MB 301: Molecular diagnosis and Molecular pathogenesis

Objective:
Infectious diseases are thriving. In the case of smallpox (and soon polio), the disease can be eliminated from the earth before details of it pathogenesis have been unraveled. Nevertheless, we need to keep studying pathogenesis, because understanding it lends a helping hand to therapy, control of transmission, vaccine development and to the science of immunology. It is no accident that the recent Nobel laureates, Peter Doherty and Rolf Zinkernagel, made their discovery of the MHC restriction of cytotoxic T-cells in the course of studies on the pathogenesis of a virus infection of mice.
It has been said that the gene sequence of a microbe is like the Rosetta stone- impressive to see, but to have value it must be translated. It will be an immense help if we can become better at predicting protein function from sequence and understand the pathogenesis at molecular level. Keeping in mind, therefore, this paper is planned to acknowledge the students regarding molecular pathogenesis, including most of the advanced molecular diagnostic technology.

Unit: 1 Molecular Detection and Identification of microorganisms

1.1 Non amplified nucleic acid probes **Ref: Murray**
1.2 Amplified nucleic acid technique
1.3 Target Amplification technique
1.4 Probe Amplification technique
1.5 Post amplification detection and Analysis
1.6 Current Application

Unit: 2 Molecular pathosgenesis-1 **Ref: MIMS**

2.1 Attachment to and Entry of microorganisms in to the body
2.1.1 Enteropathogenic *E. coli*
2.1.2 *Shigella*
2.2 The encounter with the phagocytic cell
2.2.1 Phagocytosis in polymorhonuclear leucocytes
2.2.2 Phagocytosis in macrophages
2.2.3Growth in the phagocytic cell
2.2.4 Killing the phagocyte
2.2.5Entry into the host cell other than by phagocytosis
2.2.6 Consequences of defects in the phagocytic cell

Unit: 3 Molecular pathogenesis-2 **Ref: MIMS**

3.1The spread of microbes through the body
3.1.1 Direct spread
3.1.2 Microbial factors promoting spread
3.1.3 Spread via lymphatics
3.1.4 Spread via the blood

3.1.5 Spread via other pathways

3.2 Microbial strategies in relation to the immune response

3.2.1 Induction of immunological tolerance

3.2.2 Immunosuppresion

3.2.3 Absence of a suitable target for the immune response

3.2.4 Microbial presence in bodily sites inaccessible to the immune response

3.2.5 Antibodies mopped by soluble microbial antigens

3.2.6 Local interference with immune forces

3.2.7 Antigenic variation

3.2.8 Microorganisms that avoid induction of an immune response

3.3 Mechanisms of tissue and cell damage

3.3.1 Direct damage by microorganisms

3.3.2 Microbial toxins

3.4 Host and Microbial factors Influencing Susceptibility

3.4.1 Genetic Factors in the Microorganisms

3.4.2 Genetic Factors in the Host

Unit: 4 Molecular Plant Pathology

4.1 Host pathogen interaction **Ref: Mehrotra and Agarios**

4.2 Genetics of virulence in pathogens and of resistance in host plant. Horizontal and vertical resistance, Disease Escape **Ref: Agarios**

4.3 Examples of molecular genetics of selected plant diseases Powdery mildew and Rice blast **Ref: Agarios**

4.4 Compatible and incompatible reactions

4.5 Recognition of host and gene for gene concept **Ref: Flor and Agarios**

4.6 Resistance genes of plants, Signal transduction between pathogenicity and resistance genes, Signaling and regulation of programmed cell death **Ref: Agarios**

References:

1. Murray, P. (2003). *Manual of Clinical Microbiology Vol-1*, 8th Ed. ASM Press.

2. Mims, C. A. *et al* (2000).*MIMS' Molecular pathogenesis of Infectious Disease,5th Ed.* Academic Press.

3. Pandey, B. P. (2005) *Plant Pathology: Pathogen and Plant disease,* S. Chand & Company Ltd. New Delhi.

4. Mehrotra, R. S. and Aggarwal, A. (2007) *Plant Pathology*, 2nd Ed., Tata McGraw-Hill Publishing Company Limited New Delhi.

