Enclosure- I

Shree Manibhai Virani and Smt.Navalben Virani Science College,Rajkot (Autonomous)
Affiliated to Saurashtra University, Rajkot

Department of Biochemistry

B.Sc. BIOCHEMISTRY Syllabi for Semester V & VI

SEMESTER -V

16UBCCC16	**Core -12: Molecular Biology –II Gene Expression and Regulation**	**4 Hrs/wk**	**4 Credits**

Objectives:

To enable the students to:

1. Compare and contrast the mechanisms of bacterial and eukaryotic Transcription, and Translation.
2. Understand the molecular mechanisms behind different modes of gene regulation in bacteria and eukaryotes at both pre- and post-transcriptional levels.

Unit 1: Biosynthesis of RNA in Prokaryotes (8 Hrs)

- RNA polymerases, transcription cycle in bacteria, sigma factors, bacterial promoters, identification of DNA binding sites by DNA footprinting,
- RNA synthesis- initiation, elongation and termination
- Inhibitors of transcription and applications as anti-microbial drugs.

Unit 2: Biosynthesis of RNA in eukaryotes (10 Hrs)

- Comparison between prokaryotic and eukaryotic transcription.
- Transcription by RNA polymerase II, RNA polymerase II core promoters, general transcription factors, transcription by RNA polymerase I and III, various types of RNA processing .
- Post transcriptional modifications, Chemistry of RNA splicing, the spliceosome machinery, splicing pathways, group I and group II introns, Alternative splicing, exon shuffling, RNA editing.
- Inhibitors of eukaryotic transcription and their applications.

Unit 3: Biosynthesis of proteins (10 Hrs)

- Genetic code and its characteristics.
- Overview of protein synthesis and role of different types of RNA.
- Protein Synthesis in prokaryotes and eukaryotes.
- Inhibitors of protein synthesis and applications in medicine.

- Post translational modifications, signal sequences for cellular compartments, bacterial signal sequences

Unit 4: Regulation of gene expression in prokaryotes (10 Hrs)

- Principles of gene regulation, negative and positive regulation,
- Concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and trp operon,
- Induction of SOS response, transcriptional regulation in λ bacteriophage.

Unit 5: Regulation of gene expression in eukaryotes (10 Hrs)

- Heterochromatin, euchromatin, chromatin remodeling,
- Regulation of galactose metabolism in yeast.
- Tissue specific gene expression.
- Regulation by phosphorylation of nuclear transcription factors, regulatory RNAs, riboswitches,
- RNA interference – mechanism and importance.

Text Books:

1. Rusell P. (2010). *iGenetics: A Molecular Approach*. 3rd Edition. Pearson Benjamin Cummings Publishing.
2. Watson, J. D., Bell, S. P., Gann, A., Baker, T. A., Losick, R., & Levine, M. (2011). *Molecular biology*. Pearson.

Reference Books:

1. Karp, G. (2009). *Cell and Molecular Biology: concepts and experiments*. John Wiley & Sons.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). *Cell and Molecular Biology*.(ed. 8th). Philadelphia, Lippincott Williams and Wilkins,.
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.

16UBCCC17	Core -13: Genetic Engineering and Biotechnology	4 Hrs/wk	4 Credits

Objectives:

To enable the students to

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

Unit 1: Introduction to Biotechnology and DNA Cloning (9 Hrs)

- Milestones in genetic engineering and biotechnology.

- 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, BAL31, mung bean nuclease, S1 nuclease.
- Simple cloning of DNA fragments, process of cloning and their applications.

Unit 2: Vectors in Recombinant DNA Technology (10 Hrs)

- Vectors: Definition and properties. Plasmid vectors-pBR and pUC series, Bacteriophage lambda and M13 based vectors, Cosmids.
- Overview of Shuttle vectors-BACs, YACs, MACs.
- *E. coli* expression vectors-lac, tac and T7 promoter based vectors.
- Baculovirus based vectors. Ti based vectors (Binary and Cointegrated vectors)

Unit 3: Gene Delivery and Analytical Methods (10 Hrs)

- Gene Recombination and Gene transfer : Bacterial Conjugation, Transformation, Transduction, Episomes, , Microinjection, Electroporation, Microprojectile, Shot Gun method, Ultrasonication, Liposome fusion, Microlaser and viral-mediated delivery, *Agrobacterium*-mediated delivery.
- Polymerase chain reaction – tools and mechanism , RT-PCR and Reverse transcription PCR.
- Agarose gel electrophoresis, Southern and Northern blotting techniques, Dot blot.
- Brief introduction to: Chromosome walking and jumping, DNA fingerprinting by RFLP and RAPD, SDS-PAGE and Western blotting.
- Gel retardation assays. DNA footprinting by DNase I, DNA microarray analysis.

