

**Shree Manibhai Virani and Smt.Navalben Virani Science College, Rajkot
(Autonomous)**

Affiliated to Saurashtra University, Rajkot

Department of Biochemistry

B.Sc. BIOCHEMISTRY

B.Sc. BIOCHEMISTRY Syllabus

For Students Admitted From A.Y.2019-2020 and Onwards

SEMESTER -V

19UBCCC501	Core 12: Advanced Molecular Biology	4 Hrs/wk	4 Credits
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Objectives:

To enable the students to

- Understand basic theoretical knowledge in the field of gene engineering
- State creative use of modern tools and techniques for manipulation and analysis of genomic sequences.
- Understand application of recombinant DNA technology in biotechnological research.

Unit 1: Regulation of gene expression in prokaryotes and eukaryotes [12 Hrs]

- Principles of gene regulation, negative and positive regulation.
- Concept of operons, regulatory proteins, inducers, repressors, regulation of lac operon and trp operon.
- Overview of gene regulation by Heterochromatin, euchromatin, chromatin remodeling.
- Regulation of galactose metabolism in yeast.
- Regulation of eukaryotic gene expression at transcriptional and translational levels.
- Hormonal control of gene expression.

Unit 2: DNA modifying enzymes and Gene Cloning [12 Hrs]

- Restriction modification systems: Types I, II and III. Mode of action, nomenclature.
- Applications of Type II restriction enzymes in genetic engineering.
- DNA modifying enzymes and their applications: Terminal deoxynucleotidyl transferase, kinases and phosphatases, DNA ligases and DNA polymerases, reverse transcriptases, bacteriophage RNA polymerases, exonuclease III, S1 nuclease.
- Simple cloning of DNA fragments, process of cloning and their applications.

Unit 3: Vectors in Recombinant DNA Technology [12 Hrs]

- Vectors: Definition and properties.

- Plasmid vectors-pBR and pUC series, Bacteriophage lambda and M13 based vectors, Cosmids, Phagemids.
- Overview of Shuttle vectors-BACs and YACs.
- Baculovirus based vectors.
- Ti based vectors (Binary and Cointegrated vectors)

Unit 4: Gene Delivery and Analytical Methods (10 Hrs)

- Brief introduction to Gene transfer: Bacterial Conjugation, Transformation, Transduction, Episomes, Microinjection, Electroporation, Microprojectile, Ultrasonication, Shot Gun method, Liposome fusion, *Agrobacterium*-mediated delivery.
- Polymerase chain reaction – tools and mechanism, RT-PCR and Reverse transcription PCR.
- Introduction to Southern , Northern and Western blotting.
- Brief introduction to: DNA fingerprinting by RFLP , RAPD and DNA foot printing, DNA microarray.
- Overview of Genomic and cDNA libraries.

Unit 5: Applications of genetic engineering [9 Hrs]

- Applications in medicine- production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII, Recombinant vaccines and Gene therapy.
- Applications in agriculture- GM crops for disease resistance, yield and quality improvement.
- Applications in microbiology- environment, dairy, strain improvement.
- Genetic Engineering: Society, Risk and Ethics.

Text Books:

1. Satyanarayan U. (2010). *Biotechnology*. Books and allied (P) ltd.
2. Primrose, S. B., & Twyman, R. (2013). *Principles of Gene Manipulation and Genomics*. John Wiley & Sons.

Reference Books:

1. Brown, T. A. (2016). *Gene Cloning and DNA analysis: An Introduction*. John Wiley & Sons.
2. Weaver R F (2016), *Molecular Biology*. (ed 6th), WCB/McGraw-Hill
3. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA*. ASM Press

19UBCCC502	Core -13: Genetics	4 Hrs/wk	4 Credits
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Objectives:

To enable the students to

- Have working knowledge of classical and molecular genetics.
- Study population genetics, analyze quantitative characters and analyze & solve genetics problems.

Objectives:

To enable the students to

- Have working knowledge of classical (transmission) and molecular genetics.
- Study population genetics, analyse quantitative characters and analyze & solve genetics problems.

Unit 1: Basics of Mendelian genetics [12 Hrs]

- Genetical terminology
- Chromosomal basis of Mendelism
- Genetic interaction: epistatic and non epistatic
- Pleiotropy, multiple alleles, lethal alleles, null alleles and pseudo alleles.
- Interaction of gene with environment.

Unit 2: Linkage, crossing over and pedigree analysis. [12 Hrs]

- Sex linked inheritance
- Linkage
- Crossing over.
- Characteristics of dominant and recessive inheritance and pedigree analysis

Unit 3: Overview on population genetics [09 hrs]

- Introduction to Population Genetics, Mendelain population, gene frequency, gene pool.
- Hardy-Weinberg law
- Predicting allele and genotype frequencies
- Exceptions to Hardy-Weinberg principle.