5. Agarios, G. N. (2005). *Plant Pathology*, 5th ed. Elsevier.

6. Flor, H. H. (1971). Current status of the gene-for-gene concept. *Ann. Rev. Phytopath.*, 9:275-296.

7. Mitra, S. (2007). *Genetic Engineering-Principles and Practise*. Macmillan India Ltd, New Delhi.

MB 302: Bioinformatics

Objectives: This paper is mainly for the student who wants to understand the method of sequence and structure analysis. With large number of prokaryotic and eukaryotic genomes completely sequenced, access to the genomic information and synthesizing it for discovery of new knowledge by sequence analysis is the central theme of this paper.

It also consists of intricate details of in silico drug designing, protein structure prediction, protein modeling & molecular phylogeny.

	No. of Lectures.
UNIT 1: Database: *In silico* resource for the information.	11
UNIT 2: Sequence analysis	11
UNIT 3: Structural bioinformatics	12
UNIT 4: Applied Bioinformatics	11

UNIT: 1 DATABASE: IN SILICO RESOURCE FOR THE INFORMATION. Ref: Ghosh

1.1 Biological Database and database design.

1.2 Nucleotide sequence database: EMBL, gene bank, DDBJ

1.3 Protein sequences Database: PIR, Swiss-Prot

1.4 Various file formats for bio-molecular sequences **Ref: BOSU**

1.5 Sequence-based Database Searches: BLAST, PSI-BLAST, RPS-BLAST & FASTA

1.6 Metabolic pathway Database: KEGG

UNIT: 2 SEQUENCE ANALYSIS Ref: Ghosh

2.1 Genome Mapping and Assembling **Ref: Xiong**

2.2 Gene prediction: Introduction and Computational methods of Gene prediction

2.3 Pairwise sequence Alignment: Dynamic programming Algorithm **Ref: Mount**

2.4 Multiple sequence alignments (MSA): **Ref: Mount**

2.4.1 Global Multiple sequence alignments and introduction to CLUSTALW and PileUp

2.4.2 Local Multiple sequence alignments and introduction to BLOCKS, eMOTIF, MEME, GIBBS, HMM

UNIT: 3 STRUCTURAL BIOINFORMATICS **Ref: Ghosh**

3.1 Database of Protein Structure: PDB, MMDB

3.2 Protein structure Classification Databases: CATH, SCOPE

3.3 Secondary structure prediction: Computation methods for secondary structure prediction: Chou Fasman, GOR and Softwares for Secondary structure prediction

3.4 Protein Modeling: methods of Protein Modeling, Homology Modeling; fold recognition and threading approaches, and Ab-initio structure prediction methods

3.5 Protein structure comparison Method: VAST & DALI

3.6 RNA Structure Prediction: Introduction; Types of RNA Structures; RNA Secondary Structure Prediction Methods; Ab Initio Approach; Comparative Approach**.** **Ref: Xiong**

UNIT: 4 APPLIED BIOINFORMATICS **Ref: Ghosh**

4.1 Phylogeny: Statistical methods of the obtained phylogenetic tree, Software for phylogenetic analysis

4.2 Functional Genomics: Sequence-Based Approaches ; Microarray-Based Approaches ; Comparison of SAGE and DNA Microarrays **Ref: Xiong**

4.3 Molecular Interaction and Docking, Simulation Techniques,Softwares for Structure based drug design and molecular doaking, Autodock and Drug Bank

References:

1. Xiong, J. (2006). Essential Bioinformatics. Cambridge University Press, Sao Paulo.
2. Ghosh Z. and Mallik B. (2008). Bioinformatics- Principle and Application. Oxford University Press, New Delhi.
3. Bosu O. and Thukral S.(2008). Bioinformatics: Databases, Tools and Algorithms. Oxford University Press, New Delhi.
4. Mount D. (2005). Bioinformatics Sequences and Genome Analysis.2nd Edition CBS Publishers.
5. Shanmughael P. and Wadhwa G. (2009). Practicals in Bioinformatics.Pointer Publishers, Jaipur.

MB 303: Bioanalytical Techniques and Instrumentation

Objective: The objective of the course is to introduce the students to the concepts of physical principles of detection and measurement systems. Emphasis will also be given to understand the principles of major experimental techniques applied to understand these physical problems. The course will cover theoretical aspects and applications of modern analytical techniques in Modern Biology.

