BHARATHIAR UNIVERSITY:: COIMBATORE – 641 046
M.Sc. BIOTECHNOLOGY (UNIVERSITY DEPT.)
(For the students admitted during the academic year 2015– 2016 batch & onwards)
SCHEME OF EXAMINATION

Semester	Paper	Subject	Hrs / week	University examination			Total Marks	Credits
				Dur/ Hrs.	INT.	EXT		
SEMESTER I								
15BIOBC01	Paper-I	Biochemistry	4	3	25	75	100	4
15BIOBC02	Paper - II	Cell and Molecular Biology	4	3	25	75	100	4
15BIOBC03	Paper - III	Microbiology	4	3	25	75	100	4
15BIOBC04	Paper – IV	Genetics	4	3	25	75	100	4
15BIOGE01A	Elective - 1	Bio prospecting /	4	3	25	75	100	4
15BIOGE01B	”	Bioinstrumentation						
15BIOGS01	Supportive-1	Tools in Biotechnology	2	2	12	38	50	2
15BIOBCP1	Practical - I	Basic Biotechnology	6	6	25	75	100	4
SEMESTER II								
15BIOBC05	Paper – V	Developmental Biology and Physiology	4	3	25	75	100	4
15BIOBC06	Paper – VI	Immunology	4	3	25	75	100	4
15BIOBC07	Paper - VII	Bioprocess Technology	4	3	25	75	100	4
15BIOBC08	Paper VIII	Systems Biology	4	3	25	75	100	4
15BIOGE02A	Elective - 2	Pharmaceutical Biotechnology /	4	3	25	75	100	4
15BIOGE02B	”	Environmental Biotechnology						
15BIOGS02	Supportive-2	Medical Biotechnology	2	2	12	38	50	2
15BIOBCP2	Practical –II	Advanced Biotechnology	6	6	25	75	100	4
		Summer Training*						2
SEMESTER III								
15BIOBC09	Paper IX	Animal Biotechnology	4	3	25	75	100	4
15BIOBC10	Paper X	Recombinant DNA Technology	4	3	25	75	100	4
15BIOBC11	Paper XI	Plant Biotechnology	4	3	25	75	100	4
15BIOBC12	Paper - XII	Stem Cell Biology and Tissue Engineering	4	3	25	75	100	4
15BIOGE03A	Elective -3	Cancer Biology /	4	3	25	75	100	4
15BIOGE03B	”	Biosafety Bioethics & IPR						
15BIOGS03	Supportive- 3	Plant Molecular Farming	2	2	12	38	50	2
15BIOBCP3	Practical III	Applied Biotechnology	6	6	25	75	100	4
SEMESTER IV								
	Industrial Visit**							2
	Project Work***			-	-	-	200	8
	Total						**2250**	**90**

*** Summer Training:**

All the students have to undergo summer training for period of minimum 30 days. Final reports have to submit which will be evaluated.

** **Industrial visit:**

Students have to undertake an industrial /institutional visit and have to submit report for evaluation

*****Project work:**

The report is the bonafied work carried out by the candidate under the guidance of a faculty authenticated and countersigned by the HOD. This project work must be presented and defended by the candidate in the department attended by all faculties and reviewed by external examiner. Candidate who has presented the work as ‘Not qualified as per CBCS’ must resubmit the project again in the ensuing academic year.

BIOCHEMISTRY

Course Number: 15BIOBC01 **Number of Credits: 4 (Four)**

Scope: This paper presents the study of identification and quantitative determination of the substances, studies of their structure, determining how they are synthesized metabolized and degraded in organisms, and elucidating their role in the operation of the organism.

Objective: On the successful completion of the course the students will get an overall understanding of structure of atoms, molecules and chemical bonds, enzyme kinetics, bio polymers and metabolic reactions in a living system.

Goal: This paper in biochemistry has been designed to provide the student with a firm foundation in the biochemical aspects of cellular functions which forms a base for their future research.

UNIT I

Chemical foundations of Biology- pH, pK, acids, bases and buffers, Henderson - Hasselbach equation, biological buffer solutions.

Energy metabolism (concept of free energy); Principles of thermodynamics; Kinetics, dissociation and association constants; energy rich bonds; weak interactions; coupled reactions and oxidative phosphorylation; group transfer; biological energy transducers; bioenergetics.

UNIT II

Sugars - classification and reactions. Polysaccharides: classification, occurrence, isolation, purification, properties and biological reactions. Glycoproteins and proteoglycans- Structural features of homoglycans, heteroglycans and complex carbohydrates. Glycolysis and TCA cycle; Glycogen breakdown and synthesis; Gluconeogenesis; interconversion of hexoses and pentoses: Co-ordinated control of metabolism.