Unit 4: Chromosomal Aberrations [9 hrs]

- Numerical- Euploidy (Monoploidy, Haploidy and Polyploidy) Polyploidy- Autopolyploidy and Allopolyploidy. Aneuploidy- Monosomy, Nullisomy, Trisomy and Tetrasomy.
- Structural- Deletions, Duplication, Translocation and Inversions.
- Overview on evolutionary significance of chromosomal aberrations.

Unit 5: Evolution [12 Hrs]

- Theories of evolution and pattern of evolution.
- Chemical and Biological evolution
- Natural Selection and evidences supporting evolution.
- Speciation.

Textbooks

1. Verma, P. S., & Agarwal, V. K. (2005). Cell biology. Molecular Biology, Evolution and Ecology. S Chand & Company Ltd. Ram Nagar, New Delhi.
2. Green, N. P., Stout, G. W., Taylor, D. J., & Soper, R. (1998). Biological Science 1 & Cambridge University Press.

Reference books

1. Gardner, E. J., Simmons, M. J., & Snustad, D. P. (2016). Principles of genetics (No. Ed. 8). John Wiley and Sons, Inc.
2. Pierce, B. A. (2012). Genetics: A conceptual approach. W.H. Freeman & Co.
3. Carroll, S. B., Doebly, J. F., Griffiths, A. J., & Wessler, S. R. (2015). Introduction to genetic analysis., W.H. Freeman & Company (New York)

19UBCCC503	Core 14: Nutritional Biochemistry-Self Study	4 Hrs/wk	4 Credits
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Objectives:

To enable the students to

- Distinguish different foods as rich, moderate and poor dietary sources for various nutrient classes: macro nutrients, vitamins, minerals and trace elements. Extend this knowledge to prevent nutritional deficiencies and achieve good health through balanced diet.
- Review the RDA, absorption process, metabolism, storage, functions and biochemical role of different nutrients in human health.
- Identify methods to assess nutrient status and the strengths and weaknesses of these methods.
- Infer clinical manifestations of deficiency and toxicity states of various nutrients and relate biochemical and physiological roles of nutrients to these manifestations.

Unit 1: Introduction to Nutrition and Energy Metabolism [12 Hrs]

- Defining Food, Nutrition and role of macro and micro nutrients in human body. Concept of RDA, Food tables and their use
- Units of energy: calorie, Kcal or Cal (kilo calorie) Joule. Physical v/s biological energy value of foods, Measurement of energy content of foods using bomb calorimeter, Specific dynamic action of foods (SDA).
- Measurement of energy expenditure. Direct and Indirect Calorimetry, Factors affecting thermogenesis, Basal Metabolic Rate (BMR) and factors affecting BMR.
- Physical activity, Overview of calories burned during different types of physical activities, Factors affecting energy input - hunger, appetite, Energy balance- Positive and negative energy balance and factors responsible for it.
- Energy requirements for different age groups and according to life style of a person.

Unit 2: Nutritionally Important Carbohydrates and Lipids [12 Hrs]

- Overview of functions of carbohydrates. Sources, Digestion, absorption, utilization and storage of carbohydrates, Glycemic Index (GI) and low GI foods.
- Dietary fibers: different classes, examples, dietary sources and their importance in human health.
- Overview of classification, sources, functions, digestion, absorption, utilization and storage of Lipids.
- Types of Fatty acids- Saturated fatty acids, Mono and Poly unsaturated fatty acids. Essential Fatty Acids (EFA); Functions of EFA and their deficiency. Omega 3 and Omega 6 fatty acids and their importance in diet.
- Different lipoproteins and their importance in health and diseases.

Unit 3: Nutritional importance of Proteins. [9 Hrs]

- Review of functions of amino acids, peptides and proteins in the body. RDA of Proteins for different age groups.
- Different food sources of proteins, digestion and absorption of proteins.
- Essential, Semi essential and Non-essential amino acids with examples and nutritional classification of proteins: Complete proteins, Partially complete proteins and Incomplete proteins.
- Concept of Protein quality and different chemical and biological methods to evaluate quality of dietary proteins. Limiting amino acids in foods, different ways and means of improving protein quality in human diet: Fortification and Blending with suitable examples.
- Protein calorie malnutrition; Definition, etiology, clinical symptoms, biochemical changes, treatment and prevention of Nutritional Marasmus and Kwashiorkor. Causes of Protein deficiency in Adults.

