts from cultures/clinical specimens and observe permanent slides of the following: Rhizopus, Mucor, Aspergillus fumigatus, *Aspergillus flavus, Candida albicans, Blastomyces dermatidis, Penicillium marneffei, Nocardia, Histoplasma capsulatum*.
2. To demonstrate the presence of *Candida albicans* in the given clinical specimen using the germ tube test.

MBS 206: PRACTICALS

✓ ORGANIC CHEMISTRY

1. Crystallization
2. TLC, Column chromatography
3. Interpretation of IR spectra and functional groups.
4. **Preparations involving examples of reactive intermediates (any six):** Cannizaro reaction, Dibenzal, benzalacetone, Benzophenone, photochemical reaction, NBS-reaction, Reimer-Tieman reaction, Oxidation of an alcohol, Enamine reaction, Glucose phenylhydrazone, Protection of amino acids, Synthesis of dipeptide, Any example of enzymes catalyzed organic synthesis

✓ IMMUNOLOGY

1. Collection of blood: Retro -orbital bleeding, tail vein puncture
2. Separation and preservation of serum and plasma
3. Various routes of immunization: Intraperitoneal, Subcutaneous and Intra muscular
4. Immunization of animal (BALB/C) intraperitoneally with BSA 10% and adjuvant Immunodiffusion techniques
5. Circulating Immune complex level estimation by PEG method
6. Separation of mononuclear cells from blood
7. Separation of lymphocytes from solid organs, spleen and bone marrow by nylon wool method, Isolation of peritoneal macrophages
8. Functional assay for macrophages using, Nitroblue tetrazolium test (NBT), Cell adhesion assay, Phagocytosis assay.
9. Indirect haemagglutination, demonstration of ELISA technique and FACS

✓ MOLECULAR BIOLOGY AND BIOTECHNOLOGY

1. Preparation of competent cells and Transformation of E.coli with given plasmid.
2. Restriction digestion of isolated plasmids or RFLP analysis of given DNA of PCR diagnostic.
3. Ligation of a DNA fragment in an expression vector.
4. Screening of positive clones.
5. Induction of proteins cloned in expression vectors.
6. PCR of 16 S rRNA gene for phylogenetics analysis.
7. DNA protein interactions by electrophoretic mobility shift assay.
8. Mammalian cell culture & transformation of recombinant vector containing GFP.
9. Expression of proteins in mammalian cells using fluorescence microscopy.

MBS 306: PRACTICALS

✓ ADVANCED HUMAN PHYSIOLOGY

Hematology

1. To measure inspiratory and expiratory parameters
2. To record the conduction velocity of ulnar nerve
3. To prepare a stained blood smear to identify the different leukocytes in the blood smear and to do a differential leukocyte count.
4. To determine the total RBC counts per cubic millimeter of blood and to show the effect of hypotonic, isotonic, salt solutions on red blood cells
5. To determine the bleeding time by Duke method, clotting time by capillary tube method, osmotic fragility of a given sample blood.
6. To estimate the total amount of hemoglobin in human blood
7. Ergometry
8. Reticulocyte count, Eosinophil count, Platelet count

Experiment On Animal Heart (Rat/Frog)

9. Measurement of Heart Rate and to study the effect of temperature, ions on Heart Rate
10. Study of autorhythmicity of Heart
11. To measure Muscle Twitch and Tetany

✓ ANALYTICAL & BIOMEDICAL TECHNIQUES AND INSTRUMENTATION

1. To verify Lambert Beer's law .
2. To study interaction of intercalating agents like ethidium bromide and porphyrin with DNA using:
   a. UV –visible spectroscopy.
   b. Fluorescence spectroscopy.
3. Studying the Conformation change of Biomolecule using CD spectroscopy.
4. Biomolecular Interaction studies using Yeast 2 Hybrid System. DNA protein interactions by EMSA.
5. Infra red Spectroscopy.
   Recording and interpretation of IR of a biological fluid.
6. HPLC: Analysis of 5-hydroxy tryptamine from blood, HPLC analysis of Nucleobases from Calf thymus DNA.
7. Gas Chromatography.
   Analysis of opium alkaloids from opium, Analysis of Cortisol from blood.
8. Mass Spectroscopy: Identification of a biopolymer using MALDI/ LC-MS.
9. NMR: 1H and 31P spectroscopy of muscle physiology during exercise and calculation of pH change from spectra.
10. Spectral Identification of a simple organic compound/metabolite/drug.