	No. of Lectures
UNIT 1: Basic principles and fundamentals of instrumentation	08
UNIT 2: Chromatographic and centrifugation techniques	13
UNIT 3: Spectroscopy and x ray diffraction techniques	14
UNIT 4: Electrophoretic techniques	10

Unit 1: Basic principles and fundamentals of instrumentation

1.1 Units of measurement: SI unit system, Molarity, Molality, Normality and percent solution, Interconversion of units. **Ref. Wilson and Walker**

1.2 Elements of analytical instruments, test sample and selection of analytical method, Errors in chemical analysis, accuracy and precision, significant figures, Instrument calibration technique. **Ref. Khandpur**

1.3 Biosensor: Principle and components, Types, Glucose biosensor, Urea electrode. **Ref. Khandpur**

1.4 Radiolabeling techniques: Nature of radioactivity, their detection and measurement, application of radioisotopes in Biology. **Ref. Wilson and Walker**

Unit 2: Chromatographic and centrifugation techniques

2.1 Principles of chromatography, Techniques used in chromatography, Retention time, Dead time, Capacity factor, Distribution constant, phase ratio, Theoretical plates, peak broadening, Sample preparation, Instrumentation of Gas –Liquid chromatography. **Ref. Khandpur**

2.2 Liquid chromatography: Partition chromatography, Thin layer chromatography, Column Chromatography: Adsorption chromatography, Gel permeation chromatography, Ion exchange chromatography, HPLC, LPLC. **Ref. Wilson and Walker**

2.3 Centrifugation: Basic principles, sedimentation, Concept of RCF and RPM, Preparative and analytical centrifugation, practical applications, Types, care and safety aspects of centrifuges. **Ref. Wilson and Walker**

Unit 3: Spectroscopic and X-ray diffraction techniques

3.1 Introduction: Electromagnetic radiation, Interaction of radiation with matter, Beer-Lambert's law, single beam and double beam photometers. **Ref. Khandpur**
Principles, Instrumentation and applications of UV-VIS spectroscopy, Infrared spectroscopy, Spectrofluorimetry. **Ref. Wilson and Walker**

3.2 Principles, Instrumentation and applications of NMR and ESR spectroscopy.

Ref. Wilson and Walker

3.3 Mass spectrometric technique: Introduction, components, ionization, Mass analysers (Quadrupole, ion trap and MALDI TOF), Tandem mass spectrometry, LASER

Ref. Wilson and Walker

3.4 X Ray Diffraction: Bragg's Law, Diffraction of X-rays

Ref. Shrama

Unit 4: Electrophoretic Techniques

Ref. Wilson and Walker

4.1 General principles, support media, paper electrophoresis, Electrophoretic apparatus.

4.2 Electrophoresis of proteins: SDS-PAGE, Native and gradient gel, Isoelectric Focusing, Two dimentional electrophoresis, Detection, estimation and recovery of proteins from gels, Western blotting

4.3 Electrophoresis of nucleic acids: Agarose gel electrophoresis, Pulse field gel electrophoresis, capillary electrophoresis.

References:

1) Wilson K and Walker J: *Principles and Techniques of Biochemistry and Molecular Biology*. Cambrige University Press (Low price edition), New York, 6th ed.

2) Khandpur R S (2008): *Handbook of analytical instruments*. Tata McGraw-Hill Publishing Company Limited (New Delhi), 2nd ed.

3) Khopkar S M (2008): *Basic concepts of Analytical Chemistry*. New age international publishers (New Delhi), 3rd ed.

4) Sharma B K (2005): *Instrumental methods of chemical analysis*. GOEL publishing house, Meerut, 24th ed.

MB 304: BIOSTATISTICS, RESEARCH METHODOLOGY AND IPR

Objective:

The overall aim of the course is to deepen knowledge regarding basic concepts of Biostatistics, the research process in occupational therapy from formulating a problem to presenting a proposal for a research project and IPR techniques.
Introduction to Biostatistics will teach the students to organize and summarize data and there by the idea how to reach decisions about a large body of data by examining only a small part of it.
Study of Research Methodology in this section of the course is to deepen knowledge and understanding of how to use a quantitative approach and quantitative research methods in occupational therapy research. Course content includes the research process in quantitative studies, formulating quantitative research questions relating to occupational therapy, statistics, and single case-methodology.
One of the most important issues, which has been raised due to the emergence of modern biotechnology, is the legal characterization and treatment of trade related biotechnological processes and products, is described as Intellectual Property, which definitely helpful for the students related to their research work.