Unit 4: Fat and Water Soluble Vitamins [12 Hrs]

- Vitamin A, D, E and, K: Dietary sources, RDA, Absorption, Distribution, Metabolism and their biochemical functions.
- Nutritional diseases of Vitamin A and Vitamin D deficiency. Hypervitaminosis and toxicity of vitamin A and D.
- Vitamins of B complex and Vitamin C: Dietary sources, RDA, Absorption, Distribution, Metabolism and their biochemical functions.
- Clinical symptoms, diagnosis, prevention and treatment of vitamin deficiency diseases such as Beriberi, Pellagra, Vitamin deficiency Anemia.

Unit 5: Nutritionally Important Minerals [12 Hrs]

- Calcium, Phosphorus and Iron - Distribution in the body, absorption, Utilization and biochemical functions.
- Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA of Calcium, Phosphorus and Iron.
- Role of iron in prevention of anemia.

- Trace elements: Iodine, Fluoride, Mg, Cu, Zn, Se, Cr- Dietary sources, RDA, Distribution in the human body, Major Biochemical functions, and deficiency.

Text Books:

1. Passmore, R., & Eastwood, M. A. (1996). *Davidson and Passmore Human Nutrition and Dietetics*: (ed. 8th). Churchill Livingstone
2. Satyanarayan U., Chakrapani U. ,(2011). *Biochemistry*. (ed. 3rd) Books and allied (P) ltd.

Reference Books:

1. Williams, M. H., Rawson, E. S., & Branch, J. D. (2017). *Nutrition for Health, Fitness, and Sport*. McGraw Hill international edition.
2. Mahan, L. K., & Raymond, J. L. (2016). *Krause's Food & the Nutrition Care Process-E-Book*. Elsevier Health Sciences.
3. Devlin T. M. (2011). *Textbook of Biochemistry with Clinical Correlations*. John Wiley & Sons, Inc. (New York)

19UBCDC501	DSE Core-1:Plant Biochemistry	4 Hrs/wk	4 Credits
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Objectives:

To enable the students to

- Understand process of photosynthesis and its significance to plant and human environment.
- Understand and explain secondary metabolites and their potential therapeutic and nutritional uses
- Know the biosynthetic pathway of plant hormones

Unit 1: Photosynthesis and Carbon assimilation **[12 Hrs]**

- Introduction to Chloroplast and other plant pigments, PSI and PSII complexes
- Light reaction, Cyclic and non cyclic photophosphorylation.
- Calvin cycle and its regulation
- C4 cycle and Crassulacean acid metabolism (CAM) pathway.
- Photorespiration.

Unit 2: Nitrogen metabolism **[12 Hrs]**

- Biological nitrogen cycle-Nitrate reduction, nitrification denitrification.
- Symbiotic nitrogen fixation; Nodule formation and Nif-gene organization, function and regulation, nitrogenase structure and function
- Non symbiotic nitrogen fixation,
- Assimilation of fixed nitrogen by plants.

Unit 3: Regulation of plant growth **[12 Hrs]**

- Introduction to plant hormones.

- Biochemistry and mode of action of Auxins, Gibberellins, Cytokinins, Ethylene and Abscisic acid.
- Regulation of plant morphogenetic processes by light.

Unit 4: Plant Diseases and Defense Mechanism [12 Hrs]

- Biochemistry of bacterial, viral and fungal disease
- Overview of plant defense mechanisms against common plant pathogens.
- Mineral nutrient deficiency in plants.

Unit 5 : Secondary metabolites [12 Hrs]

- Introduction to secondary metabolites and its classification
- Alkaloids: Amino acid precursors and functions.
- Phenolic Compounds: Simple phenylpropanoids, Coumarins, Benzoic acid derivatives, flavonoids, tannins and lignin and biological role.
- Terpenoids and Carotenoids: Classification and biological functions.

Text Books:

1. Heldt, H. W., & Piechulla, B. (2004). *Plant Biochemistry*.(ed. 3rd) Academic Press.
2. Taiz L. & E-Zeigler (1998), *Plant Physiology*. (ed. 2nd), Sinauer Associates, Inc., Publishers..

Reference Books:

1. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2000). *Biochemistry & Molecular Biology of Plants* (Vol. 40). Rockville, MD: American Society of Plant Physiologists.
2. Peter J. Lea & Richard C. Leegood (1999). *Plant Biochemistry and Molecular Biology*. (ed. 2nd), John Wiley and Sons.

19UBCDC502	DSE Core-2: Basic Microbiology	4 Hrs/wk	4 Credits
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Objectives:

To enable the students to

- Study different categories of microorganisms
- Understand the important events and their significance associated with microbial metabolism
- Know the principle reasons for and methods of controlling and/or eliminating microorganisms
- Understand microbial mechanism of pathogenicity

Unit 1: Morphology and Ultrastructure [12 Hrs]

- Classification and Ultrastructure of bacteria, fungi, algae and protozoa.
- Structure and Composition of bacterial, fungal and archebacterial cell wall.