Unit 4: Genomic libraries and sequencing (9 Hrs)

- Genomic and cDNA libraries: Preparation and uses.
- Screening of libraries by colony hybridization and colony PCR.
- Maxam-Gilbert's, Sanger's and Automated methods for DNA sequencing.
- Human genome sequencing project.

Unit 5:Applications of genetic engineering (10 Hrs)

- Site-directed mutagenesis and Protein engineering
- Applications of genetic engineering: in medicine, production of recombinant pharmaceuticals such as insulin, human growth hormone, factor VIII. Recombinant vaccines. Gene therapy.
- Applications in agriculture- GM crops for disease resistance, yield and quality improvement
- Applications in microbiology- environment, dairy, strain improvement.
- Biotechnology: 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

16UBCCC18	Core 14: Nutritional Biochemistry-Self Study	4 Hrs/wk	4 Credits

Objectives:

To enable the students to

1. Understand biochemical and physiological functions of the nutrient and illustrate roles of nutrients in these functions.
2. Identify methods to assess nutrient status and the strengths and weaknesses of these methods.
3. Understand manifestations of deficiency and toxicity states and relate biochemical and physiological roles of nutrients to these manifestations.

Unit 1: Introduction to Nutrition and Energy Metabolism (10 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, Biological oxidation of foodstuff. Measurement of energy content of foods, Physiological energy value of foods, SDA.
- Measurement of energy expenditure. Direct and Indirect Calorimetry, Factors affecting thermogenesis, Basal Metabolic Rate (BMR).
- Physical activity, Overview of calories burned during different types of physical activities, Factors affecting energy input - hunger, appetite, Energy balance.
- Energy requirements for different age groups.

Unit 2: Nutritionally Important Carbohydrates and Lipids (10 Hrs)

- Overview of functions of carbohydrates. Sources, Digestion, absorption, utilization and storage of carbohydrates, Glycemic Index (GI) and low GI foods.
- Dietary fibers 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.
- Different food sources of proteins, digestion and absorption of proteins.
- Essential and Nonessential amino acids.
- Concept of Protein quality and different ways and means of improving protein quality in human diet.
- Protein calorie malnutrition; Marasmus and Kwashiorkor.

Unit 4: Fat and Water Soluble Vitamins (10 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 (9 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)

16UBCDC01	DSE Core-1:Plant Biochemistry	4 Hrs/wk	4 Credits

Objectives:

To enable the students to

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

Unit 1: Photosynthesis and Carbon assimilation (10 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 (9 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 (9 Hrs)

- Introduction to plant hormones.
- Biochemistry and mode of action of Auxins, Gibberellins, Cytokinins, Ethylene and Abscissic acid.
- Regulation of plant morphogenetic processes by light.

Unit 4: Plant Diseases and Defense Mechanism (10 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 (10 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.

16UBCDC02	DSE Core-2: Basic Microbiology	4 Hrs/wk	4 Credits

Objectives:

To enable the students to

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

Unit 1: Morphology and Ultrastructure (9 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 (9 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 (10 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 (10 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 (10 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.

16UBCDC03	DSE Core-3: Research Methodology	4 Hrs/wk	4 Credits

Objectives:

To enable the students to

1. Understand the significance of research methodology in life science research.
2. Understand the types, tools and methods of research

Unit 1: Introduction to Research Methodology (9 Hrs)

- Science, scientific methods, scientific approach.
- Objectives of research: Explanation, control and prediction.
- Types of research: Historical, Descriptive, Experimental, case study
- Social research and survey: Meaning, definition, nature, scope, objects, types. distinction between social survey & research.
- Pre-testing and pilot survey.

