**P.G. 1st Semester**

**Paper: MBB801C (Core)**
**Immunology**
**Credits: 4 = 3+1+0 (48 Lectures)**

**Unit 1: Immunology-Basic concepts and anatomy of the immune system**
Components of innate and acquired immunity; Phagocytosis, inflammation, Molecules, cells and organs of the immune system: Lymphoid cells, Mononuclear phagocytes, Granulocytic cells; Primary Lymphoid Organ, Secondary Lymphoid Organ, Mucosa-associated lymphoid tissues

**8 Hours**

**Unit 2: Antigens and antigen recognition**
Antigens, immunogen, hapten, adjuvants, epitopes, major histocompatibility complex antigens-MHC genes, HLA typing. Non self recognition by the innate system; pattern recognition receptors, toll like receptors, B cell recognition of antigen, T cell recognition of antigen.

**4 Hours**

**Unit 3: Immune response mechanism**
B-cell generation, activation and differentiation; T-cell maturation; activation and differentiation; antigen processing and presentation- antigen presentation; antigen processing pathways-cytosolic and endocytic pathway. Acute inflammatory response, cytokines families and functions, therapeutic use; cell mediated immune response- subsets of CD4+ effector T cells and their functions; antibody dependent cellular cytotoxicity (ADCC); opsonisation.

**9 Hours**

**Unit 4: Immunoglobulin and antigen antibody interaction**
Basic structure of immunoglobulins; classes and subclasses; generation of antibody diversity, antigen-antibody reactions-precipitation, agglutination, complement fixation.

**4 Hours**

**Unit 5: Complement system**
Activation of complement system; alternative and classical pathway, functions, regulation of complement system.

**2 Hours**

**Unit 6: Immunotechnology**
Immunoassay using labelled reagents (RIA, solid phase radio immunoassay, ELISA), western blotting; Immuno histochemistry; cytokine immunoassays; monoclonal antibodies-production and applications.

**4 Hours**

**Unit 7: Immunization and immunodeficiency diseases**
Active and passive immunization; vaccines; whole organism, live attenuated, subunit, purified macromolecules, inactivated exotoxins, capsular polysaccharides and recombinant microbial antigens, recombinant-vector vaccines; DNA vaccines; immunodeficiency disease-primary immunodeficiencies, acquired or secondary immunodeficiencies.

**7 Hours**

**Unit 8: Clinical immunology**

Hypersensitivity- type I, type II, type III and type IV; autoimmunity-types of auto immune diseases, mechanism and role of CD4+ T cells; MHC and TCR in autoimmunity; treatment of autoimmune diseases; immunological basis of graft rejection, clinical transplantation and immunosuppressive therapy, cancer immunotherapy, reproductive immunology-Th1, Th2 shift. tumour antigens, immune responses to tumours, cytokine and cellular immunotherapy of tumours, immunotherapy of tumours with antibodies, tumour vaccines.

**10 Hours**

**Suggested Readings**


1. Kindt. T. J., Goldsby, R. A., Osborne, B. A. and Kuby, J. Immunology. W. H. Freeman, 2007.
2. Roitt. I. V. and Delves, P. J. Essential Immunology. 10th Ed, Blackwell Publishing Company, 2004.
3. Abbas. A. K., Lichtman. A. H. and Pillai, S. Cellular and Molecular Immunology. Elsevier. 8th Ed, 2015.
4. Shetty, N. Immunology: Introductory text book. 2nd Ed, New Age International Publishers, India.
5. Owen. J., Punt J. and Stranford. S. Kuby Immunology. 7th Ed, W. H. Freeman, 2013.


## Paper: MBB802C (Core)
## Bioinformatics and Biostatistics
## Credits: 4 = 3+1+0 (48 Lectures)

**Unit 1:**

Introduction to Bioinformatics; Biological databases (protein and nucleic acid); Sequence data formats; Conversion of sequence formats; Sequence submission to databases; Sequence flatfile format; Exploring resources at NCBI; Data searching engine and retrieval tools; Basics of programming. **4 Hours**

**Unit 2:**

Sequence alignment and similarity search- sequence identity, sequence similarity and sequence homology, global alignment, local alignment, pairwise alignment, multiple alignment, Basics of alignment algorithm, introduction of scoring matrices, alignment score, Basic local alignment search tool (BLAST); sequence assembly; Gene prediction methods; Functional annotation of genes; Computational tools for gene expression analysis; Comparative genome analysis. Tools used for solving basic biological problems (Restriction map and Site directed mutagenesis). **12 Hours**

**Unit 3:**

Introduction to computer, hardware and software; Basics of operating system and their use in Bioinformatics; Computational infrastructure for bioinformatics; Types of operating systems-Introduction to LINUX and basic commands, Windows operating system; Introduction to PERL. **3 Hours**

**Unit 4:**
Molecular phylogeny-Molecular evolution, phylogenetic tress, types of trees, phylogenetic analysis, tree building methods, software for phylogenetic analysis.

