THEORY

Marks: 100

1. **Introduction to Toxicology**  
   *(Chapter 1 and 2: Klaassen) (6 Lectures)*  
   Definition, scope and different branches of toxicology, Spectrum of toxic doses, Classification of toxic agents, Characteristic of exposure, Spectrum of undesired effects, Interaction of chemicals and their toxic effect, Tolerance

2. **Dose-Response relationship**  
   *(Chapter 2: Klaassen) (4 Lectures)*  
   Graded and Quantal response, Hormesis, Assumption and evaluation of dose response relationship, Variation in toxic responses

3. **Measuring toxicities**  
   *(Chapter 2: Klaassen; Chapter 1: Stine and Brown) (10 Lectures)*  
   Toxicity testing methods, The LD$_{50}$ Experiment, Acute, Short-Term and Chronic toxicities and its manifestations: Mode of application, administration, exposure and *in vitro* tests

4. **Disposition of toxicants**  
   *(Chapter 5 and 6: Klaassen) (15 Lectures)*  
   Absorption, Distribution, Metabolism and Excretion (ADME) of toxicants and chemicals, Xenobiotic Biotransformation by Phase I (Hydrolysis, Oxidation, and Reduction) and Phase II (Glucuronidation, Sulfation, Acetylation, Methylation and Conjugation reactions).

5. **Mechanism of toxicity**  
   *(Chapter 3: Klaassen) (7 Lectures)*  
   Delivery of the toxicant, Concept of ultimate toxicant, Reaction of the ultimate toxicants.

6. **Toxic agents**  
   *(Chapter 22, 23 and 24: Klaassen and Whatkins) (12 Lectures)*  
   Toxic effects of metals: Mercury, Lead, Arsenic, Fluoride; Source, exposure, absorption, target site interaction and health hazards.  
   Toxic effects of 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.  
   Toxic effects of solvents and vapours: Solvent-induced chronic encephalopathy, solvent abuse, Chlorinated hydrocarbons, fuel and fuel additives

7. **Ecological Toxicology**  
   *(Chapter 29: Klaassen and Whatkins; Chapter 14: Stine and Brown) (3 Lectures)*
Ecotoxicology: Chemical movement, fate and exposure; Biomarkers; Effects of Toxicants at the population, community and ecosystem level, Examples of ecosystems and vulnerability to toxicants

8. Applications of Toxicology

(Chapter 31 and 32: Klaassen and Whatkins) (3 Lectures)
Toxicologic investigation of a poison death, Therapeutic and Biological monitoring, Clinical Strategy for treatment of the Poisoned Patient.

REFERENCE BOOKS FOR THEORY PAPER

Text Books:

Reference Books:

BOHP 610: TOXICOLOGY

PRACTICALS Marks: 50

1. Toxicological Investigations and Therapeutic drug monitoring (At least two)
   a. Perform a colour test to check the presence of salicylates in the given urine sample.
   b. Indicate the presence of paracetamol in the given biological sample using the O-cresol test.
   c. General screening for alcohols and acetone OR methanol and formaldehyde.
   d. Testing for phenol toxicity.

2. Solvent Extraction and separation methods (any one)
   a. Separation of a mixture of benzoic acid, \( \bullet \)-naphthol and naphthalene by solvent extraction and identification of their functional groups.
   b. Analysis of the given sample for the presence of pesticides
3. **Water analysis (Perform any four analysis)**

   a. Determination of total dissolved solids.
   b. Determination of dissolved oxygen of water (DO) using Winkler’s Method.
   c. Determination of biochemical oxygen demand (BOD) of water.
   d. Determination of chemical oxygen demand (COD) of water.
   e. Detection of coliforms to determine water purity using membrane filter method.
   f. Perform quantitative estimation of residual chlorine in the given water sample.
   g. To determine the total, permanent and temporary hardness of water by complexometric method using EDTA.

4. **Other Misc. Experiments**

   a. Determine the acid value of the given oil sample.
   b. Estimate the formaldehyde content of the given sample.
   c. Estimation of LD$_{50}$ value of an insecticide from the data provided.

(Perform at least one experiment from each group and in all at least eight practicals)
Theory

1. **Introduction:**
   
   *(Chapter 1: Kuby) (2 Lectures)*
   
   Historical background, general concepts of the immune system. Innate and adaptive immunity, Active and passive immunity. Primary and secondary immune response (Concepts and definitions).