- Flagella and pili.
- Cell inclusion bodies.

Unit 2: Microbial Growth and Metabolism **[12 Hrs]**

- Microbial growth - definition. Mathematical expression of growth, growth curve, measurement of growth and growth yields, synchronous growth, continuous culture, factors affecting growth.
- Bacterial Cell division
- Nutritional based microbial classification: Autotrophs, Heterotrophs, Chemolithotrophs and Chemoorganotrophs.
- Nitrogen metabolism, nitrogen fixation.
- Anaerobic fermentation in yeast and bacteria.

Unit 3: Microbiological Techniques **[12 Hrs]**

- Determinative method dependent identification of bacteria.
- Pure culture techniques, Theory and practices of sterilization.
- Types of culture media; simple, Defined, Selective, Differential and Enriched.

Unit 4: Viruses **[12 Hrs]**

- Cultivation of viruses; Cell line dependent, Embryonated egg.
- Structure and Baltimore Classification of virus.
- Replication of Bacteriophage - Lytic cycle and lysogeny.
- Herpes, Pox, TMV, Adenoviruses, Retroviruses, Viroids and Prions

Unit 5: Medical Microbiology **[12 Hrs]**

- Infectious disease transmissions. Respiratory infections caused by bacteria and viruses; Tuberculosis, sexually transmitted diseases including AIDS.
- Vector borne diseases, water borne diseases.
- Pathogenic fungi: Rot, Smut and wilt, Candida and Aspergillus.
- Antimicrobial agents: Types and mode of actions.
- Resistance to antibiotics.

Textbooks:

1. Atlas RM. (1997). *Principles of microbiology*. (ed. 2nd), W M.T.Brown Publishers.
2. Pelczar MJ, Chan ECS and Krieg NR. (1993). *Microbiology*. (ed. 5th), McGraw Hill Book Company

Reference Books:

1. Prescott, L. M., Harley, J. P., & Klein, D. A. (2005). *Microbiology*. 5th. *McGraw JHill Higher Education*.
2. Tortora, G. J., Funke, B. R., Case, C. L., & Johnson, T. R. (2004). *Microbiology: an introduction*. San Francisco, CA: Benjamin Cummings.

19UBCCC504	Core Practical 5: Biochemistry Practicals V	6 Hrs/wk	3 Credits
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Objectives:

To enable the students to

1. Demonstrate proficiency in advanced molecular biology techniques.
2. Identify methods for Genomic and Extra Chromosomal DNA purification and quantification.
3. Use various tools for Gene cloning.

List of Practicals:

1. Isolation of plasmid DNA from *E. coli* cells by CTAB method
2. Isolation of plasmid DNA from *E. coli* cells by alkaline lysis method
3. Digestion of plasmid DNA with restriction enzymes.
4. Gel electrophoresis of digested product.
5. Ligation of foreign DNA in plasmid.
6. Bacterial conjugation.
7. Preparation of bacterial competent cells.
8. Gene transfer in bacterial competent cells by CaCl₂ method.
9. Gene transfer in bacterial competent cells by electroporation method.(demonstration)
10. Antibiotic screening / blue-white selection of transformants.
11. Amplification of a DNA fragment by PCR. (demonstration)
12. Pedigree Analysis.
13. Numerical problems for calculation of gene frequencies.
14. Numerical problems for epistasis.
15. Numerical problems for gene mapping.

Reference Books:

1. Sambrook J., Russell D.W., Maniatis T. (2001) *Molecular cloning: a laboratory manual*. (ed 3rd.).Cold Spring Harbor, N.Y.,Cold Spring Harbor Laboratory Press, 2001.
2. Ausubel F [et al.]. (2001). *Current protocols in molecular biology*.(Vol. 5) New York: John Wiley & Sons.

19UBCDC503	DSE Core Practical-1 Plant Biochemistry Practical	2 Hrs/wk	1 Credit
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Objectives:

To enable the students to

1. Understand Plant growth and development.
2. Study secondary metabolites present in plants.

List of Practicals

1. Induction of hydrolytic enzymes proteinases /amylases/lipase during germination
2. Estimation of carotene
3. Estimation of ascorbic acid
4. Estimation of phenols
5. Estimation of tannins in fruits and vegetables
6. Isolation and estimation of chlorophyll
7. Separation of photosynthetic pigments by TLC

Reference Book:

1. Khan N.A. (2014), *Laboratory manual in Biochemistry*. Daya Publishing House.

19UBCDC504	DSE Core Practical-2 Basic Microbiology Practical	2 Hrs/wk	1 Credit
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Objectives:

To enable the students to

1. Understand appropriate and safe microbiological procedures
2. Understand the staining procedure appropriate for a given microorganism
3. Understand the proper differential & selective media used to culture specific types of bacteria

List of Practicals:

1. Microbiology Laboratory Practices and Biosafety.
2. To study the principle and applications of important instruments (biological safety cabinets, autoclave, incubator, BOD incubator, hot air oven, light microscope, pH meter)
3. Preparation and sterilization of culture media for bacterial cultivation.
4. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/pictographs.
5. Staining of bacteria using Gram staining
6. Isolation of bacteria by different streaking methods.
7. Antibiotic sensitivity test (Disc diffusion methods).