Unit 2: Identification to Research Problem (9 Hrs)

- Definition and identification of research problem.
  • Selection of research problem.
  • Justification.
- Fact, Theory and concept.

- Hypothesis : Definition, sources, characteristics, importance, main difficulties in formation of hypothesis, disadvantages, Limitations and Delimitations of the problems.
- Types of variables.

Unit 3: Research Design **(10 Hrs)**

- Basic principles of research design:
  • Purposes of research design: fundamental, applied and action, exploratory, and descriptive, experimental, ex-post facto.
  • Longitudinal and cross sectional, co-relational.
- Data gathering instrument.
  • Observation,Questionnaire,Interview, Scaling method, Case study, Home visits.
- Reliability and validity of measuring instruments.

Unit 4: Theory of Probability and Sampling **(10 Hrs)**

- Non-probability sampling: purposive, Quota and volunteer sampling/snow ball sampling
- Sampling : Population and sample, Meaning, Characteristics, advantages and disadvantages.
- Types : Probability sampling, Random sampling (Simple random, systematic random sampling,), Purposive sampling, Stratified sampling, Other sampling methods (two stages and multistage sampling, cluster sampling.

Unit 5: Data Analysis and Presentation **(10 Hrs)**

- Classification and tabulation of data.
- Analysis and interpretation of data.
- Preparation of report
- Diagrammatic presentation of data

Text Books:

1. Chawla, D., & Sodhi, N. (2011). *Research methodology: concepts and cases*. Vikas Publishing House.
2.Khan, I. A., & Khanum, A. (2004). *Fundamentals of Biostatistics*. Ukaaz Publications.

Reference Books:

1 Kothari, C. R. (2004). *Research methodology: Methods and techniques*. New Age International.
2. Kumar R (2005*). Research methodology: A step by step guide for beginners*, (ed.2nd), Pearson Education.
3. Daniel, W. W., & Wayne, W. D. (1978). *Biostatistics: a foundation for analysis in the health sciences* . New York: Wiley.

16UBCCC19	Core Practical 5: Advanced Molecular Biology Practicals	6 Hrs/wk	3 Credits

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. Amplification of a DNA fragment by PCR.
6. Ligation of foreign DNA in plasmid.
7. Bacterial conjugation.
8. Preparation of bacterial competent cells.
9. Gene transfer in bacterial competent cells by $CaCl_2$ method.
10. Gene transfer in bacterial competent cells by electroporation method.
11. Antibiotic screening / blue-white selection of transformants.

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.

16UBCDC04	**DSE Core Practical-1 Plant Biochemistry Practical**	**2 Hrs/wk**	**1 Credit**

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.

16UBCDC05	**DSE Core Practical-2 Basic Microbiology Practical**	**2 Hrs/wk**	**1 Credit**

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.

16UBCDC06	**DSE Core Practical-3 Research methodology Practical**	**2 Hrs/wk**	**1 Credit**

1. A teacher (adviser) who would guide the student will discuss with student and identify a topic of mutual interest.
2. The student will collect the literature, collate the information and write the same in the form of a term paper with proper incorporation of references using appropriate software such as EndNote.
3. The student will identify scope of research on the topic and will frame objectives to be addressed in the project through a work plan.
4. The student will write standard operating protocols (SOPs) and identify requirement for equipment and reagents.
5. Each student will be asked to make presentation about the project including literature available, objective sought and work plan including methodologies as described above.

Semester VI

16UBCCC22	Core 16:Advanced Cell Biology	4 hrs/wk	4 Credits

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 (9 Hrs)

- Properties and Composition of Nuclear Membrane
- Structure of Nuclear Envelope
- Nuclear Pore Complex
- Transport Across Nuclear Envelope
- Regulation of Nuclear Protein Import and Export.

Unit 2: Cell-Cell Interaction (10 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: Cell Cycle and Programmed Cell Death (10 Hrs)

- Overview of The Cell Cycle
- Eukaryotic Cell Cycle; Events Of Mitotic Phase; Cytokinesis; Events Of Meiosis And Fertilization
- Regulation Of Cell Division And Cell Growth;
- Apoptosis And Necrosis,
- Stem Cells And Maintenance of Adult Tissues, Hematopoiesis, Embryonic Stem Cells and Therapeutic Cloning

Unit 4: Cancer Biology (9 Hrs)

- Development and causes Of Cancer

- Genetic Basis of Cancer
- Oncogenes, Tumor Viruses
- Molecular Approach to Cancer Treatment.