2. **Structure, properties and functions of the immune cells & organs:**
   
   *(Chapter 2: Kuby) (3 Lectures)*
   
   Hematopoiesis, T and B lymphocyte, NK cells, Monocytes and macrophages; Neutrophils, eosinophils, basophils, Mast cells and dendritic cells. Thymus and bone marrow; Lymph nodes, spleen, MALT, GALT and SALT.

3. **Innate Immune Response:**
   
   *(Chapter 31: Prescott and Chapter 7: Kuby) (8 Lectures)*
   

   b. Complement system: Components of the complement activation - classical, alternative and lectin pathways. Biological consequence of complement activation

4. **Adaptive immune response:**
   
   *(Chapter 4,8,10 & 11: Kuby) (23 Lectures)*
   

   b. Major Histocompatibility Complex: Organization of MHC and inheritance in humans. Concepts of polygeny and polymorphism with respect to MHC.

   c. Antigen presenting cells, antigen processing and presentation pathway (cytosolic and endocytic).

   d. Humoral immune response

      Concepts of B cell development in bone marrow, generation of plasma cells and Memory B cells in lymphoid organs.

      Antibodies: Historical perspective of antibody structure. Structure, function and properties of the antibodies; Different classes and subclasses and biological activities of antibodies. Concepts of antibody diversity and class switching. (isotype, allotype and idiotype). Transport of IgA, Hybridoma technology, monoclonal antibodies Basic concepts of abzymes, immunotoxin, chimera, hybrid antibodies.

   e. Cell mediated immune response.

      T cell maturation in thymus, thymic selection, self MHC restriction of T cells, T cell receptor complex, Trimolecular complex formation between APC and NaiveT cells, clonal expansion, generation of effector and memory T cells. Cell types (CTLs, NK cells, macrophages and TDTH cells), effector mechanisms and
effector molecules of cell mediated reactions. Assessment of cell-mediated cytotoxicity.
Cytokines - properties and functions of Interferon and Interleukins(IL1,IL2,IL4).

5. **Immunological principles of various reactions and techniques:**

   *(Chapter 6: Kuby) (12 Lectures)*

   Affinity and avidity, cross reactivity, precipitation, agglutination, immunodiffusion, immunoelectrophoresis, ELISA (indirect, sandwich, competitive, chemiluminescence, and ELISPOT assay), western blotting, immunofluorescence, flow cytometry and fluorescence, and immuno-electron microscopy.

6. **Vaccines**

   *(Chapter 19: Kuby) (6 Lectures)*

   Types and their characteristics. Adjuvants, overview of National Immunization Programme.

7. **Dysfunctions of immune system:**

   *(Chapter 32: Prescott) (6 Lectures)*

   Hypersensitivity: Types with one example each.
   Autoimmunity (general overview).
   Immunodeficiency disorders: Animal models of primary immunodeficiency (nude mouse and SCID mouse). Specific impaired functions in lymphoid and myeloid lineage.

**REFERENCE BOOKS FOR THEORY PAPER**

**Text Book:**


**Reference Books:**

BOHP 611: IMMUNOLOGY

PRACTICALS

1. To perform immunodiffusion by Ouchterlony method.
2. Immunodiffusion by Mancini method
3. Analysis of the Ouchterlony and Mancini method
4. To perform ELISA checkerboard experiment.
5. To perform Complement fixation assay
6. To perform Immuno affinity chromatography.
7. To perform Agglutination inhibition Assay
8. To perform sandwich ELISA.
9. To perform Immunoprecipitation

Marks: 50
Special Paper 23a - BOHT 612a: BIOINFORMATICS

THEORY

Marks: 100

1. Introduction to Bioinformatics
   (Chapter 1: Ignacimuthu) (2 Lectures)
   Definitions, important contributions, aim and task of bioinformatics, applications of
   bioinformatics in pharmaceuticals industry and business, challenges and opportunities

2. Information Networks
   (Chapter 2: Ignacimuthu) (4 Lectures)
   Introduction, computer and programs, internet, world wide web, browsers, EMBnet, and
   SRS, NCBI, HTTP, HTML and other URLs.