✓ PHARMACOLOGY & TOXICOLOGY

1. Animal handling and precautions, and study the routes of administration
2. Topical application of Atropine and Pilocarpine on rabbit eye
3. Analgesic effect of diclofenac on mice/rat
4. Study the effects of acetylcholine (Ach) and plot the dose-response curve.
5. Study the effect of general anaesthesia with ketamine
6. To determine the effect of promethazine on phenobarbitone induced sleeping time in mice.
7. To determine the acute toxicity of a given drug and calculate the LD50 value.
8. Detection of organophosphorous pesticides in biological sample.
9. To test the presence of paracetamol in the given biological sample.
10. To study the effect of organophosphate Malathion on the specific activity of the enzyme acetylcholinestrase in rat brain homogenate.

Dr. B R Ambedkar Center for Biomedical Research
Faculty of Science
University of Delhi

SYLLABUS FOR Ph.D. COURSE WORK

The center in keeping with its inter-disciplinary nature offers the following syllabus for the Ph.D. Course work. There are a total of four papers that each student has to clear. Paper I (Research Methodology), Paper II (Tools and Techniques in Biomedical Research) and Paper III (Writing a Research proposal) are compulsory. In Paper IV a student can opt for any two modules.

Overview of the Papers:

The Research Methodology paper has been designed to inculcate a scientific temperament in the student and introduce the basic requirements for being a good and motivated researcher. Emphasis is laid on the need to identify a challenging research topic following an extensive literature survey. Learning how to design simple and complicated experiments, the need for reproducibility, analyses of the data obtained and its significance in moving forward follows this. In parallel, the student is also trained to follow ethical guidelines, display scientific integrity; identify conflict of interest and plagiarism issues while writing scientific documents.

The Paper on Tools and Techniques in Biomedical Research focuses on the principles, scope and applications of routine and advanced techniques the student is likely to use in his/her research. This will prepare the student to keep in mind the scope and limitations of each technique that will be useful in designing experiments and interpreting the data.

The Paper on Writing a Research Proposal, prepares the students for writing grant proposals that will be extremely useful following the successful completion of the Ph.D. With a number of post-doctoral fellowships now being offered by leading National and International funding agencies this paper will be beneficial to him/her.

The Advanced Modules Paper with an array of modules is in keeping with the inter-disciplinary nature of ACBR. A student can opt for any two. Any student is welcome to attend the courses of other modules as well but will be evaluated on his/her choice of the modules opted at the start of the semester.

Course structure and evaluation criteria:

All the papers will be evaluated at the end of each semester and include internal assessment. The individual teachers as per their chosen criteria will decide the internal assessment. A written exam will be held for Papers I, II and IV. For Paper III (Writing a Research Proposal) the student will have to submit a project proposal and defend the same in the form of power-point presentation.

The student has to score at least 50% marks in each paper to qualify the same.

Program Structure

PAPER NO.	Paper Title	End-semester Examination	Internal Assessment
PHBS-I	**Research Methodology**	**50 Marks (July-December)**	**50 Marks (July-December)**
PHBS-II	**Tools and Techniques in Biomedical Research**	**70 Marks (July-December)**	**30 Marks (July-December)**
PHBS-III	**Writing a Research Proposal**	**70 Marks (January-June)**	**30 Marks (January-June)**
PHBS-IV	**Advanced Modules (any two)**	**70 Marks (January-June)**	**30 Marks (January-June)**

PHBS-I: Research Methodology

Research Methodology: An Introduction

Objectives and motivation in research, Approaches to scientific research- Issues and concerns related to scientific investigation; lack of exclusivity of methods of research; Merging of various approaches in practice of scientific research

Literature Search and managing research outcomes

Introduction to peer-reviewed and open access journals, E-journals and E-books. Citation of papers; Search of research articles via subject and author index. Common search engines for literature- NCBI, Scopus, Google Scholar, Scirus, SciFinder. Systematic literature search. The importance of reliability of retrieved data; source evaluation. Formulating key word(s)based query to retrieve appropriate data, Managing personal reference database.

