

**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:** 30<sup>th</sup> June, 2009  
**Course:** M.Sc. in Biomedical Science

**Check List of New Course Evaluation for AC Consideration**

<b>S.No.</b>	<b>Parameters</b>	<b>Status</b>
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.

		<b>Semester – Odd</b>	<b>Semester-Even</b>
<b>Part I</b>	First Year	Semester – I	Semester – II
<b>Part II</b>	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 2<sup>nd</sup> Semester and complete at the end of 4<sup>th</sup> 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	<b>Interdisciplinary</b>	Chemistry
2	MBS 404	Advanced Medicinal Chemistry	<b>Interdisciplinary</b>	Chemistry
3	MBS 405	Radiation Biology	<b>Interdisciplinary</b>	Zoology
4	MBS 406	Topics in Clinical Research		
5	MBS 407	Advanced Toxicology & Pharmacology		
6	MBS 408	Advanced Immunology	<b>Interdisciplinary</b>	Zoology

**SCHEME OF EXAMINATION**

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

**Theory**

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

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, benzyne, 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. 6<sup>th</sup>; Wiley-Interscience; 2007.
- 2 Advanced organic chemistry: Part A: structure and mechanisms by Francis A. Carey and Richard J. Sundberg; Ed. 5<sup>th</sup>; Springer; 2008.
- 3 Asymmetric synthesis: the essentials by Mathias Christmann and Stefan Bräse; Wiley-VCH; 2007.
- 4 Organic chemistry by Thomas N. Sorrell; Ed. 2<sup>nd</sup>; University Science Books, 2005
- 5 Organic chemistry by Robert Thornton Morrison and Robert Neilson Boyd; Ed. 6<sup>th</sup>; Prentice Hall of India; New Delhi; 2002.
- 6 Organic chemistry by T. W. Graham Solomons and Craig B. Fryhle; Ed. 9<sup>th</sup>; Wiley, 2007

# MBS 102: BIOCHEMISTRY

## Structure Of Protein

Secondary and tertiary structure of protein:  $\alpha$  helix,  $\beta$  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  $K_m$ ,  $V_{max}$ , specificity, Michaelis-Menten equation.

Reaction Mechanism: Acid-base catalysis and covalent catalysis (giving examples). Regulation of enzyme activity: Reversible and irreversible inhibition (non-competitive, uncompetitive) and their effects on  $K_m$  and  $V_{max}$ , 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-transcriptional 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 synthesis - 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 prosthetic 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. 25<sup>th</sup>; McGraw-Hill; 2000.