3. Databases, Tools and Uses.
   (Chapter 5: Ignacimuthu and Chapter 13: Sundara Rajan & Balaji) (7 Lectures)
   Introduction, biological databases, DNA sequence databases, specialized genomic
   resources, web address, protein primary sequences data bases, composite protein
   sequences databases secondary data bases, composite protein pattern databases, structure
   classification databases, web addresses.

4. DNA Sequence Analysis
   (Chapter 4: Ignacimuthu and Chapter 14: Sundara Rajan & Balaji) (6 Lectures)
   Introduction, why analyze DNA, gene structure and DNA sequences, feature of DNA
   sequence analysis, issue in the interpretation of EST searches, gene hunting, expression
   profile of a cell, cDNA libraries, and ESTS, different approaches to EST analysis, effect
   of EST data on DNA databases.

5. Sequence Alignment
   (Chapter 3 & 4: Mount and Chapter 6: Ignacimuthu) (8 Lectures)
   Algorithm, goals and type of alignment, study of similarities, scoring mutations,
   deletions and substitutions, dot plot, pair wise database searching, FASTA, BLAST,
   multiple sequence alignment.

6. Predictive methods using DNA and Protein Sequences
   (Chapter 8 & 9: David Mount and Chapter 7: Ignacimuthu) (8 Lectures)
   Gene-prediction strategies, programs, Proteins-prediction strategies, secondary structure
   prediction, intrinsic tendency of amino acids to form B turns, rotamer libraries, three
   dimensional structure, prediction comparative modeling, threading, energy bases
   prediction, protein prediction program, molecular visualization

7. Phylogenetic Analysis
   (Chapter 8: Ignacimuthu) (8 Lectures)
   Phylogenetics, cladestics and ontology, building phylogenetic trees, distance base
   methods and character bases methods, molecular approaches to phylogeny, phylogenetic
   analysis databases
8. Drug Discovery and Pharmainformatics

(Chapter 9: Ignacimuthu) (7 Lectures)

Discovering a drug, target identification and validation, identification the lead compounds, optimization of lead compounds, pharmacoinformatics, chemical libraries, search programming

REFERENCE BOOKS FOR THEORY PAPER

Text Books:


Reference Books:


BOHP 612a: BIOINFORMATICS

PRACTICALS

Marks: 50

1. Searching of scientific information using NCBI, or any search engine
2. Identification of gene using gene scan
3. Primer designing using software
4. Pair wise alignment and multiple sequence alignment.
5. Prediction of primary and secondary structure and various parameters in protein structure and function
6. Three dimensional analysis of protein molecule
7. Phylogenetic analysis.
Special Paper 23b - BOHT 612b: HUMAN GENETICS

THEORY

Marks: 100

1. History of Human Genetics
   (Chapter 1: Vogel and Motulsky) (1 Lecture)

2. Pedigree Analysis
   (Chapter 3: Strachan and Read) (2 Lectures)
   - Gathering family history
   - Pedigree symbols and construction of pedigrees, inheritance pattern and risk assessment
   - Presentation of molecular genetic data in pedigrees

3. Patterns of Inheritance for Monogenic Traits
   (Chapter 3: Strachan and Read) (9 Lectures)
   a. Autosomal inheritance-dominant, recessive
   b. Sex-linked inheritance
   c. Sex-limited and sex-influenced traits
   d. Mitochondrial inheritance
   e. Deviations from the basic pedigree patterns- nonpenetrance, variable expressivity, pleiotropy, late onset, dominance problems, anticipation, genetic heterogeneity and uniparental disomy, spontaneous mutations and X-inactivation and dosage compensation
   f. Mosaicism and chimerism
   g. Consanguinity and its effects
   h. Epigenetic modifications, imprinting
   (Website: OMIM)

4. Human Genome Project:
   (Chapters 4, 13: Strachan and Read; Chapter 11: Cantor and Smith) (4 Lectures)
   a. History, organization and goals of human genome project
   b. Tools (Vectors- BAC, PAC, YAC and sequencing techniques) and approaches (Hierarchial and shotgun sequencing),
   c. Outcomes and ethical issues.
   d. Applications in human diseases
   (For topics 1 and 3 refer to Human Genome Project site.)