Reference Book:

1. Cappuccino, J. G. (2016). *Microbiology: a Laboratory manual*, Global Edition. Pearson Education Limited.

Semester VI

19UBCCC601	Core 16: Immunology	4 hrs/wk	4 Credits
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Objectives:

To enable the students to

- Identify the Structure and functions of various components of immune System.
- Understand the working and significance of Normal as well as Abnormal functioning of Immune System.

Unit 1: Immunity and Immune Response [12 Hrs]

- Historical Perspective:- Early theories of immunity, discovery of humoral and cellular immunity
- Innate Immunity-Anatomic barrier, Physiologic barrier, Endocytic and Phagocytic barrier, Inflammatory barrier
- Acquired Immunity:- Characteristics of Specific Immune response, Functions of humoral and cell mediated immunity, Generation of cell mediated and Humoral response, Primary and Secondary immune Response, Clonal selection of lymphocytes.
- Major Histocompatibility Complex-Location and Functions of MHC regions, Structure of Class I and II molecules, Organization of class I and Class II genes.
- Polymorphism of Class I and Class II molecules, Peptide binding by MHC molecules

Unit 2: Cells, Organs, Antigen and Antibody [12 Hrs]

- Cell and Organs Involved in the Immune System-Cells of immune system; Lymphoid cells, Mononuclear cells, Granulocytic cells, mast cells, Dendritic cells Primary Lymphoid organs; Bone Marrow, Thymus
- Secondary lymphoid organs; Spleen, Lymph nodes, MALT
- Antigen:- Immunogenicity, Antigenicity, Factors Influencing the Immunogenicity, Adjuvants, Epitopes, Haptens, Exotoxins, Endotoxins, Mitogens.
- Immunoglobulin:- Determination of Basic Structure of immunoglobulin, Introduction to the fine structure of Immunoglobulin, Isotypic, Allotypic and Idiotypic Determinants, Immunoglobulin Classes, Introduction to monoclonal antibodies and Immunoglobulin superfamily.

Unit 3: Complement Fixation and Antigen Antibody Reactions [12 Hrs]

- Antigen-Antibody Reactions in vitro and in vivo-Concept of Antibody affinity and Avidity, Cross Reactivity
- Precipitation reactions in fluids and gels
- Agglutination Reactions; hemagglutination, Bacterial Agglutination, Passive agglutination and agglutination inhibition

- Components of Complement System-, Classical and Alternative pathway of Complement Activation, Cell Lysis, Inflammatory Response, Opsonization, Viral neutralization, .
- Organization and Expression of Immunoglobulin Genes.-Multigene Organization of Ig Genes, variable Region gene Rearrangements. Introduction to generation of antibody diversity and Class Switching

Unit 4: Hypersensitive Reactions, Autoimmunity and Tumor Immunology [12 Hrs]

- Hypersensitive Reaction-Ig E Mediated Hypersensitivity, Antibody Mediated Cytotoxic Hypersensitivity, Immune Complex mediated hypersensitivity T_{DTH} mediated hypersensitivity
- Tumor immunology-Tumor specific antigens and tumor associated Antigens Immune Response to Tumors
- Autoimmune Diseases-Organ Specific Autoimmune Diseases; Hashimoto's Thyroiditis, Autoimmune Anaemia's, Goodpasture's Syndrome, Insulin Dependent Diabetes Mellitus, Graves Disease, Myasthenia Gravis
- Systemic Autoimmune Disease; SLE, Multiple Sclerosis, Rheumatoid Arthritis

Unit 5: Processing and Presentation of Antigen, Vaccines and Immunodeficiency [12 Hrs]

- Antigen Processing and Presentation-The Cytosolic Pathway; proteasome mediated peptide generation, peptide transport from to cytosol to RER, Overview of the pathway
- The Endocytic Pathway; Peptide generation of endocytic vesicles, Transport of Class II MHC molecule to Endocytic Vesicles, Overview of the pathway
- Vaccines-Active and passive Immunization, Whole Organism vaccine, Introduction to Recombinant Vector vaccine, DNA Vaccine, Multivalent Subunit Vaccine.
- HIV and Immunodeficiency-Structure of HIV, Target cell of HIV and consequences of infection, Transmission of HIV, Diagnosis of HIV infection,
- Concept of HAART.
- Severely Combined Immuno Deficiency Disease and AIDS