- 2 Biochemistry by Donald Voet and Judith G. Voet; Ed. 3<sup>rd</sup>; Wiley; 2008.
- 3 Lehninger principles of biochemistry by David L. Nelson and Michael M. Cox; Ed. 5<sup>th</sup>; W.H. Freeman, 2004.
- 4 Biochemistry by Christopher K. Mathews and Kensal E. van Holde and Kevin G. Ahern; Ed. 3<sup>rd</sup>; Prentice Hall, 1999.
- 5 Textbook of biochemistry with clinical correlations by Thomas M. Devlin; Ed.6<sup>th</sup>; Wiley-Liss; 2005.
- 6 Biochemistry by Jeremy M. Berg and John L. Tymoczko and Lubert-Stryer; Ed. 6<sup>th</sup>; 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 channels, 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. 5<sup>th</sup>; Garland Science; 2008.
2. Molecular biology of the cell: the problem book by John Wilson and Tim Hunt; Ed. 5<sup>th</sup>; Garland Science; 2008.
3. Molecular cell biology by Harvey Lodish and Arnold Berk, Chris A. Kaiser, and Monty Krieger; Ed. 6<sup>th</sup>; W H Freeman and Company; New York; 2008.
4. Cell: molecular approach by Geoffrey M. Cooper and Robert E. Hausman; Ed. 4<sup>th</sup>; ASM Press; 2007.
5. Cell biology by Thomas D. Pollard and William C. Earnshaw; Ed. 2<sup>nd</sup>; 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. 6<sup>th</sup>; 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. 6<sup>th</sup>; 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. 17<sup>th</sup> 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. 24<sup>th</sup>; McGraw-Hill Medical, 2007.
- 6 Topley and Wilson's Microbiology and Microbial Infections by Leslie Collier and Albert Balows and Max Sussman; Ed. 9<sup>th</sup>; 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 using 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 polymorphisms 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.5<sup>th</sup>; John Wiley & Sons Ltd; 2008.
2. Principles of genetics by Eldon John Gardner and Michael J. Simmons and D. Peter Snustad Ed.8<sup>th</sup>; 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.9<sup>th</sup>; 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.8<sup>th</sup>; Sinauer Associates; 2006.
6. Genes by Benjamin Lewin; Ed.9<sup>th</sup>; 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, phosphodiesteres, 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,  $\text{NAD}^+$  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.6<sup>th</sup>; Wiley-Interscience; 2007.
- 2 Advanced organic chemistry: Part A: structure and mechanisms by Francis A. Carey and Richard J. Sundberg; Ed. 5<sup>th</sup>; Springer; 2008.
- 3 Organic chemistry by Thomas N. Sorrell; Ed.2<sup>nd</sup>; University Science Books, 2005
- 4 Organic chemistry by Robert Thornton Morrison and Robert Neilson Boyd; Ed. 6<sup>th</sup>; Prentice Hall of India; New Delhi; 2002.
- 5 Organic chemistry by T. W. Graham Solomons and Craig B. Fryhle; Ed. 9<sup>th</sup>; Wiley, 2007
- 6 Modern methods of organic synthesis by W. Carruthers and Iain Coldham; Ed. 4<sup>th</sup>; 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.9<sup>th</sup>; Brooks Cole, 2009.
- 8 Biological and Pharmaceutical Nanomaterials: Nanotechnologies for the Life Sciences by Challa S. S. R. Kumar; Ed.1<sup>st</sup>; 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 lysogenic 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, polynucleotide 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.7<sup>th</sup>; Oxford; 2008.
- 2 Molecular cell biology by Harvey Lodish and Arnold Berk, Chris A. Kaiser, and Monty Krieger; Ed.6<sup>th</sup>; W H Freeman and Company; New York; 2008
- 3 Cell: a molecular approach by Geoffrey M. Cooper; Ed.3<sup>rd</sup>; 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; 2<sup>nd</sup> 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; 5<sup>th</sup> Ed.; John Wiley; 2003.
- 4 Biostatistics: a foundation for analysis in the health sciences by Wayne W. Daniel; 8<sup>th</sup> Ed.; John Wiley; 2005.
- 5 John E. Freund's mathematical statistics with application by Irwin Miller and Marylees Miller; Ed.7<sup>th</sup>; Pearson; 2006.
- 6 Essential Mathematical Biology by Nicholas F. Britton; Ed.1<sup>st</sup>; Springer; 2004.
- 7 Differential Calculus by Shanti Narayan ; Ed. 30<sup>th</sup>; 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, Immunoglobulins, Antibody Structure and Function, Antibody Effector Mechanism, Antibody Receptors, Antibody Diversity, Immunoglobulin Gene Recombination, Effect of Somatic Mutations on 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<sub>H</sub>1 and T<sub>H</sub>2 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 IgE, Mast cells, Genetic Allergic Response, Tumors

## **Immune Tolerance**

Self Tolerance, Transplantation and Rejection.