UNIT III

Proteins: Amino acids and peptides-classification, physico-chemical properties. Peptide bond, Primary structure of proteins, structural comparison at secondary and tertiary levels (Ramchandran map), conformation of proteins and polypeptides (secondary, tertiary, quaternary and domain structure). Silk fibroin, coiled coils, collagen triple helix and hemoglobin. Denaturation and renaturation of proteins. Lysozyme- structure, enzymic activity, mechanism of lysozyme action.

Enzyme Nomenclature; Enzyme kinetics (negative and positive cooperativity); Ordered and ping pong mechanism; Regulation of enzymatic activity; Enzyme catalysis. Active sites; Enzymes and coenzymes: Coenzymes interactions: activators and inhibitors, kinetics of enzyme inhibitors, isoenzymes, allosteric enzymes; Ribozyme, hammer head, hair pin and other ribozymes, strategies for designing ribozymes. Abzyme: structure and drug targets (enzymes and receptors); Drug development; Prodrug delivery using enzymes; Bioluminescence.

UNIT IV

Lipids: Classification, structure and functions. Triglycerides; Phospholipids; Steroids and terpenes. Lipoproteins - structure and function. Role of lipids in biomembranes. Oxidation of fatty acids; Biosynthesis of fatty acids; Triglycerides; Phospholipids; Sterols.

UNIT V

Nucleic acids: Structure of double stranded DNA (B, A, TA, G, and Z DNA). The biological significance of double strandedness, sequence dependent variation in the shape of DNA. Physical properties of double stranded DNA, types of RNAs and their biological significance. Topology of DNA, Conformational properties of polynucleotides, secondary and tertiary structural features and their analysis. Biosynthesis of purines and pyrimidines;

References:

1. Biochemistry (3rd Edition) - Christopher K. Mathews, Kensal E. van Holde, Kevin G. Ahern, Pearson Education.
2. Principles of Biochemistry – Smith et al., McGraw – Hill International book Company, 8th Edition.
3. Principles of Biochemistry – Lehninger , Nelson, Cox, CBS publishers
4. Fundamentals of Biochemistry – Voet et al., John Wiley and Sons, Inc.
5. Biochemistry – Zubay , WCB publishers
6. Harper's Biochemistry – R.K.Murray, D.K.Granner, P.A.Mayes and V.W Rodwell, Prentice-Hall International.
7. Biochemistry (VIthEd.) – J.M Berg; J.L.Tymoczko and L.Stryer, W H Freeman and Company, NY.

CELL AND MOLECULAR BIOLOGY

Course Number : 15BIOBC02 **Number of Credits: 4 (Four)**

Scope: This paper provides a thorough knowledge about structure and function of cells, cellular energetics, protein trafficking, bio molecules and cellular development.

Objective: Understanding the structural and functional aspects of the cell provides the student with a strong foundation in the molecular mechanisms underlying cellular function.

Goal: Students after completion of this paper will be exceptionally well prepared to pursue careers in cellular and sub cellular biological research, biomedical research, or medicine or allied health fields.

UNIT I

Structure and function of cells in prokaryotes and eukaryotes; Structure and organization of Membrane - Model membranes, Glyco conjugates and proteins in membrane systems; Active and passive transport channels and pumps, of cells. Neurotransmission, neuromuscular junction. Extra cellular matrix – cell to cell and cell matrix adhesion – selectins, integrins, cadherins, gap junctions.

UNIT II

Mitochondria – structure, biogenesis; Chloroplast – structure, biogenesis; Molecular events of electron transport chain, ATP synthesis, photosynthesis and photorespiration. Structure of Endoplasmic reticulum, Golgi complex, lysosomes; protein synthesis and post translational modification; of proteins vesicular transport and import into cell organelles

UNIT III

Oxidative reactions in microbodies and nucleus. The nucleosome, the supranucleosomal structures. DNA replication; transcription and translation. Gene regulation: prokaryotic gene regulation- Operon concept; lac operon and tryptophan operon; Eukaryotic gene regulation: transcriptional and translational regulations.

UNIT IV

Cytoskeleton of cells. Mitosis and Meiosis - Regulation of cell cycle; factors and genes regulating cell cycle. Cell signaling – types of cell signaling - G protein mediated, Tyrosine kinase mediated signaling.

UNIT V

Biochemistry and molecular biology of Cancer, tumor suppressor and oncogenes. Llife cycle and molecular biology of some pathogens – AIDS virus, tuberculosis, malarial parasite, hepatitis virus, filarial parasite and kala- azar parasite.