Text Books

1. Dr. P. M. Latha, (2012). *A Text Book of Immunology*. S. Chand & Company
2. Ladyard P.M., Whelan A. & Fanger M.W. (2002). *Instant notes in immunology*. Viva Books Private limited

Reference Books

1. Kuby J. (2007). *Immunology* (ed. 6th) New York. W.H Freeman and Company.
2. Male, D., Brostoff, J., Roth, D. B., & Roitt, I. (2006). *Immunology*. (ed. 7th). Philadelphia, PA: Elsevier.

3. A. K. Abbas, A.H. Lichtman, Shiv Pillai, *Cellular and Molecular Immunology* (ed. 7th), Elsevier.

19UBCCC602	Core 17:Advanced Cell Biology	4 hrs/wk	4 Credits
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Objectives:

To enable the students to

1. Acquire in depth understanding and advanced knowledge of a range of general and specialized areas in cell biology.
2. Develop insight into the complexities of cell structure and function, the molecular controls that govern the cells' dynamic properties, and cellular interactions with the organism as a whole.
3. Understand cell signaling and apply this knowledge to the cell functioning and its regulation.
4. Recognize the structure and mechanical elements of cell functioning (including adhesion and mobility) and integrate this knowledge into an understanding of the structural and mechanical on function in normal and diseased cells

Unit 1: Nuclear membrane and Transport **[12 Hrs]**

- Properties and Composition of Nucleus, Nucleolus and Nuclear Membrane
- Structure of Nuclear Pore Complex
- Transport of ribosome, RNA , Proteins across Nuclear Envelope and Nuclear Pore complex.
- Regulation of Nuclear Protein Import and Export.
- Abnormalities associated with Nuclear transport.

Unit 2: Cell-Cell Interaction **[12 Hrs]**

- Cell-Cell Interactions and Cell-Matrix Interactions
- Components of Extracellular Matrix
- Collagen and Non-Collagen Components
- Tight Junctions; Gap Junctions; Desmosomes; Hemidesmosomes; Focal Adhesions And Plasmodesmata
- Cell Wall; Role of Cell Interaction in Development.

Unit 3: Control of Cell Cycle and Programmed Cell Death **[12 Hrs]**

- Control and regulation of cell cycle.
- Regulation Of Cell Division And Cell Growth
- Necrosis and Molecular mechanism of Apoptosis .
- Stem Cells And Maintenance of Adult Tissues, Hematopoiesis, Embryonic Stem Cells and Therapeutic Cloning

Unit 4: Cancer Biology **[12 Hrs]**

- Development and Types Of Cancer
- Benign and Malignant Tumors and Steps involved in Metastasis.
- Physical, Chemical and Biological Carcinogens.

- Genetic Basis of Cancer
- Diagnosis and different approaches for cancer treatment

Unit 5: Advanced Methods in Cell Biology

[12 Hrs]

- Ultracentrifugation
- Atomic Force Microscopy.
- Confocal Microscopy
- Plant and Animal Cell Culture
- Immunohistochemistry.

Text books:

1. Cooper, G.M. and Hausman, R.E. (2009). *The cell: A molecular approach*. (ed.5th). Washington, D.C. Sinauer Associates, MA. ASM Press & Sunderland.
2. Karp, G. (2009). *Cell and Molecular Biology: concepts and experiments*. John Wiley & Sons.

Reference Books:

1. Alberts, B., Johnson, A., Lewis, J., and Enlarge, M. (2008) *Molecular Biology of the Cell*. (ed.5th). Garland Science (Princeton).
2. Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J., (2012). *Molecular Cell Biology*. (ed. 7th), W.H. Freeman & Company (New York)
3. Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, G. P. (2009) *The World of the Cell*. (ed. 7th). San Francisco. Pearson Benjamin Cummings Publishing.

19UBCDC601	DSE Core 3-Clinical Biochemistry	4 Hrs/wk	4 Credits
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Objectives:

To enable students to,

1. Identify the different patterns of biochemistry test results observed in various disease states
2. Understand common analytical techniques used in clinical chemistry
3. Understand causes of pre-analytical error and describe the quality control processes used in clinical biochemistry

Unit 1: Laboratory Setup and Safety

[12 Hrs]

- Requirements of setting up of clinical laboratories. Different types of clinical laboratories.
- Introduction to instrumentation and automation in clinical biochemistry laboratories
- SI units in clinical laboratory
- Collection preparation, preservation, and handling of clinical samples
- Quality control, MSDS, Safety measures in clinical laboratory
- Formulation of clinical and diagnostic kits, Safety aspects.