## **Antigen Antibody Interaction**

### **Immunological Techniques**

Haemagglutination, Direct/Indirect Immunofluorescence, 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. 6<sup>th</sup>; 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. 6<sup>th</sup>; Saunders, 2007.
- 3 Immunology; Ed.7<sup>th</sup> 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; 7<sup>th</sup> 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. Secretory 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.11<sup>th</sup>; Saunders; 2005.
- 2 Review of medical physiology by William F. Ganong; Ed. 22<sup>nd</sup>; McGraw Hill; 2005.
- 3 Essential medical physiology by Leonard R. Johnson and Ed. 3<sup>rd</sup>; ELSEVIER; 2003.
- 4 Principles of anatomy and physiology by Gerard J. Tortora and Bryan Derrickson; Ed.1<sup>th</sup>; 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; 12<sup>th</sup>; 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. Adrenal Cortex, Structure and function of its hormones; Adrenal Medullary; 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.11<sup>th</sup>; Saunders; 2005.
- 2 Review of medical physiology by William F. Ganong; Ed. 22<sup>nd</sup>; McGraw Hill; 2005.
- 3 Essential medical physiology by Leonard R. Johnson and Ed. 3<sup>rd</sup>; ELSEVIER; 2003.
- 4 Principles of anatomy and physiology by Gerard J. Tortora and Bryan Derrickson; Ed.1<sup>th</sup>; John Wiley; 2006. With (Brief atlas of the skeleton surface anatomy, and selected medical images) and Best and Taylor's physiological basis of medical practice by John B. West; 12<sup>th</sup>; B I Waverly Pvt. Ltd.; New Delhi; 1990.
- 5 Medical physiology: a cellular and molecular approach by Walter F. Boron and Emile L. Boulpaep; Saunders; 2003.
- 6 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,  $\beta$ -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. 2<sup>nd</sup>; ELSEVIER; 2004.
- 2 Foye's Principles of Medicinal Chemistry by Thomas L Lemke and David A Williams; Ed. 6<sup>th</sup>; Lippincott Williams & Wilkins; 2007.
- 3 Medicinal chemistry: principles and practice by Frank D. King; Ed. 2<sup>nd</sup>; The Royal Society of Chemistry; 2002.
- 4 Introduction to medicinal chemistry by Graham L. Patrick; Ed. 3<sup>rd</sup>; 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. <sup>13</sup>C 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 : <sup>31</sup>P, <sup>19</sup>F, <sup>23</sup>Na, <sup>15</sup>N

## 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, Magnetic Assisted Cell Sorting

## Reading List

- 1 Spectrometric identification of organic compounds by Robert M. Silverstein and Francis X. Webster; Ed. 6<sup>th</sup>; John Wiley; 1997.
- 2 Principles of instrumental analysis by Douglas Skoog and F. James Holler and Timothy A. Nieman; Ed. 5<sup>th</sup>; Saunders; 1998.
- 3 Contemporary instrumental analysis by Kenneth A. Rubinson and Judith F. Rubinson; Prentice Hall 2000.
- 4 Organic spectroscopy by William Kemp; Ed. 3<sup>rd</sup>; Palgrave; 1991.
- 5 Basic one and two dimensional NMR spectroscopy by Horst Friebolin; Ed.3<sup>rd</sup>; Wiley-VCH; 1998.
- 6 NMR and its applications to living systems by David G. Gadian; Ed. 2<sup>nd</sup>; Oxford; 1995.
- 7 Structure determination of organic compounds: tables of spectral data by E. Pretsch and P. Bühlmann and C. Afholter; Springer; 2005.
- 8 MRI principles by Donald G. Mitchell; W S Saunders; 1999.
- 9 HPLC: a practical user's guide; Ed.2<sup>nd</sup> 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 surveillance 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, Neoangiogenesis, 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 T antigen 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. 7<sup>th</sup>; Oxford; 2000.
- 2 Principles of Genetics by Eldon J. Gardner and Michael J. Simmons and D. Peter Snustad; Ed. 8<sup>th</sup>; John Wiley, 2005.
- 3 Molecular cell biology by Harvey Lodish and Arnold Berk, Chris A. Kaiser, and Monty Krieger; Ed. 6<sup>th</sup>; 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;

Absorption, 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, psychopharmacological 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, coagulants and anticoagulants.