Defining a Research Problem

Identifying gaps in knowledge through literature mining, identifying area of societal need like health/technology/anticipated crisis such as epidemic, energy, water. Elements for outlining a research problem. Developing an approach strategy, feasibility testing.

This unit will have extensive classroom discussion, and students' participation through formulation of pilot projects to illustrate identification of research problems.

Designing of Experiment: Strategies, Planning and Analysis

Selection of research topic and its national and international scenario. Techniques involved in research plan using an illustration, Defining Standard Operating Protocols (SOPs), Research Conditions, Repeatability, reproducibility and reliability of results, Accuracy and Precision, Significant figures with reference to numerical data, Errors and uncertainty analysis. Types of errors: Gross error, systematic error, random error, Statistical analysis of data.

Methods in Biomedical Research

To illustratively discuss Clinical Research, Ethical issues in clinical research, Epidemiology: (classical examples of epidemiological studies such as leprosy, twin studies), Good clinical research methodology

Laboratory and Safety Practices

Biosafety; Introduction to occupational health and safety (chemical, biological and radiation), awareness about handling toxic laboratory chemicals, pathogenic microorganisms, and their safe disposal. Idea about labels and Material Safety Data Sheet (MSDS), safety equipment and procedures, Fire extinguishers, First aid kit.

Research Ethics and Intellectual Property

Research and scientific writing ethics, plagiarism, concept of peer-review, conflict of interest, research misconduct. Illustrations of violation of ethical conduct. Introduction to IPR (Patent, trademarks, copyright, trade secrets), Importance of academia-industry interaction, Marketing of research outcome.

Scientific Documentation

Significance of report writing, steps in report writing, Types of report: Decision-oriented (Technical) and Survey-based report. Guidelines for reviewing draft report format, typing instructions, citing references with examples.
Writing a scientific paper; structuring a manuscript, data representation for effective communication. Discussions on Journals relevant to Biomedical research and their paper writing patterns could be discussed.

SUGGESTED READINGS:

1. Research in Education (2005) 10th ed., Best, J.W. and Kahn, J.V., Prentice Hall of India Pvt. Ltd. (ISBN-13: 978-0205458400)

2. At the Bench: A Laboratory Navigator (2005) Barker, K., Cold Spring Harbor Laboratory Press (New York). ISBN: 978-087969708-2.

3. Research Methodology - Methods and Techniques (2004) 2nd ed., Kothari C.R., New Age International Publishers. (ISBN-13 / EAN: 9788122415223)

4. Research Methodology: A Step by Step Guide for Beginners (2010) 3rd ed., Kumar R., Pearson Education. (ISBN-13: 978-1849203012)

5. The Craft of Research (Guides to writing, editing and publishing) (2008), Booth, W.C., Colomb, G.G., Williams, J.M., University of Chicago Press, 2008. (ISBN-13: 978-0226065663)

PHBS-II: Tools And Techniques in Biomedical Research

Spectroscopic techniques and their biomedical application
Absorption Spectroscopy: UV-Vis and IR spectroscopy- Beer's Lambert's Law, Hook's Law, Instrumentation, Application in quantitation of Protein and Nucleic acid samples

Circular Dichroism Spectroscopy- Cotton effect and Basic principle, instrument, Application in elucidation of protein secondary structure

Fluorescence spectroscopy- Principle, Instrument, Stoke's shift, fluorophores- extrinsic and intrinsic, various type of probes, Application in biomolecule quantitation. Basic principle of FRET (Fluorescence Resonance transfer)

NMR - Basic principle, Instrument, Sample preparation, [^{1}H] NMR analysis, troubleshooting **with its biomedical application**

Mass spectroscopic techniques- Basic principle and EI, Instrument, calculate m/z, MALDI-TOF instrument and principle.

Chromatographic techniques: HPLC, FLPC, RPLC, and *Gel chromatography:* protein, DNA and RNA purification and separation by PAGE, SDS PAGE, and Agarose gel electrophoresis, Sample preparation and trouble shooting.

1. **Centrifugation**: Principle and different types of centrifugation- differential, density gradient and equilibrium.