5. Organization of the Human Genome:
   (Chapters 7, 11: Strachan and Read) (5 Lectures)
   a. General features: Gene density, CpG islands, RNA-encoding genes,
   b. Gene clusters
   c. Diversity in size and organization of genes
   d. Types of repetitive DNA
   e. Pseudogenes, gene families
   f. Endoreplication and amplification
   g. Genetic markers and their applications
6. **Human Cytogenetics:**  
(Chapters 2, 18: Strachan and Read; Chapter 7: Cantor and Smith) (5 Lectures)  
   a. Techniques (Karyotyping and FISH)  
   b. Human Karyotype: Banding pattern and nomenclature (G and Q banding)  
   c. Common syndromes due to numerical chromosome changes  
   d. Common syndromes due to structural alterations (translocations, duplications, deletions, microdeletion, fragile sites)  
   e. Common chromosome abnormalities in cancer.  

7. **Techniques for Genomics:**  
(Chapter 6: Strachan and Read) (4 Lectures)  
   a. DNA sequencing  
   b. DNA fingerprinting  
   c. Polymorphism screening (Genotyping of SNPs and Microsatellite markers)  
   d. Expression analysis and proteome analysis  

8. **Mapping strategies:**  
(Chapters 6, 8: Cantor and Smith) (3 Lectures)  
   a. Physical Maps (different types - restriction and cytogenetic maps)  
   b. Genetic Maps  

9. **Identification of Genetic Basis of Disease:**  
(Chapter 13: Cantor and Smith; Chapter 3: Vogel and Motulsky) (6 Lectures)  
   a. Principles and strategies  
   b. Positional and Candidate Gene approaches, Positional- cloning approach  
      Examples- HD, CFTR  
   c. Concept of Twin and Adoption Studies  

10. **Population Genetics:**  
(Chapters 3,12: Strachan and Read) (4 Lectures)  
   a. Genotypic and Allelic frequencies  
   b. Linkage Disequilibrium  
   c. Haplotype construction (two loci using SNPs and/or microsatellites)  

11. **Prenatal Diagnosis**  
(Chapter 18: Vogel and Motulsky) (2 Lectures)  
   a. Brief introduction  
   b. Methods of prenatal diagnosis  

12. **Clinical Genetics:**  
(Chapters 7, 10: Vogel and Motulsky; Chapter 11,12,15: Wilson) (6 Lectures)  
   a. Inborn errors of metabolism and their genetic basis (Example- Phenylketonuria)  
   b. Genetic disorders of Haemopoietic systems (Examples- Sickle cell anemia and Thalassemia)  
   c. Genetic basis of color blindness  
   d. Genetic basis of Familial Cancers (Example- Retinoblastoma)  
   e. Genetics of infertility and in vitro fertilization  
   f. Genetics of Mental Retardation
13. Implications of Genome Research:
(Chapters 7,18: Vogel and Motulsky; Chapter 6,17: Pasternak) (9 Lectures)

a. Diagnosis and screening of Genetic Disorders
b. Prenatal genotyping for mutations in β- globin gene and sickle cell anemia
c. DNA profiling: establishing identity and relationships
d. Applications in personalized medicine (Genetic polymorphism in drug metabolism genes e.g. CytP450 and GST and their effect on drug metabolism and drug response)
e. Genetic counseling

REFERENCE BOOKS FOR THEORY PAPER

Text Books:


BOHP 612b: HUMAN GENETICS

PRACTICALS Marks: 50

2. Karyotyping with the help of photographs.
3. Abnormal karyotypes and chromosome aberrations.
4. PTC testing to prove monogenic inheritance.
5. Preparation of Pedigree charts of some common characters like Tongue rolling, Ear lobes, Blood group, Color blindness.
6. Polymorphism analysis using PCR.
7. Website based analysis.
8. Haplotype construction.
Special Paper 23c - BOHT 612c: MEDICAL BIOTECHNOLOGY

THEORY                                                Marks: 100

1. Introduction to Biotechnology
   (Chapter 1,2: Primrose and Twyman) (1 Lectures)
   Brief history and Importance.

2. DNA Manipulation
   (Chapter 3: Primrose and Twyman) (5 Lectures)
   Isolation and purification of genomic and plasmid DNA: Restriction and modification systems, Type I-IV restriction endonucleases, nomenclature and sequence recognition, restriction mapping.

