PANJAB UNIVERSITY CHANDIGARH- 160 014 (INDIA)
(Estted. under the Panjab University Act VII of 1947-enacted by the Govt. of India)

FACULTY OF SCIENCE

SYLLABI

FOR

M.SC. HUMAN GENOMICS (SEMESTER SYSTEM)
EXAMINATIONS 2014-2015

--:O:--
M.Sc. in Human Genomics

Following is the syllabus for two years M.Sc. (Human Genomics) course work.

Each theory paper will have four units. Each unit will comprise of tentatively ten lectures.

First Semester

MHG 101: Foundation Course
MHG 102: Immunology and Cell Biology
MHG 103: Genetics and Cytogenetics
MHG 104: Analytical Techniques
MHG 105: Lab course-I
MHG 106: Lab course-II

Second Semester

MHG 201: Biomolecular Structure and Bioinformatics-I
MHG 202: Molecular Biology
MHG 203: Human Molecular Genetics-I
MHG 204: Genetic Engineering and Molecular Biology Techniques
MHG 205: Lab course-I
MHG 206: Lab course-II

Third Semester

MHG 301: Human Molecular Genetics-II
MHG 302: Frontiers in Genomics and Proteomics
MHG 303: Biomolecular Structure and Bioinformatics-II
MHG 304: Gene Regulation and Evolution
MHG 305: Lab course-I
MHG 306: Lab course-II

Fourth Semester

MHG 401: Advance Course in Genomics
MHG 402: Project Work and Presentation
MHG 403: Clinical Round & Viva
MHG 404: Educational Tour & Journal Club
**Scheme of Examination:**

### First Semester

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Instructions to the Paper Setters:

Set nine questions in all. Q. No. 1 will comprise of short answer type questions covering the entire syllabus. There must be two questions from each unit and one has to be attempted. All questions carry equal marks. The theory paper will be of 80 marks and time duration will be three hours.

Instructions to the candidates:

Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.
Semester-I

Paper I (MHG 101): Basic Foundation Course

Instructions to the candidates:

Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

Unit I: Biostatistics
Introduction to Biostatistics, Measures of Central Tendency, Standard Deviation, Skewness, Elementary Probability Theory, Binomial and Normal Distribution, Statistical Decision theory, Test of Significance, Correlation and Regression, Analysis of Variance, Bayesian methods in Biological sequence Analysis.

Unit II: Biomembrane Organization & Transport
Evolution of membrane, composition of membrane, membrane fluidity and regulation of membrane fluidity, structural and functional asymmetry of membrane; Membrane bound proteins - structure, properties and function; case study of potassium channel, calcium ATPase, MDR proteins, porins; transport phenomena; transport of small molecules across cell membranes, active and passive transport, lactose permease, channels, junctions.

Unit III: Metabolism
Primary concept and design of metabolism; transformation of energy in a cell; concept of metabolic pathways; organic reaction mechanisms; thermodynamics of phosphate compounds; oxidation-reduction reactions; integration of metabolic pathways.

Unit IV: Enzyme Kinetics
Kinetics of enzyme action: steady-state kinetics, M-M equation, reciprocal plots; theories of enzyme catalysis; examples of enzyme mechanism, NMP kinases, chymotrypsin; regulation of enzyme activity: enzyme inhibition reversible and irreversible; allosteric regulation: models of allostery, Aspartate trans carbamoylase as a case study.

Recommended Books
Paper II (MHG 102): Immunology and Cell Biology

Instructions to the candidates:
Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

Unit I: Basic Immunology
Types of immunity, Cells & Organs of immune system, Antibody structure and function, Antigen-Antibody interactions, T & B- Cell maturation and activation, Complement System.

Unit II: Immunogenetics
Organization of Ig genes, Means of diversification, Expression of Ig genes; MHC class I & II structure, Peptide interaction, detailed genomic maps of MHC genes; Immunodeficiency (Primary & secondary), Auto immunity (central, peripheral tolerance), Antigen sequestration, Organ specific autoimmunity, Systemic Autoimmunity.

Unit III: Cell Biology
Cell communication, Intracellular receptor I and cell surface receptors, Signaling via G-protein linked receptors (PKA, PKC, CaM kinase), Enzyme linked receptor signaling pathways, Network and cross-talk between different signal mechanisms, Programmed & Non programmed Cell Death.