Unit 5: Advanced Methods in Cell Biology (10 Hrs)

- Ultracentrifugation,
- Fluorescence Microscopy- FACS
- Confocal Microscopy
- Electron 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.

16UBCCC23	Core 17: Immunology	4 hrs/wk	4 Credits

Objectives:

To enable the students to

1. Identify the Structure and functions of various components of immune System.
2. Understand the working and significance of Normal as well as Abnormal Functioning of Immune System.

Unit 1: Immunity and Immune Response (9 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 (10 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 (10 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 (10 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 **(9 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.

16UBCDC07	DSE Core -4 Plant Tissue Culture	4 Hrs/wk	4 Credits

Objectives:

To enable students to,

- Understand basic concepts of plant tissue culture
- Identify nutritional requirement of plant.
- Understand different plant tissue culture techniques.
- Practice storage and preservation of germplasm

Unit 1: Introduction to Plant Tissue culture **(9 Hrs)**

- Introduction to Plant Tissue culture
- Principle and significance of tissue culture
- Historical background
- Laboratory organization - Tools and techniques,
- Methods of sterilization - Laboratory contaminants; it's control and measures

Unit 2 : Media Preparation **(9 Hrs)**

- Role of micro and macro nutrients, Vitamins and carbon source in tissue culture
- Growth regulators and its in vitro role
- Media preparation- methodology and factors affecting media preparation
- Various types of tissue culture media *viz.* MS, B5, SH, woody plant medium, Nistch
- Role of environmental conditions; pH, temperature, light, humidity

Unit 3: Culture Techniques I (10 Hrs)

- Explants selection and preparation
- Sterilization and inoculation of explant
- Callus culture
- Embryo culture and embryo rescue
- Micropropagation – various stages

Unit 4: Culture Techniques II (10 Hrs)

- *Invitro* production of haploids
- Protoplast culture
- Special culture techniques
- Protoplast fusion – Chemical and Physical methods
- Selection of hybrids after fusion experiments – Use of visual markers and complementation

Unit 5 :Applications of Plant Tissue Culture (10 Hrs)

- Suspension culture and secondary metabolites
- Somatic embryogenesis
- Synthetic seed technology
- Germplasm storage amd cryopreservation
- Various applications of plant tissue culture

Text Books:

1. Chawla, H. S. (2012). *Introduction to Plant Biotechnology*. New Delhi. Oxford & IBH Publishing Co. Pvt. Ltd.
2. S. S. Bhojwani, M.K. Razdan; *Plant Tissue Culture, Theory and Practice*, (Rev ed.), Elsevier

Reference books:

1. Razdan, M. K. (2003). *Introduction to Plant Tissue Culture*. (ed. 3rd). Science Publishers
2. Purohit, S. D. (2012). *Introduction To Plant Cell Tissue And Organ Culture*. PHI Learning Pvt. Ltd..
3. Bhojwani, S. S., & Dantu, P. K. (2013). *Plant Tissue Culture: An Introductory Text* .India: Springer.

16UBCDC08	DSE Core 5-Clinical Biochemistry	4 Hrs/wk	4 Credits

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 (9 Hrs)

- Requirements of setting up of clinical laboratory Introduction to instrumentation and automation in clinical biochemistry laboratories
- SI units in clinical laboratory
- Collection preparation, preservation, and handling of clinical samples
- Quality control, Safety measures in clinical laboratory
- Formulation of clinical and diagnostic kits, Safety aspects.
- Use of LDH, SGPT, SGOT, acid and alkaline phosphatase, amylase, lipase, cholesterol, albumin, creatinine etc. in diagnosis and monitoring of disorders

Unit 2: Liver And Kidney Disorders And Diagnosis: **(10 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.
- Glomrular 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 Diagnosis (10 Hrs)

- Ischemic heart disease
- Role of enzymes and other proteins in assessment of myocardial infarction.
- Hypertension – types and causes of hypertension
- Basis of drug therapy for hypertension
- Total and differential blood count
- Blood groups and Rh factor incompatibility
- Plasma proteins
- Types of anaemias and porphyries and molecular basis of hemoglobinopathies.