3. Cloning Vectors
   (Chapter 4,5: Primrose and Twyman) (8 Lectures)
   Basic biology of plasmid and phage vectors (pBR322 and pUC vectors, T-vectors); expression vectors examples of prokaryotic and eukaryotic expression vectors; Inducible and constitutive expression vectors with one example each; Bacteriophage λ vectors-replacement & insertion vectors, in vitro packaging, cosmids, phasmids, brief life cycle and DNA replication of phage M13 and its vectors. Joining DNA molecules: ligase, adaptors, linkers, homopolymer tailing.

4. Cloning and Expression of cloned genes in
   (Chapter 11: T.A. Brown) (8 Lectures)
   a. Prokaryotic cells (4)
   b. Eukaryotic cells (4)
   Challenges in expression of foreign proteins in heterologous host; factors affecting the expression-host cell physiology, promoters, codon choice, plasmid copy no. etc.; expression in eukaryotic cells (yeast expression system, Baculovirus system; Shuttle vectors, ligation, transformation and selection procedures (blue/white and antibiotic selection methods).

5. Polymerase chain reaction (PCR)
   (Chapter 9: Sambrook and Russell) (5 Lectures)
   Principle and applications, primer-design, brief overview of various PCR techniques: inverse-, multiplex-, hotstart-, touchdown, nested PCR; RT-PCR

6. Construction of genomic and cDNA libraries, Screening & Selection of Recombinants
   (Chapter 6: Primrose and Twyman) (7 Lectures)
   Choice of vector, immunochemical methods of screening, nucleic acid hybridisation (Colony and Plaque hybridisation), gene probes, south-western screening.

7. Sequencing of DNA
   (Chapter 7: Primrose and Twyman) (3 Lectures)
   Conventional and modern Methods and analysis of sequence DATA.
8. **Random and Site-directed mutagenesis**  
   *(Chapter 8: Primrose and Twyman) (8 Lectures)*  
   Cassette mutagenesis, Primer extension methods, PCR methods of site directed mutagenesis, screening and identification of mutants, protein engineering- subtilisin, oxidation- resistant variants of á- antitrypsin (AAT).

9. **Application of Medical Biotechnology**  
   *(Chapter 14 and 16: T.A. Brown) (7 Lectures)*  
   a. Production of recombinant biomolecules:  
      - Insulin, somatostatin, and recombinant factor VIII  
   b. DNA Profiling:  
      - Introduction, DNA profiling based on STRs, minisatellites, RFLP, AFLP, SNPs.

10. **Genetic manipulation of animals**  
    *(Chapter 11: Primrose, Twyman and Old) (6 Lectures)*  
    Transgenesis in mice: pronuclear microinjection; Transfection of Embryonic stem cells, Gene targeting in ES cells, Designing targeting vectors, Selection strategy, Application of genetically modified mice; Application of gene targeting; Nuclear transfer technology, Gene transfer in Zebra fish; Transgenic flies-Drosophila P-elements.

11. **Protein interaction technologies**  
    *(Chapter 11: T.A. Brown) (2 Lectures)*  
    Basics and applications: Phage display, yeast two-hybrid system.

**REFERENCE BOOKS FOR THEORY PAPER**

**Text Books:**


**Reference Books:**

BOHP 612c: MEDICAL BIOTECHNOLOGY

PRACTICALS

Marks: 50

1. Separation of DNA by agarose electrophoresis.
2. Extraction of DNA from agarose gel
3. Analysis of DNA sequences
5. To perform Native PAGE for DNA.
6. To perform Native PAGE for protein.
7. To perform SDS-PAGE for proteins and analyse the result
8. Application of PCR and Analysis of the PCR amplicon

REFERENCE BOOKS FOR PRACTICAL PAPER

THEORY

Marks: 100

1. **Concepts of Health and Disease:**
   (Chapter 2: Park) (3 lectures)

2. **Principle of Epidemiology and Epidemiological methods:**
   (Chapter 3: Park) (10 lectures)
   Terms used in describing disease transmission and control. Morbidity and mortality indicators. Measurements of epidemiological indicators, Epidemiology study designs. Concept of association, causation and bias. Screening for diseases.