Unit IV: Model Genetic Systems
Drosophila as a model tool for studying genetics, Polytene chromosomes and studying gene expression at the cytological level, P-element mediated mutagenesis, Life cycles and advantages of organisms commonly used in genetic studies: T4 and λ phages, Neurospora, E.coli, Saccharomyces cerevisiae and Schizosaccharomyces pombe, Caenorhabditis, Drosophila, Zebra fish, Mouse, Conventions of nomenclature of genes and gene products in different model systems.

Recommended Books
12. Journal of Molecular and General Genetics (Journal)
Paper III (MHG 103): Genetics and Cytogenetics

Instructions to the candidates:
Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

Unit I- Basic Genetics
Mendelian Genetics (Laws of Inheritance, Monogenic Traits, Polygenic Traits) Deviation from Mendelian Genetics (Gene Interactions), Mendelian inheritance patterns (Autosomal and X-linked dominant & recessive; Y-linked), Complications to Mendelian inheritance (Pseudodominance, Penetrance, Late onset of character, Variable expression, Anticipation, Imprinting, Mosaicism, Chimerism, X-inactivation and Male lethality)

Unit II- Population Genetics
Alleles, Genotypes and Haplotypes, Hardy-Weinberg distribution and departures from H-W relationship (Inbreeding, Genetic drift, Selection, founder effect), Factors affecting allele frequency; Linkage & Recombinations, Genetics of multifactorial characters (Quantitative model, polygenic theory & hidden assumptions, Heritability measures, Threshold model for dichotomous characters, Empiric risks)

Unit III- Chromosome Structure & Function
Chrom. Structure (primary & higher order), Centromere and kinetochore, Telomere and its maintenance, Chromosomal domains (matrix, loop domains) and their functional significance, Heterochromatin and euchromatin, boundary elements; Chromosomal analysis (banding, painting and karyotyping), Chromosomal Anomalies (Numerical anomalies, Structural anomalies, Robertsonian translocations).

Unit IV: Developmental Genetics
Genotype – phenotype relationship – and overview

Recommended Books
4. Wilson, G.N., Clinic Genetics, Willy-Liss, 2000
Paper IV (MHG 104): Analytical Techniques

Instructions to the candidates:
Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

Unit I: Chromatographic & Electrophoretic Techniques
Chromatographic methods for macromolecule separation –theoretical basis of chromatography, partition coefficient; Gel permeation chromatography, Ion exchange chromatography, Hydrophobic interaction chromatography, Reverse-phase chromatography, HPLC and Affinity chromatography. Theory of Polyacrylamide and Agarose gel electrophoresis; sequencing gels, SDS-PAGE, Native PAGE.

Unit II: Spectroscopy and Centrifugation
Fundamental aspects of spectroscopy: electronic transitions, vibrational and rotational transitions; Theory and application of UV and Visible Spectroscopy: Beer-lambert’s law, chromophores, intrinsic and extrinsic, difference spectroscopy, solvent perturbation effects. Fluorescence: basic principle; and distinction from absorption, intrinsic and extrinsic fluor, applications; basic theory of Circular Dichroism; applications of CD, Centrifugation: basic theory (RCF, Sedimentation coefficient); applications; Radioisotopes and their use in biology.

Unit III: Microscopy, Culture & Histochemical techniques
Cell and tissue culture, Imaging Techniques: Light and phase contrast microscopy, fluorescent microscopy, Electron microscopy (TEM and SEM), Confocal microscopy, Flowcytometry (FACS), Histochemical and Immuno-histochemical methods, mammalian chromosome preparations and karyotyping, Cytogenetics and in situ hybridization, LASER capture methodology.

Unit IV: Molecular tools and their Applications
Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR (multiplex, nested, reverse transcriptase, Real time PCR, Touchdown PCR, hot start PCR, colony PCR), cloning of PCR products; T-vectors; Proof reading enzymes; Site specific mutagenesis; PCR in molecular diagnostics; PCR based mutagenesis.

Recommended Books
SEMESTER- II

Paper I (MHG 201): Biomolecular Structure and Bioinformatics-I

Instructions to the candidates:
Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

Unit I: Molecular interactions
Non covalent interactions: electrostatic interactions, hydrophobic interaction, hydrophobicity scales, hydropathy; Van der Waals interaction: dipole-dipole, dipole induced dipole etc; Hydrogen bond, LBHB and HBHB; steric repulsion; standard states in biology, distance dependency of interactions.