Unit 4: Inborn Errors Of Metabolism: (10 Hrs)

- Disorders associated with carbohydrate metabolism-glycogen storage diseases, Galactosemia

- Protein metabolism – phenylketonuria, albinism, alkaptonuria
- Lipid metabolism – Niemann – Pick disease, Tay-Sach's disease, I-cell disease
- Disorders due to chromosomal aberrations – Down's syndrome, Turner's syndrome, Klinefelter's syndrome molecular basis and symptoms.

Unit 5: Ageing: (10 Hrs)

- Physiological and biochemical changes in ageing.
- Different theories of ageing
- Importance of superoxide dismutase in ageing, plasticity and regeneration.

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 VoI.I-III Tata Mc Graw – Hill Publishing Company Ltd. (New Delhi)

Reference Books:

1. W. J. Marshall and S. K. Bangert, Churchill Livinston 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)

16UBCDC09	DSE Core 6: Bioinformatics	4 Hrs/wk	4 Credits

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 (9 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 (9 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 (10 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 (10 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 (10 Hrs)

- Gene ontology
- Enzyme classification
- Ligand-protein interaction
- Structure-based function prediction
- 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.

16UBCCC24	Core Practical 6 : Cell Biology and Immunology Practicals	6 Hrs/wk	3 Credits

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 organelles by sub-cellular fractionation.
2. Study of cell viability /death assay by use of trypan blue and MTT assay.
3. Study of apoptosis through analysis of DNA fragmentation patterns in mitochondria.
4. Identification and study of cancerous cells using permanent slides and photomicrographs.
5. Isolation of lymphocytes from blood and macrophages from peritoneal cavity or spleen.
6. Purification of immunoglobulins.
7. Assays based on precipitation reactions - Ouchterlony double diffusion (ODD) and Mancini radial immunodiffusion.
8. Assays based on agglutination reactions - Blood typing (active) & passive agglutination.
9. Rocket Immunoelectrophoresis technique
9. Enzyme linked immune-sorbent assay (ELISA).

16UBCDC10	**DSE Core Practicals-4: Plant Tissue Culture Practical s**	**2 Hrs/wk**	**1 Credit**

Objectives:

To enable students to,

1. Understand the various components of plant tissue culture media, e.g. minerals, growth factors, hormones, and what governs the choice of components,
2. Understand Plant tissue culture techniques , micropropagation, including morphogenesis .

List of Practicals:

1. Study of various laboratory equipments used in plant tissue culture
2. Sterilization techniques in plant tissue culture
3. MS Stock preparation.
4. MS medium preparations
5. Explant selection, treatment and inoculation
6. Subculture of initiated cultures

Reference book:

1. Purohit S. D. and Joshi Neelu. *Molecular biology and biotechnology – a practical manual.* Apex Publishing House

16UBCDC11	**DSE Core Practical-5: Clinical Biochemistry Practicals**	**2Hrs/wk**	**1 Credit**

Objectives

To enable students to,

1. Understand biochemistry and pathophysiology associated with tests performed in a clinical biochemistry laboratory
2. Understand common result patterns related to pathophysiology in relation to routine clinical biochemistry

LIST OF PRACTICALS

1. Estimation of Blood Glucose by Glucose Oxidase Method
2. To estimate the glucose tolerance.
3. Estimation Of Blood Urea and Serum Creatinine
4. Estimation Total Protein, Serum Albumin and Globulin
5. Estimation Of Aminotransferases (Transaminases)
6. Estimation of Serum Bilirubin
7. Estimation of serum triglycerides, Cholesterol (Total), HDL cholesterol
8. Estimation of Enzymes in diagnosis of Myocardial infraction
9. Estimation of Serum Calcium, Phosphorus (Inorganic)
10. Estimation Of Serum Uric Acid
11. Examination of Cerebrospinal Fluid (CSF): to estimate sugar, protein and chloride in CSF (Optional)
12. To estimate serum amylase.
13. Thyroid function test and 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 .

16UBCDC12	DSE Core Practicals- 6: Bioinformatics Practicals	2 Hrs/wk	1 Credit

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