**3 Hours**

**Unit 5:**
Protein modeling and Drug design- protein Secondary structure prediction, visualisation of molecular structures- RasMol and Pymol; Fold Recognition; Ramachandran plot, Transmembrane topology prediction; Protein modelling methods-Homology modelling, *Ab initio/Denovo* methods; Drug discovery process; Techniques in drug design; Molecular docking. **8 Hours**

**Unit 6:**
Terms and symbols used in Biostatistics; Sample and sampling methods; Data collection and representation-collection, classification and tabulation of data, graphic and diagrammatic representation of data.

**4 Hours**

**Unit 7:**
Measure of central tendency and dispersion-Types of measure of central tendency-mean, mode, median; Measure of dispersion- range, mean deviation, standard deviation, variance; Test of significance-Null hypothesis, Alternative hypothesis, Hypothesis testing, Z-test, T-test, ANOVA; Chi-Square test; Probability distribution-Binomial, Poisson and Normal; Introduction to correlation and regression.

**11 Hours**

**Unit 8:**
Introduction to Statistical software packages and application; Microsoft Excel for basic statistical analysis; Statistical Package for the Social Sciences (SPSS); XLSTAT; Numerical Taxonomy and Multivariate Analysis System (NTSYS).

**3 Hours**

**Suggested Readings**


1. Campbell and Heyer, Discovering Genomics, Proteomics, and Bioinformatics. 2nd Ed, Benjamin Cummings, 2002.
2. Cynthia. G. and Per. J., Developing Bioinformatics Computer Skill. 1st Edition, O'Reilly Publication, 2001
3. Baxevanis. A.D. and Ovellette B. F. F. Bioinformatics: A practical guide to the analysis of genes and proteins. Wiley-Interscience, 2002.
4. Prem S. M., Introductory Statistics. Latest Ed, Wiley..
5. John. A. R., Mathematical Statistics and Data Analysis. 3rd Ed, Duxbury Press, 2007.
6. Xiong, J. Essential Bioinformatics, 1st Edition, Cambridge University Press, 2006.

**Paper: MBB803C (Core)**
**Genetic Engineering**
**Credits: 4 = 3+1+0 (48 Lectures)**

**Unit 1: Tools and techniques in Genetic Engineering**
Restriction Endonuclease-Nomenclature, restriction mapping, type I to IV; Isoschizomers and Neoschizomers; Start Activity; DNA ligase; DNA modifying enzymes-Nucleases, DNA Polymerases, alkaline phosphatase, polynucleotide kinase, and terminal transferase; Labeling of DNA-End labelling, Nick translation, Random priming, Radioactive and non-radioactive techniques; Northern, Southern and Colony hybridization**.**

**10 Hours**

**Unit 2: Polymerase chain reaction and application**
Polymerase Chain reaction (PCR); Primer design; PCR types-multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, Long-distance PCR (LD-PCR), RACE; PCR based methods for site-directed mutagenesis; Mutation detection methods-Single Strand Conformation Polymorphism (SSCP), Denaturing Gradient Gel Electrophoresis (DGGE).

**11 Hours**

**Unit 3: Vectors**
Cloning vectors-plasmid vectors, phage vectors, cosmids, YACs, BACs, PACs, BIBACs, Plant transformation vectors (Ti and Ri plasmids), Protein expression vectors; Protein expression and purification; Animal Virus derived vectors-SV-40, vaccinia/bacculo and retroviral vectors; Host cells for cloning.

**10 Hours**

**Unit 4: Cloning strategies**
Transformation and Transfection; Construction of genomic and cDNA libraries; Jumping and hopping libraries; Phage display; cDNA and genomic cloning; Expression cloning; Yeast two hybrid system; Selection and screening of transformants- marker and reporter genes, positive and negative selection, insertion inactivation, alpha complementation; Cloning strategies for PCR product cloning.

**10 Hours**

**Unit 5: Nucleic acid sequencing methodologies:**
Sanger's method of DNA sequencing; Automated DNA sequencing by capillary electrophoresis; Dye chemistries and sequencing platforms; Interpretation of Electropherogram; Next Generation sequencing technologies and Single molecule sequencing.