Unit II: Structure of Nucleic Acids
Configuration and conformation of monomer constituents, structural hierarchy of DNA, double helix; features and characteristics, A, B, Z DNA; secondary structure and structure polymorphism of DNA, classification and structures of RNA, secondary structure of RNA, RNA folds, and structural motifs, tertiary structure of RNA.

Unit III: Protein Structure and folding

Unit IV: Introduction to bioinformatics
Data acquisition (sequence information, structural information, gene expression data, data from Proteome analysis); databases (nucleic acid sequence databases, protein sequence database, structural databases, proteomic databases); introduction to NCBI, ENTREZ, SRS, EXPASY ; Introduction to sequence alignment: concept of homology, significance of pairwise sequence alignment, dot plot, scoring schemes, concept of local and global alignment, concept of matrix (PAM).

Recommended Books
Paper II (MHG 202): Molecular Biology

Instructions to the candidates:
Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

Unit I: Replication
DNA polymerases, DNA proof reading, Nick translation, Priming and DNA synthesis, Coordination of leading and lagging strand synthesis, Repair synthesis, Interallelic recombination and gene conversion, Topological configuration of DNA and topoisomerases, DNA Replication in prokaryotes and eukaryotes, Maturation of DNA strands and Termination.

Unit II: Transcription
Transcription in Prokaryotes, Mechanism of Transcription, Bacterial Promoter Structure and RNA Polymerases, Operon Model of RNA transcription, Transcription in Eukaryotes, Basal Transcription Machineries, components and transcription factors, DNA Binding Domain, Motifs, Trans-activation Domain etc, Transcriptional Co-activator and Repressors.

Unit III: Translation
Genetic Code; Ribosome structure (prokaryotic as well as eukaryotic ribosome); Detailed description of initiation, elongation and termination steps of translation in prokaryotes (a similar perspective of translation in eukaryotes), Protein synthesis inhibitors.

Unit IV: Split Genes & Splicing
Introduction and Perspectives, Splice junctions, Spliceosome, Alternative splicing, Cis- and trans-splicing, Splicing in Yeast tRNA, RNA editing, RNAi mediated gene silencing, antisense RNA and ribozyme and their therapeutic implications.

Recommended Books
**Paper III (MHG 203): Human Molecular Genetics – I**

**Instructions to the candidates:**
Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

**Unit I- Org. of Human Genome**
General organization of Nuclear & Mitochondrial genome; Organization & function of RNA genes (including piRNA, SiRNA & other regulatory RNAs); Organization & function of polypeptide encoding genes; Tandemly repeated noncoding DNA; Interspersed repetitive noncoding DNA; Genetic mechanisms (Replication slippage, Gene conversions); Pathogenic Mutations; Pathogenic potential of repetitive sequences.

**Unit II- Human genetic Variability & its consequences**
Types of variations (Rare variants, Polymorphisms, Balanced polymorphism, SNPs, Mutations).
Sources of Variations (Mutations, recombinations, migration).
Types of mutations (Induced & spontaneous).
Small Scale pathogenic Changes (missense, non-sense, splice site variants, frameshifts, pathogenic synonymous variants)
Pathogenic potential of repetitive sequences (Dynamic mutations & Pre-mutation alleles)

**Unit III- Molecular Pathology**
Effects of Variants (Loss of func., Gain of Function, Haploinsufficiency); Allelic hetero & homogeneity; Dominant -negative effects; GOF & interaction with regulatory signals; Genotype- phenotype correlations (compound heteros., Status in mitochondrial mutations, modifier genes); Abnormal gene dosage pathogenesis (single, contiguous, segmental)

**Unit IV: Human Genome project and its implications**
Goals of human genome project; Its implications on research and society, Molecular Medicine; Comparative genome analysis, Gene therapy, Risk assessment; DNA forensics (identification) diagnostic techniques in clinical genetics, genetic counselling, ethical, legal & social issues

**Recommended Books**
2. Ruvinsky, A and Graves, J.A. Mammalian Genomics, CABI Publishing, 2005
5. Living with the Genome by Angus Clarke Flotichrust, Palgrave (2006)
Paper IV (MHG 204): Genetic Engineering & Molecular Biology Techniques

Instructions to the candidates:
Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

Unit I: Molecular cloning
Overview of different types of common cloning vectors (Plasmids, Bacteriophages, Phagemids, Lambda, Cosmid vectors; YACs; BACs); Ti and Ri plasmids and mechanism of DNA transfer in plants; animal virus derived vectors: pCMV and SV40; Bacculo virus and retroviral vectors; pET- vectors; Yeast and Pichia vectors. Various methods of DNA transfer into host cells; Construction of cDNA and genomic libraries; Methods of selection and screening; Jumping and hopping libraries.