## 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: Carcinogenicity, 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, Cholestasis, 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 cardiotoxic 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; 6<sup>th</sup> 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. 11<sup>th</sup>; McGraw-Hill Professional; 2005.
- 3 Pharmacology H. P. Rang and M.M. Dale and J.M. Ritter and P.K. Moore; Ed. 5<sup>th</sup>; 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. 3<sup>rd</sup>; Mosby; 2006.
- 5 Principles of toxicology by Karen E. Stine and Thomas M. Brown; Ed. 2<sup>nd</sup>; CRC Press; 2006.
- 6 Lu's basic toxicology: fundamentals, target organs and risk assessment by Frank C. Lu and Sam Kacew; Ed. 5<sup>th</sup>; Informa Healthcare; 2009.
- 7 Casarett and Dull's toxicology: the basic science of poisons by Curties D. Klaassen; Ed. 7<sup>th</sup>; 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 cerevisiae*: 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](http://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 (Hierarchical 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  $\beta$ - globin gene and sickle cell anaemia. 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](http://www.ncbi.nlm.nih.gov), [www.ensembl.org](http://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. 3<sup>rd</sup>; 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. 4<sup>th</sup>; Springer; 2009.
- 3 Genomics: the science and technology behind the human genome project by Charles R. Cantor and Cassandra L. Smith; Ed. 2<sup>nd</sup>; John Wiley; 2002.
- 4 Genetics: From Genes to Genomes by Leland Hartwell, Leroy Hood, Michael L. Goldberg, and Ann E. Reynolds; Ed. 3<sup>rd</sup>; McGraw Hill Higher Education; 2006.
- 5 Basic human genetic by Elaine Johnson, Mange and Arthur P. Mange; Rastogi Publications; 2005.
- 6 Molecular and Genetic Analysis of Human Traits by Gustavo Maroni; Ed.1<sup>st</sup>; 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. 6<sup>th</sup>; 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,  $\beta$ -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. 2<sup>nd</sup>; 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. 4<sup>th</sup>; 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. 6<sup>th</sup>; 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)

$\beta$ -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-molecules 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. 2<sup>nd</sup>; 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. 3<sup>rd</sup>; Wiley-VCH; 2008.
- 4 Biopharmaceuticals: Biochemistry and Biotechnology by Gary Walsh; Ed. 2<sup>nd</sup>;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 hematopoietic 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. 6<sup>th</sup>; Lippincott; 2005.
- 2 Basic Clinical Radiobiology by G. Gordon Steele; Hodder Arnold Publication; 2002.
- 3 Introduction to Radiobiology by A. Wambersie; Ed. 1<sup>st</sup>; Taylor & Francis; 2007.
- 4 Introduction to Radiobiology by A.H.W. Nias; Ed. 2<sup>nd</sup>; 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, 1<sup>st</sup> Ed., The Johns Hopkins University Press; 1 Edition, 2003.
- 2 The Pharmaceutical Regulatory Process (Drugs and the Pharmaceutical Sciences), Ira R. Berry, 1<sup>st</sup> Ed., Informa HealthCare, 2004.
- 3 Fundamentals of Biostatistics, Bernard Rosner, Duxbury Press; 6<sup>th</sup> Ed., 2005.
- 4 Epidemiology and Biostatistics: An Introduction to Clinical Research, Bryan Kestenbaum, 1<sup>st</sup> Ed., Publisher: Springer, 2009.
- 5 Adaptive Design Methods in Clinical Trials, Shein-Chung Chow, CRC, 2006.
- 6 Introduction to Randomized Controlled Clinical Trials, 2<sup>nd</sup> 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, Pathogenesis 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.6<sup>th</sup>; 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. 6<sup>th</sup>; Saunders; 2007.
- 3 Immunology; Ed.7<sup>th</sup> 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. 7<sup>th</sup>; 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 bioaccumulation, 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, psycho-pharmacological 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 laxatives, 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; 5<sup>th</sup> 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; 9<sup>th</sup> Ed.; 1995.

- 3 Pharmacology H. P. Rang and M.M. Dale and J.M. Ritter and P.K. Moore; Ed.5<sup>th</sup>; 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.2<sup>nd</sup>; CRC Press; 2006
- 6 Lu's basic toxicology: fundamentals, target organs and risk assessment by Frank C. Lu and Sam Kacew; Ed.4<sup>th</sup>; Taylor & Francis; 2002
- 7 Casarett and Dull's toxicology: the basic science of poisons by Curties D. Klaassen; Ed.7<sup>th</sup>; McGraw Hill; New York; 2007
- 8 Toxicology by Hans Marquardt 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 marneffeii*, *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: <sup>1</sup>H and <sup>31</sup>P 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 acetylcholinesterase in rat brain homogenate.