**7 Hours**

**Suggested Readings**

1. Primrose. S. B. Twyman. R.M. and Old. R.W., Principles of Gene Manipulation. 7th Ed, Blackwell, 2006.
2. Brown. T. A, Genomes 3. 3rd ed. Garland Science, 2007.
3. Brown. T. A, Gene Cloning and DNA Analysis: An Introduction, 7th Ed, 2016
4. Desmonf. S and Nicholl T, An introduction to Genetic Engineering, 3rd Ed., Cambridge University Press.
5. Kingsman. S.M and Kingsman A . J, Genetic Engineering, An Introduction to gene analysis and exploitation in eukaryotes, , Blackwell Scientific Publications, Oxford, 1998

6. Primrose. S. B. and Twyman. R.M, Principles of Gene Manipulation and Genomics. Wiley Blackwell, 7th Ed., 2007.
7. Watson. J. D., Gilman M., Witkowski, J and Zoller. M. Recombinant DNA Technology. 2nd Ed, Scientific American Books, 1992.
8. Sambrook . J, and Russel. D.W., Molecular Cloning: A Laboratory Manual, Vols 1-3, 3rd Ed, Cold Spring Harbour Laboratory, 2001.

**Paper: MBB802C (Core)**
**Genomics and Proteomics**
**Credits: 4 = 3+1+0 (48 Lectures)**

**Unit 1: Basics of genomics and proteomics**
Prokaryotic and Eukaryotic genome organization, Extra-chromosomal DNA: mitochondria, Chloroplast, bacterial plasmids.

**5 Hours**

**Unit 2: Genome mapping and sequencing**
Genetic and physical maps; markers for genetic mapping- AFLP, SSLP, SSR, SNPs; Linkage and Pedigree analysis in genome mapping; Techniques for physical mapping- restriction mapping, Fluorescence *in situ* Hybridization (FISH), sequence tagged sites (STS). Sequencing and analyzing genome – Sequencing strategies for the systematic sequencing of complex genomes, sequence assembly and analysis, gene location in genome sequence and gene function prediction.

**8 Hours**

**Unit 3: Genome sequencing projects**
Microbes, plants and animals, Accessing and retrieving genome project information from web, Human Genome Project.

**4 Hours**

**Unit 4: Comparative genomics**
Identification and classification of organisms using molecular markers-16S rRNA typing/sequencing, SNPs. Use of genomes to understand the evolution of eukaryotes, to track emerging diseases, to design new types of antibiotics and new class of medication, gene location in genome sequence.

**5 Hours**

**Unit 5: Proteomics**
Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing), 2-D electrophoresis of proteins, isoelectric focusing, Peptide fingerprinting, LC/MS-MS for identification of proteins and modified proteins, MALDI-TOF, PAGE and Differential display proteomics, Protein-protein interactions such as Yeast two hybrid system, Analytical ultracentrifuge and SPR methodologies.

**10 Hours**

**Unit 6: Functional genomics and proteomics**
Cloning systems used in genomics-cosmids, P1 bacteriophage, BAC and YAC cloning vectors, Isolation of High molecular weight DNA and separation of chromosomes by PFGE, Transcriptome analysis for identification and functional annotation of gene, Contig assembly, Chromosome walking and map-based cloning, Mining functional genes in the genome, Gene function-forward and revere genetics, Gene tagging strategies and application. ESTs and its

utility in genomics, Differential gene profiling methods, reverse transcription PCR, Real time PCR, Protein and peptide microarray-based technology.

**12 Hours**

**Unit 7: Application of genomics and proteomics**

Genomics application: Genomics in Biopharmaceutical Industry, pharmacokinetics, Chemoinformatics, New Pathogen Discovery and Microbial Typing, Gene Therapy, drug discovery and development, toxicology .

Proteomics applications: Understanding the mechanism of pathogenesis, Drug discovery, Disease diagnosis, identification and characterization of novel proteins, Proteomics in plant genetics and breeding.

**4 Hours**

**Suggested Readings**


1. Voet D, Voet J.G and Pratt CW, Fundamentals of Biochemistry, 2nd ed. Wiley, 2006.
2. Brown T.A, Genomes, 3rd Edition. Garland Science, 2006.
3. Primrose S and Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
4. Liebler, Daniel C, Introduction to proteomics- tools for the new biology, Humana Press, Totowa, NJ, 2002.


**Paper: MBB805L (Lab)**

**Lab 2**

**Credits: 4 = 0+0+4**

**List of practical**

1. Procedure for submission of DNA sequences to public database.
2. Phylogenetic tree construction using MEGA.
3. ORF finding from a gene sequence.
4. Functional annotation of genes using online tools
5. Homology searching using BLAST.
6. PCR primer designing using online tools.
7. Protein structure prediction through homology-modeling.
8. Competent cell preparation and cloning in E coli.
9. Demonstration of DNA insert in the recombinants by Polymerase Chain Reaction
10. SDS-PAGE for protein analysis
11. Data presentation (tables/figures): 1-D and 2-D bar charts, pie diagrams, graphs (using computer software packages).
12. Calculation of mean, mode, and median, standard deviation and standard error.
13. Application of statistical software package.
14. Experiment on agglutination and radial immunodiffusion for testing the antigen antibody reaction.
15. Demonstration of Enzyme Linked Immunosorbent Assay (ELISA) technique.
16. Experiment on raising antisera in animal model to understand the mechanism of immune response.