Unit II: Basic Techniques in Gene Analysis
Nucleic acid Hybridization, Minisatellite & Microsatellite analysis, Restriction fragment length polymorphism, Single strand conformation polymorphism, dHPLC, Heteroduplex Analysis, Conformation sensitive gel electrophoresis, Repeat Expansion Detection, Enzymatic, Chemical and Automated DNA sequencing, Next generation sequencing, Bisulphite Genomic Sequencing of Methylated Cytosines.

Unit III: Regulatory RNA technology
siRNA technology; Micro RNA; Construction of siRNA vectors; Gene targeting. Gene knockouts and knock out mice; Disease models: SCID mouse, NOD mouse, SLE model.

Unit IV: Stem Cells and Nano-biotechnology
Introduction to Stem Cells and Embryonic Stem cells; Identification, isolation and characterization of stem cells; Applications and tissue engineering in stem cells. (Parkinson’s & Alzheimer Diseases); in tissue system Failures (Diabetes, cardiomyopathy, kidney failure); Nanomaterials and structures, Bio conjugation of nanoparticles for bio technology and bio analysis, Methods and applications of metallic nanoshells in biology and medicine, Drug and gene delivery.

Recommended Books
SEMESTER-III

Paper I (MHG 301): Human Molecular Genetics –II

Instructions to the candidates:
 Attempt total five questions. Question no. 1 is compulsory. Attempt one question from each section. All questions carry equal marks

Unit I- Genetic Mapping of Mendelian Characters
Role of recombination (Recom. Fraction, Mapping function, Linkage maps, Estimation through chiasma counts, Genetic map distances & physical map distances);
Mapping disease locus (informative & non informative meiosis, Genetic markers & their heterozygosity), Linkage disequilibrium; Two point Mapping (scoring recombinants, Lod score, known & unknown phases, exclusion mapping); Multipoint Mapping (CEPH fam., framework of markers); Autozygosy mapping; Difficulties with Lod score analysis

Unit II- Susceptibility genes for Complex Diseases
Family study, Twin study, Segregation Analysis, Linkage analysis; Association studies & LDs (Possible causes, distinction from LA, Hap-Map project, Tag SNPs); Association study in practice (TDT, Sib-pair analysis, Case ctrl design, GWAS); Identifying causal factors from association studies; Limitations of Asso. Study (inadequate ctrls, multiple testing, power of study).

Unit III- Identification of Human Disease Genes
Positional cloning (Candidate reg, candidate genes, Prioritization of cand. genes for mutation testing, Appropriate expression, function, Homologies, & functional relationship, Model organism esp mouse, Utility of chrom. aberration, X-autosomal translocations, balanced rearrangements); Position independent strategies (Protein product, function & interaction of product, Animal Model, DNA sequence characteristics); Examples of disease gene identification (DMD, Cystic fibrosis, Multiple sulfatase deficiency, Breast Cancer); Significance in complex diseases

Unit IV- Molecular & Biochemical Basis of Genetic Diseases
Generation of mutations in different classes of proteins, Enzyme defects, Receptor protein abnormalities, Transport defects, Structural protein disorders, Neurodegenerative diseases and Pharmacogenetic diseases.

Recommended Books
2. Living with the Genome by Angus Clarke Flotichrust, Palgrave (2006)
6. Research Articles.
Instructions to the candidates:
Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks

Unit I: Pharmacogenetics and Pharmacogenomics
Drug Metabolism; Genetic make up & Drug Response; High throughput screening for drug discovery; Identification of drug targets; Pharmacogenetics and drug development; Disease predictive potential of genetic polymorphism of enzymes (Cyp 450).

Unit II: Cancer Genetics
Tumours: Types and Characteristics, Genetic heterogeneity and clonal evolution; Chrososomal aberrations in neoplasia; Cell cycle check point and cancer; Cell transformation and tumorigenesis; Oncogenes and Tumour suppressor genes; DNA repair genes and genetic instability; Familial cancers: Retinoblastoma, Wilms’ tumour, Li-Fraumeni syndrome, colorectal cancer, breast cancer; Genetic predisposition to sporadic cancer; Tumour progression: angiogenesis and metastasis.