Unit 2: Liver and Kidney Disorders and Diagnosis: [12 Hrs]

- Bilirubin metabolism, types of jaundice and clinical assessment.
- Acute and chronic liver diseases, cirrhosis, viral, metabolic and drug induced/toxic liver diseases.
- Liver cancer, liver function tests, non-invasive investigations of liver function.
- Glomerular filtration rate, Renal threshold and clearance values
- Disorders of kidney, renal failure and proteinuria, renal tubular disorders and renal stones.
- Renal function tests, artificial kidney.

Unit 3: Heart and Blood Disorders And their Diagnosis [12 Hrs]

- Ischemic heart diseases, Cardiovascular stroke, Acute myocardial infarction, cardiac failure.
- Role of enzymes and other proteins as markers in assessment of ischemic heart diseases.
- Hypertension – types and causes of hypertension
- Basis of drug therapy for hypertension. Different classes of antihypertensive drugs and their mode of action.
- Types of anaemia and porphyries and molecular basis of hemoglobinopathies.

Unit 4: Inborn Errors of Metabolism: [12 Hrs]

- Disorders associated with carbohydrate metabolism-glycogen storage diseases, Galactosemia, Lactose intolerance.
- Protein metabolism – phenylketonuria, albinism, alkaptonuria
- Lipid metabolism – Niemann – Pick disease, Tay-Sach's disease, Gaucher's disease.
- Disorders due to chromosomal aberrations. Their molecular basis, symptoms, diagnosis and management: Down's syndrome, Turner's syndrome, Klinefelter's syndrome.

Unit 5: Ageing: [12 Hrs]

- Definitions, contributory factors for longevity. Constructive use of extended life span by elderly people. Physiological and biochemical changes in ageing.
- Model systems for ageing related studies.
- Different theories of ageing.
- Importance of antioxidant vitamins, superoxide dismutase and other enzyme systems in ageing.

Text Books:

1. Kaplan L.A. and Pesce A. J. C. V. Mosby, (1989). Clinical Chemistry.
2. Mukherjee, K.L., (2010), Medical Laboratory Technology - a Procedure Manual for Routine Diagnostic Tests Vol.I-III Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi)

Reference Books:

1. W. J. Marshall and S. K. Bangert, Churchill Livingston N.Y.(1995). Clinical Biochemistry.
2. Tietz Text book of Clinical Chemistry 2nd edition, (1994).
3. Baynes, J.W. and Dominiczak, M.H., (2005) Medical Biochemistry 2nd ed., Elsevier Mosby Ltd. (Philadelphia)

19UBCDC602	DSE Core 4: Bioinformatics	4 Hrs/wk	4 Credits
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Objectives:

To enable students to,

1. Understand basic concepts of bioinformatics.
2. Understand importance of biological databases and tools.
3. Identify life science oriented web based tools and their use in bioinformatics.

Unit 1: Introduction to Bioinformatics and Databases [12 Hrs]

- History & Future prospects of Human Genome Project
- Overview of Bioinformatics & Applications
- Introduction, Need & Types of databases.
- Biological Databases: Nature of Biological data, Importance of Biological Databases in Biological Discovery
- Microarray-Principle & Applications

Unit 2: Biological Databases - Tools and Their Uses [12 Hrs]

- Introduction to bibliographic databases: PubMed
- Major Bioinformatics Resources: NCBI, EBI & ExPASy
- Nucleic acid sequence databases: GenBank, EMBL, DDBJ
- Protein sequence databases: SWISS-PROT, TrEMBL

Unit 3: Structure Identification, Data Bases And Evolutionary Analysis [12 Hrs]

- Experimental methods for protein structure determination (John Karanicolas) : X-ray crystallography ,Nuclear magnetic resonance (NMR), Infrared Spectroscopy(IR) etc..
- Protein Structure data base: PDB
- Structure databases (CATH, SCOP, and PDBsum)
- Overview of Comparative & Functional Genomics
- Phylogenetic Analysis

Unit 4: Sequence Alignments and Visualization [12 Hrs]

- Introduction to Sequences, alignments and Dynamic Programming; Local alignment and Global alignment (algorithm and example)
- Pairwise alignment (BLAST and FASTA Algorithm)
- Multiple sequence alignment (Clustal W algorithm).