	No. of Lectures.
UNIT 1: Introduction to Biostatistics.	10
UNIT: 2 Chi square test	10
UNIT: 3 Research methodology	14
UNIT: 4 Intellectual Property Rights (IPRs)	10

. **Unit 1: Introduction to Biostatistics**

1.1 Introduction to Biostatistics **Ref: Arora**
- 1.1.1 Definition of statistics and biostatistics
- 1.1.2 Development of biostatistics
- 1.1.3 Applications and role of biostatistics

1.2 Sources and Presentation of Data **Ref: Gurumani**
- 1.2.1 Types of data and Collection of data
- 1.2.2 Classification and tabulation
- 1.2.3 Diagram and Graph
- 1.2.4 Frequency distributions of data .

1.3 Sampling **Ref: Sundar Rao**
- 1.3.1 Introduction and Definition
- 1.3.2 Types of population
- 1.3.3 Sample, sampling variation and Bias
- 1.3.4 Listing of population and sample size

1.4 Measures of central Tendency: **Ref: Sundar Rao**
- 1.4.1 Mean, Median and Mode
- 1.4.2 Position of averages
- 1.4.3 Selection of the appropriate measure of central Tendency

1.4.4 Geometric mean and Harmonic mean

Unit: 2 Chi-Square Test **Ref: Sundar Rao**

2.1 The formula for Chi-Square Test
- 2.1.1 Distribution of Chi-Square Test and degree of freedom
- 2.1.2 Application of Chi-Square Test
- 2.1.3 Misuse of Chi-Square Test

2.2 Student t-test **Ref: Gurumani**
- 2.2.1 Introduction
- 2.2.2 Student's t-Distribution
- 2.2.3 Application of t-Distribution

2.3 Analysis of Variance (ANOVA) **Ref: Gurumani**
- 2.3.1 Principle of Anova
- 2.3.2 Partitioning of Anova
- 2.3.3 Comparison of pairs of Means
- 2.3.4 Assumption Underlying Anova
- 2.3.5 Application of Anova

Unit:3 Research Methodology

3.1 Introduction to Research Methodology **Ref: Dr. Ranjit Kumar**
- 3.1.1 Applications of research
- 3.1.2 Definitions and Characteristics of Research
- 3.1.3 Types of Research

3.2 Formatting a Research Problem
- 3.2.1 Reviewing the literature
- 3.2.2 Formulating a research problem
- 3.2.3 Identifying variables &Constructing Hypothesis

3.3 Conceptualizing a Research Design
- 3.3.1 The Research Design
- 3.3.2 Selecting a study Design & a method for Data Collection
- 3.3.3 Selecting a Sample

3.4 Writing a Research Proposal
- 3.4.1 Collecting, Processing Data
- 3.4.2 Developing a Frame of Analysis
- 3.4.3 Analysis & Displaying Data

3.5 Writing a Research Paper

Unit:4 Intellectual Property Rights (IPR) **Ref: Gupta**

4.1 IPR: Patents, trade secrets, copyright, and trademarks

4.2 Choice of intellectual property protection
- 4.2.1 IPR & Plant genetic Resources: GATT and TRIPs.

4.3 Patenting of Biological Material
- 4.3.1 International Conventions
- 4.3.2 International Cooperation

4.3.4 Obligations with Patent applications
4.3.5 Implications of patenting
4.4 Patenting genes and DNA sequences
4.4.1 Plant breeder's right (PBRs) and Farmer's right

References:

1. Arora, P. N. (2007). *Biostatistics*. Himalaya Publishing House.

2. Sundar Rao, P. S. S. (2006). *Introduction to Biostatistics and Research Methods*. 4th Edition. Prentice-Hall of India Private Limited, New Delhi.

3. Gurumani, N. (2005). *An Introduction to Biostastistics*. 2nd Edition. MJP Publishers, Chennai.

4. Kumar, R. (2005). *A Step-by-step Guide for Beginners*. Sage Publications.

5. Gupta, P. K. (2005). *Elements of Biotechnology*, Rastogi Publications.

M.Sc. MICROBIOLOGY PRACTICALS

SEMESTER 3

1 Internet Gene Bank Search
2 BLAST and FASTA analysis
3 Multiple sequences alignment analysis by CLUSTAL W
4 Computer assisted oligonucleotide primer designing.
5 Rasmol application
6 Protein Secondary structure prediction
7 Homology modeling
8 Separation of sugars and amino acid mixture by paper and thin layer chromatography.
9 Extraction of lipids from tissues and their separation using TLC.
10 Fractionation of egg proteins and quantification by SDS-PAGE.
11 Sucrose density gradient centrifugation for cell fractionation.
12 Isolation of casein from milk by isoelectric precipitation and its quantification by dry weight estimation.