2. **Radioactivity:** Basic principle, various labels and their energy, radioactivity decay, Concentration vs specific activity, biomedical application, biosafety

3. **Microscopic techniques and its biomedical application**: bright field, dark field, phase contrast, confocal, fluorescence, electron microscopy, infrared and ultraviolet microscopy. Sample preparation and trouble-shooting.

4. **Flow cytometry-**Basic Principle, Instrument, Sample preparation and quantitation and trouble-shooting and biomedical application of flow cytometry.

5. **Living organisms as tool for research**
   A. Bacteria: *Handling of bacteria:* laminar flow hoods its principle and SOP, preparation of culture media for bacterial propagation, sterilization and disinfection, identification of contamination and its prevention, bacterial growth curve, transformation, competent cell preparation, disposal of bacterial culture and media.

B. **In-vitro cell culture:** *concept of cell culture:* isolation of cell, maintaining cells in culture medium, cell line contamination and its detection, *manipulation of cell culture*: passage and transfection, sterilization of culture room, disposal of cell culture and media, application of cell culture.

6. **Bio-statistical tools for data analysis**: Introduction to Mean, mode, median, mean deviation, Standard deviation, coefficient of variation. Correlation (Karl Passions, Co-efficient of correlation, Rank correlation) and Regression analysis, taking suitable examples from biological data. Probability: Theorems on probability, Binomial and normal distribution. Methods of Sampling of biological data and analysis using various tests of significance for small and large samples (AVONA and post-hoc analysis).

PHBS-III: Writing a Research Proposal

Under this course, each student will write a project proposal and defend it through presentation. The student will collect the relevant literature, collate the information and write a research proposal with proper incorporation of references using appropriate software like Reference Manager or EndNote or Mendeley on a topic of mutual interest of the mentor.

The student will identify a problem on which he/she would be able to work, identify the scope of research on the chosen topic and will frame the objectives to be addressed in the project through a work plan.

The student will write the standard operating protocols (SOPs) and identify requirement for equipment and reagents. Each student will be required to make a presentation and defend the proposed project including literature available, objective sought and work plan as described above.

PHBS-IV – ADVANCED MODULES (Opt any two)

A. Methods in Enzyme kinetics, Ligand binding and protein Structure

Enzyme kinetics:
Introduction to enzyme catalysis, Michaelis-Menten relations, enzyme assay methods, specific activity estimation, determination of Activation energy, Determination of inhibition mechanisms, Determination of enzymatic parameters (K_m, k_{cat}, V_{max}).

Ligand binding:
Introduction to ligand, concept of stoichiometry of binding, common instruments used to study ligand binding (ITC, SPR and FRET): principle and method of analysis binding curves, Methods for determination of binding constants and other thermodynamic parameters, Determination of number of binding sites

Protein Structure:
Concept of native and denatured state, common tools use to address protein structure (UV-vis, Fluorescence spectroscopy, CD, FTIR, NMR, X-ray etc.) (Principle and applications), Protein denaturation, Different mode and Mechanisms of denaturation, Understanding and analysis of melting curves, Tools commonly use to monitor protein denaturation (Optical methods and DSC) co-solutes and their interaction with native protein

B. Computational and Molecular Modeling Method

1. Basic bioinformatics: Databases, sequences, sequence alignment-pair wise/multiple, global/local protein family, domain, sequence conservation.

2. Basic structural elements of protein and nucleic acids- Primary, secondary and tertiary structures of the proteins and DNA, super secondary structure, hairpin, beta-beta units, beta-alpha unit etc. nucleic acid structures.

3. Analysis of 3D Structures: Adding hydrogens, analyzing H-bonds, analyzing cavities, analysis of atomic contacts etc.

4. Structural modeling and secondary structure prediction: Structure prediction in ID space, *scoring function*: force fields, knowledge based potentials, surface area based function, searching procedures: grid search, *Monte carlo* algorithm, genetic algorithm, *Building*

Models- homology models, fold recognition, Ab initio methods, modeling side chain conformation, rotamer libraries.

5. Molecular docking- Protein-protein docking, protein-ligand docking.

6. Molecular motions: Energy minimization methods and conformational sampling and optimization (grid search, steepest descent, conjugate gradient), molecular dynamics.