3. **Epidemiology of Communicable diseases:**
   (Chapter 5,7: Park) (20 lectures)
   Extent of problem, Diagnosis- clinical and lab, Treatment and control, Health Programmes (if applicable)
   Respiratory infections: measles, rubella, mumps, influenza, diphtheria, whooping cough, tuberculosis.
   Intestinal infections: poliomyelitis, viral hepatitis, cholera, typhoid, food poisoning, acute diarrheal diseases
   Arthropod-borne infections: dengue, malaria, filariasis, leismaniasis.
   Zoonosis: rabies,
   Surface infections: leprosy, HIV/AIDS

4. **Epidemiology of Chronic non-communicable disease and conditions:**
   (Chapter 6: Park) (5 lectures)
   Coronary heart disease, cancer, diabetes, hypertension, blindness

5. **Nutrition and Health:**
   (Chapter 10: Park) (6 lectures)

6. **Environment and Health:**
   (Chapter 12: Park) (4 lectures)
   Water pollution: Indicators of water pollution, Prevention and Control
   Air pollution: Indicators of air pollution, Prevention and Control

7. **Reproductive and Child Health:**
   (Chapter 8: Park) (6 lectures)
   Child Health, Maternal Health, Immunization, Population Control Measures.
8. **Occupational Health:**
   (Chapter 13: Park) (2 lectures)
   Basic Concepts (Silicosis and Byssinosis.)

9. **Health Care system in India:**
   (Chapter 19: Park) (4 lectures)
   Health planning, National Health Policy, Primary Health Care, Health Care delivery system in India

**REFERENCE BOOKS FOR THEORY PAPER**

**Text Books:**

Paper 24 – GGHT 602: GENETICS AND GENOMICS II

THEORY

Marks: 100

Unit 1. Genetic Analysis and Mapping in Bacteria and Bacteriophages   (Ch 6, Klug and Cummings/ Ch 5, Griffith et al.)
Conjugation; Transformation; Transduction, Recombination.

Unit 2. Genome Dynamics-Transposable genetic elements, Eukaryotic Viruses   (Ch 22, Klug and Cummings/ Ch 14, Griffith et al.)
Prokaryotic transposable elements- IS elements, Composite transposons, Tn-3 elements;
Eukaryotic transposable elements- Ac-Ds system in maize and P elements in *Drosophila*; Uses of transposons; Eukaryotic Viruses.

Unit 3. Developmental Genetics and Model System   (Ch 19, Klug and Cummings)
Study of model systems in developmental genetics- *Drosophila melanogaster*,
*Sachharomyces cerevisiae*, *Caenorhabditis elegans*, *Arabidopsis thaliana*, and *Xenopus laevis*.

Unit 4. Genomics, Bioinformatics and Proteomics   (Ch 21, Klug and Cummings/Ch 8-9, Russell/ Ch2, 3, 4 Ghosh, Z. and Mallick, V.)
Genomes of bacteria, *Drosophila* and Humans; Human genome project; Evolution and Comparative Genomics.
Introduction to Bioinformatics, Gene and protein databases; Sequence similarity and alignment; Gene feature identification.
Gene Annotation and analysis of transcription and translation; Post-translational analysis-Protein interaction.

Unit 5. Genomic Analysis- Dissection of Gene Function   (Ch 23, Klug and Cummings)
Genetic analysis using mutations, forward genetics, genomics, reverse genetics, RNAi, functional genomics and system biology.

Unit 6. Population Genetics   (Ch 27, Klug and Cummings)
Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift.

Unit 7. Evolutionary Genetics   (Ch 28, Klug and Cummings)
Genetic variation and Speciation.
GGHP 602: GENETICS AND GENOMICS II

PRACTICALS

1. Genomic DNA isolation from *E. coli* (without plasmid).
2. Restriction enzyme digestion of genomic DNA from *E. coli*.
3. Isolation of plasmid DNA and genomic DNA together from *E. coli* and restriction enzyme digestion.
4. Restriction enzyme digestion (EcoRI) of genomic and plasmid DNA obtained from Expt.3.
5. Estimation of size of a DNA fragment after electrophoresis using DNA markers.
6. Construction of Restriction digestion maps from data provided.
7. Demonstration of DNA fingerprinting.

SUGGESTED BOOKS