Unit III: Detection & Mass Spectrometry
Detection of proteins in gels and electroblot membranes: organic dyes and stains, reverse stains, colloidal stains, etc; Mass spectrometry based methods for protein identification: basics of mass spectrometry, correlative mass spectrometry, De novo sequencing using mass spectrometry; Image analysis: data acquisition, image processing, data analysis and presentation, databases.

Unit IV: Global approaches for interactions
Protein–protein interaction and functional proteomics, Yeast two-hybrid system, Mammalian two-hybrid system, Subtractive hybridization, Immuno-screening, Protein chip technology, GFP-protein tagging.

Recommended Books
Paper III (MHG 303): Biomolecular Structure and Bioinformatics-II

Instructions to the candidates:
Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

Unit I: Similarity Searches & Phylogenetics
Database searching for similar sequences, BLOSUM matrices, BLAST, steps in BLAST, blast related programmes, concept of E and P value; multiple sequence alignment- introduction to CLUSTAL W, Molecular Phylogenetics- molecular clock hypothesis, neutral theory of evolution; concept of phylogenetic tree, types of trees, elementary idea of clustering method and cladistic methods.

Unit II: Macromolecular Structure Determination
Principle Structure determination methods: X-ray crystallography,:crystal, diffraction principles, protein crystallization, diffraction data collection, refinement. NMR spectroscopy: principles of NMR, NMR active nuclei, chemical shift, J-J coupling, 1D, 2D NMR, NOESY and COESY; cryo-electron microscopy: advantages of cryoelectron microscopy, single particle image reconstruction molecular visualization tools.

Unit III: Protein Structure Prediction
Secondary structure prediction, first, second, third generation methods; prediction of membrane helices: toplogy prediction, solvent accessibility; homology modeling: basis of homology modeling, steps in modeling, validation of the model; fold recognition methods: limitations of homology modeling, steps in fold recognition; a brief introduction to molecular dynamics

Unit IV: Protein profiles & patterns, Evolution & Docking
Introduction to profile and patterns, databases of profiles and patterns; Protein structure evolution and SCOP; CATH database; structural quality assessment; structure comparison and alignment; principles of docking, steps in computational aided ligand design.

Recommended Books
Paper IV (MHG 304): Gene Regulation & Evolution

Instructions to the candidates:
Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

Unit I: Regulation of gene expression
Activation of gene structure, transcription initiation, posttranscriptional events, transcription regulation, mRNA transport, localization and half life, translational regulation, chromatin remodeling.

Unit II: Gene silencing by methylation
Selective gene expression and cell-cell Signaling, Pattern of methylation, CpG Island and gene methylation, Host specificity, Gene expression and imprinting, the non-equivalence of paternal and maternal genome.

Unit III: Expression Profiling
Two dimensional PAGE for proteome analysis: sample preparation, sample solubilization, first dimension (IEF with IPG), second dimension(SDS-PAGE), resolution and reproducibility of 2-DE Expression systems, gene transfer, differential gene expression, Microarray analysis

Unit IV: Genes, Genomes & Evolution

Recommended Books
7. Ruvinsky & Graves, Mammalian Genomics, CABI, 2005.
SEMESTER- IV

Paper I (MHG 401): Advance Course in Genomics

Instructions to the candidates:

Attempt total five questions. Question no.1 is compulsory. Attempt one question from each section. All questions carry equal marks.

Unit I: Structural Genomics & Systems Biology:

Basic concepts of systems biology & structural biology; protein interaction prediction & structural information; structural proteomics & post genomic era; Structures and pathway modeling, structures, pathways and disease.

Unit II: Chemical Biology

Introduction to Chemical biology; self assembled nano-structures based on DNA; RNA as drug target; multivalent ligands and cell surface interaction; protein misfolding and disease.

Unit III: Genomic Research & Progress in Human Disorders

Genetic Disease burden in Humans, Current status of disease gene discovery, Methods to define disease causing Genes, Association analysis in out bred populations, Human diseases and their modeling in mice, Common genetic disorders of Indian subcontinent.

Unit IV: Genome Scanning for Quantitative Trait Loci

Principles of QTL detection, Two marker QTL linkage mapping, Designs of QTL mapping experiments, Half-sib designs, Complex pedigree designs, Linkage disequilibrium mapping, Combined LD-LA mapping, Meta analysis, Simultaneous detection of multiple interacting QTLs.