7. Drug design- Docking, virtual screening, QSAR, ADMET, drug likeliness etc.

C. Introduction to tools of Genomics Research

1. Generation of disease models for Biomedical Research.
   Transgenic animals, targeted Knock-out and knock-in, Cre-lox and CRSPR-Cas system, Design of knock-down through siRNA/RNAi

2. Assessment of genetic manipulation: example PCR, RT-PCR, qPCR, LAMP

3. Introduction to New Generation Sequencing methods.

4. Transcriptomics: Microarray,RNA-sequencing, exome sequencing, exome Chip,

5. Tools for epigenome analysis: DNA methylation analysis, Chromatin Immuno-precipitation (ChIP), ChIP-sequencing, Approaches to long range interaction in the genome.

D. Introduction to Tools of Proteomics Research

1. Methods of protein analysis: Different types of Gel electrophoresis, substrate gel electrophoresis, ELISA, EMSA, Western Blot.

2. Co-Immunoprecipitation, Yeast Two hybrid: experimental design and strategy, read-outs, and trouble-shooting Applications and its limitations.

3. Proteome analysis: 2D-PAGE, Mass spectroscopy for protein: principle, sample preparation handling and trouble-shooting, Orbitrap Mass analyser.

4. Introduction to software used for proteomics data analyses.

5. Concept of Metabolomics and Lipidomics and their applications.

E. **Techniques in translational Research**

1. Prokaryotic and eukaryotic organisms as model. (OPT ANY ONE)

a) Guide for the selection of appropriate microorganism as model organism-Bacteria, basic maintenance and propagation and storage, methods to identify species by sequencing, disease model based on prokaryotes.

b) Guide for the selection of appropriate eukaryotic organism as model organisms e.g. Yeast, *C. elegans*, Drosophila, Mouse, Rat based disease-models.

c) Mouse and rat as research tools: Animals and their welfare, basic animal handling, breeding and maintenance, understanding of animal behavior, use of anesthesia and analgesia, Euthanasia, Sample size and statistical analysis, administration of drug and animal waste disposal, contamination and infection.

d) Research ethics for animal and human use for experiments: animal and human welfare in research, justification of research, skill of personnel conducting the research, *experimental procedures and its rationale:* choice of biological fluid withdrawal and route of drug administration.

2. **Techniques in translational research (OPT ANY ONE)**

a) **Techniques in physiology:** ECG- basic cardiology and analysis of ECG, General organization of brain-receptors, neuro-transmitters and analysis of EEG, General muscle physiology and EMG analyses.

b) **Techniques in Behavioral pharmacology and toxicology:** Acute toxicity, LD_{50}, ADMET studies, behavioral test for cognition and motor function.

c) **Techniques in Immunology:** ELISA, immunizations, antibody generation in small animals. Techniques to study innate immune responses, use of FACS, MACS, RNAi and real time lime lapse video microscopy to study immune activation/inhibition in 4-dimensions.

F. Essential Paradigm in Medicinal Chemistry Research

1. Basic principles of Medicinal chemistry –Biochemical reactions relating to organic reactions, endogenous ligand and their role in drug design, serendipity in new drug discovery.
2. Concepts in drug targeting: Pathology of diseases e.g. PD, Alzheimer and Cancer, molecular pathways for identification of target for drug design.
3. Strategies for lead discovery-Lead identification and modification: Hammett equation, Hansch postulates and extension of Hansch equation, SAR and QSAR.
4. Ligand based drug discovery: Conventional methods and High Through put screening of the virtual libraries. Structure based drug design- *Classical methods and In-silico tools*.
5. Pharmacophore and the Factors modulating the pharmacophore.
6. Theories of drug and receptor (biomolecule) interactions.
7. Factors influencing drug receptor interactions.
8. Pharmacokinetics and drug metabolism and factors influencing drug metabolism.
9. Modulation of drug like properties of compounds.
10. Measure the binding of agonist and antagonist with receptor and Enzyme kinetics to calculate substrate binding.
11. Example of existing drug and their design strategies: drug acting on receptors and DNA.
12. Methods of Drug Discovery to Improve pharmacokinetic profile.