- Methods for presenting large quantities of biological data: sequence viewers (Artemis, SeqVISTA), 3D structure viewers (Rasmol, SPDBv, Chime, Cn3D, PyMol)

Unit 5: Protein: Structure-Based Function Annotation and Drug Discovery Process

[12 Hrs]

- Gene ontology
- Enzyme classification
- Overview of Ligand-protein interaction
- Structure-based function prediction
- Overview of Discovering a drug - target identification and validation

Textbooks:

1. Westhead, D. R., Parish, J. H., & Twyman, R. M. (2002). *Instant Notes: Bioinformatics, The INSTANT NOTES Series*.
2. David, W. M. (2001). *Bioinformatics: Sequence And Genome Analysis*. Cold Spring Harbor Laboratory Press.

Reference Books:

1. Attwood, T. K., & Parry-Smith, D. J. (2003). *Introduction to Bioinformatics*. Prentice Hall.
2. Rastogi .S. C., Rastogi P and Mendiratta N.(2008). *Bioinformatics methods and applications: Genomics proteomics and drug discovery*. PHI Learning Pvt. Ltd
3. Baxevanis, A. D., & Ouellette, B. F. (2004). *Bioinformatics: a practical guide to the analysis of genes and proteins* (Vol. 43). John Wiley & Sons.

19UBCCC603	Core Practical 6: Biochemistry Practicals- VI	6 Hrs/wk	3 Credits
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Objectives:

To enable students to

1. Use modern experimental techniques and instruments.
2. Acquire practical skills for immunodiagnosis of infectious diseases.
3. Critically assess laboratory results.

List of Practicals:

1. Isolation of cell organelles by sub-cellular fractionation method.
2. Study of cell viability /death assay by use of Trypan blue and MTT assay.
3. Identification of cancerous cells using permanent slides
4. Comparison of neoplastic cells with the normal cells using photomicrographs.
5. Ouchterlony Double Diffusion Technique
6. Mancini Radial Immunodiffusion Technique
7. Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
8. Rocket Immunoelectrophoresis Technique

9. Sandwich Dot ELISA method
10. Determination of serum antibody titer
11. Qualitative analysis of hormone using immobilized immunoglobulins

19UBCDC603	DSE Core Practical-3: Clinical Biochemistry Practicals	2Hrs/wk	1 Credit
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Objectives

To enable students to,

1. Understand biochemistry and pathophysiology associated with tests performed in a clinical biochemistry laboratory.
2. Perform different clinical tests and evaluate common result patterns in routine clinical biochemistry investigations.

LIST OF PRACTICALS

1. Estimation of Blood Glucose by Glucose Oxidase/Peroxidase (GOD-POD) method.
2. To perform and interpret glucose tolerance test (GTT).
3. Estimation of Blood urea and Serum creatinine to evaluate kidney function.
4. Estimation Total Protein, Serum Albumin and Globulin levels and A/G ratio.
5. Estimation Of Aminotransferases (Transaminases)
6. Estimation of Serum Bilirubin and its role in diagnosis in different types of jaundice.
7. Lipid profile :serum triglycerides, Cholesterol (Total), LDL and HDL cholesterol
8. Estimation of Enzymes in diagnosis of myocardial infarction.
9. Estimation of Serum Calcium, Phosphorus (Inorganic)
10. Estimation of Serum Uric Acid in diagnosis and management of gout.
11. To estimate serum amylase.
12. Thyroid function tests: T3, T4 and TSH estimation methods and their interpretation.

Reference Books:

1. Godkar B.P. (1994). *Clinical Biochemistry Principle And Practice*. Mumbai Bhalani Publishing House
2. Mukherjee, K.L., (2010), *Medical Laboratory Technology - A Procedure Manual For Routine Diagnostic Tests* (Vol.I). NewDelhi, Tata Mc Graw–Hill Publishing Company Limited .

19UBCDC604	DSE Core Practicals- 4: Bioinformatics Practicals	2 Hrs/wk	1 Credit
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Objectives

To enable students to

1. Understand the major public sequence databases,
2. Recognize different computational tools to find sequences, analysis of protein and nucleic acid sequences by various software packages
3. Understand phylogenetic analysis and predict protein structures

List of Practicals:

1. Introduction to PUBMED database using the ENTREZ search engine.
2. Retrieval of desired biological sequences by exploring and querying the nucleic acid databases. GenBank, EMBL & DDBJ
3. Database similarity search through BLAST.
4. Getting the amino acid sequences by exploring and querying the protein sequence database.: Swiss Prot, Uniprot.
5. 3-D Protein structure visualization using RasMol.
6. Multiple alignment of the given sequences by using ClustalW

Reference Books:

1. Attwood, T. K., & Parry-Smith, D. J. (2003). *Introduction to bioinformatics*. Prentice Hall.
2. Rastogi .S. C., Rastogi P and Mendiratta N.(2008). *Bioinformatics methods and applications: Genomics proteomics and drug discovery*. PHI Learning Pvt. Ltd