Recommended Books

Paper II (MHG 402): Project Work and Presentation:

Instructions to the candidates:
To make students learn how to carry out research independently. This involves how to raise a query, its possible hypothesis, experimentation and analysis of data obtained.

- Project work under supervision of Departmental Faculty member;
- Submission of Project Report;
- Evaluation of Project Work & Report through a Panel of Examiners;

Paper III (MHG 403): Clinical Round & Viva:

Instructions to the candidates:
Visiting hospital/clinical laboratories provides a real picture of various human diseases along with the treatment & sufferings of those patients. This will motivate students to understand such cases & work for discovering the cause of disease & new treatment of diseases. These clinical visits are also supplemented by lectures taken by clinicians.

- Visit to PGIMER clinical/research laboratories;
- Lectures by renowned PGIMER faculty;
- Submission of Report;
- Evaluation of visit & report by a Panel of Examiners;

Paper IV (MHG 404): Educational Tour & Journal Club:

Instructions to the candidates:
Objective is to provide students a chance to interact with principal investigators of various national reputed Universities/Institutes so that students get personal account of research in frontier & emerging areas. Other objective of this paper is to make students understand & analyze the research articles published in international/national journals of repute. They also learn to interpret & make presentation of such research work.

- A mandatory tour to research institute/University of national repute under the supervision of a faculty member and non-teaching staff;
- Submission of Educational Tour Report;
- Evaluation of Educational Tour Report;
- Two Power Point Presentations/Seminars discussing the recent scientific papers;
- Presentation/Seminar evaluation by Internal Examiners;
List of lab courses

Semester wise list of practical for M.Sc. Human Genomics

**Semester-I**

1. Chromosome preparation from mouse bone marrow.
2. Karyotyping
3. To prepare single cell suspension of splenocytes and report the yield of viable cells by performing trypan blue dye exclusion test.
5. Protein estimation by Bradford and Biuret assay
6. Gel-filtration chromatography
7. Ion exchange chromatography & SDS-PAGE analysis
8. To identify the inheritance of a character/disease via pedigree drawing/analysis.
10. Calculating the risk of inheritance of a particular disease using Bayesian calculations.
11. Isolation of Ig-G using affinity chromatography.
12. To study the interaction of Ag-Ab through Rocket Immunelectrophoresis (RIEP)/ODD.

**Semester-II**

1. DH5α competent cell preparation and transformation.
2. Plasmid DNA isolation using mini prep.
3. Sub cloning and Identification of positive clone by Blue/white selection.
4. Genomic DNA isolation from mouse tissue.
5. Isolation of genomic DNA from human blood sample.
6. Southern Transfer
8. To detect a novel variation through SSCP.
9. How to identify the restriction endonuclease to be used in RFLP (usage of NEB cutter software).
10. How to screen a known mutation/variation using RFLP.
11. DNA fingerprinting using random amplification of polymorphic DNA (RAPD).
12. To study variations via heteroduplex formation in CSGE.
13. Repetitive sequence detection/repeat expansion analysis
14. Mutation detection through Allele specific PCR.
15. Identification of methylation status using bisulfite treatment & PCR.
16. Isolation of total RNA using guanidine isothiocyanate method & quantitation by spectrophotometer.
17. Reverse Transcriptase PCR.
18. Northern transfer
19. Inducible over-expression of recombinant protein.
20. Introduction to primary databases in bioinformatics.

**Semester-III**

1. 2-D gel separation (e.g. Mouse heart, lung etc. total proteins)
2. Western blot analysis of total protein from control and heat shocked
3. Development of polyclonal antibody in rabbit
4. Identifying informative and non-informative meiosis
5. Linkage disequilibrium calculations
6. Lod score calculations
7. Linkage analysis
8. Association study analysis
9. Nucleotide BLAST
10. Protein BLAST
11. Multiple sequence alignment (Clustal-W, T-coffee)
12. Hydrophobic profiles for protein sequence analysis
13. Secondary Structure Prediction methods (Jpred, PHD, GOR)
14. Use of 3D structure databases and Molecular Visualization tools
15. Protein tertiary structure modeling using homology model
16. Genome structure analysis
17. Alternative promoter analysis
18. Molecular phylogenetic analysis