References:

1. Molecular cell Biology, by Darnell, Lodish, Baltimore, Scientific American Books, Inc., 1994.
2. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company, 1993.
3. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
4. Introduction to Practical Molecular Biology, P.D.Dabre, John Wiley & Sons Ltd., New York, 1998.
5. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxfor, 1991.
6. Molecular Biology of the Gene (4^{th} Edition), J.D.Watson, N.H.Hopkins, J.W.Roberts, J.A. Steitz and A.M.Weiner, The Benjamin/Cummings Publ. Co., Inc., California, 1987.
7. Genes VI (6^{th} Edition) Benjamin Lewin, Oxford University Press, U.K., 1998

MICROBIOLOGY

Course Number: 15BIOBC03 **Number of Credits: 4 (Four)**

Scope: This paper provides the knowledge about different types of microorganisms and their identification techniques in modern biology and there by the usefulness of the techniques in research and commercial purposes.

Objectives: In order to make the students to understand the identification of microorganisms using advanced microbiological methods and applications of microorganisms.

Goal: Students can gain the idea of how to identify the microorganisms based on the modern polyphasic approach.

UNIT I

Microbial Diversity: Concepts of species and hierarchical taxa – Bacterial nomenclature – Bergey's system of classification: Family *Enterobacteriaceae, Pseudomonadaceae, Bacillaceae, Chlamydiaceae, Flavobacteriaceae* – Classification of Viruses and Fungi – Polyphasic taxonomy – Preservation and maintenance of microbes – Microbial Culture Collection centers – India and International organizations.

UNIT II

Molecular Taxonomy: Molecular systematics: Polyphasic approach –16S rRNA gene sequencing, Phylogenetic grouping. Techniques used in taxonomy – Mol % G+C analysis, DNA-DNA hybridization, Fatty Acid Methyl Ester (FAME) analysis, peptidoglycan, Isoprenoid and quinones. BIOLOG (Physiological) and MALDI TOF based Microbial Identification.

UNIT III

Metagenomics – culture independent studies: Molecular methods to study complex microbial communities: construction of small insert and large insert metagenomic libraries, DGGE, TGGE, SSCP, T-RFLP, FISH – cloning for functional metagenomics: Screening for cellulose-encoding clones in metagenomic libraries, screening metagenomic libraries for laccase activity

UNIT IV

Agricultural Microbiology: Microorganisms in soil processes – role of microorganisms in soil fertility – carbon cycle – nitrogen cycle: nitrifying and nitrogen-fixing bacteria, microbial transformation of Phosphorus, Sulphur. Biofertilizer (Rhizobium, Azospirillum, Azolla, Phosphobacteria), Biopesticides (Bacillus thruingiensis, NPV, Pseudomonas)

UNIT V

Medical Microbiology:

Bacterial Diseases: Host-parasite relationship, epidemiology, pathogenesis, prevention and treatment –*Staphylococcus*, *Streptococcus*, *Mycobacterium*, *Salmonella* and Yersinia

Viral Diseases: Epidemiology, pathogenesis, prevention and Treatment - H1N1, Polio, Rabies, AIDS

Fungal Diseases: Infections caused by yeast: *Candida.* Filamentous Fungi: *Aspergillus* sp.
Protozoan Diseases: Malaria, Leishmaniasis, and *Ascaris* infection
Diagnosis of infectious diseases: Molecular detection and identification using variants of PCR.

REFERECES:

1. Lansing M. Prescott. Microbiology.
2. Bergey's Manual of Systematic Bacteriology. Volumes 1-5.
3. Oladele Ogunseitan. Microbial Diversity - Form and Function in Prokaryotes.
4. Wolfgang R. Streit and Rolf Daniel. Metagenomics: Methods and Protocols.
5. Dr. A. Mark Osborn and Dr. Cindy J. Smith. Taylor and Francis Group. Molecular Microbial Ecology.
6. Erko Stackebrandt. Molecular identification, systematics, and population structure of prokaryotes.
7. Martin Alexander 1976. Introduction to soil microbiology. Willy Eastern Ltd. New Delhi.
8. Robert L Tate III. 1995. Soil Microbiology. John Wiley & Sons, New York
9. Subbarao N. S. 2006. Soil Microbiology. (4^{th} Edition of Soil microbiology and Plant growth). Oxford & IBH, New Delhi.
10. Motsara,M.R. Bhattacharyya,P. and Srivastava, B. 1995. Biofertilizer-Technology, Marketing and Usage. Fertilizer Development and Consultant Organization, New Delhi.
11. Paul EA (2007) Soil Microbiology, Ecology and Biochemistry. III Edition. Academic Press, Oxford, UK.
12. Baron, Peterson and Finegold. Diagnostic Microbiology.
13. S. Rajan. Medical Microbiology by MJP Publishers.
14. Stephen H. Gillespie and Kathleen B. Bamford. Medical Microbiology and Infection at a Glance.
15. Madigan, M.T., Martinko, j. M., Stahl, D.A., and Clark, D.P. 2012. Brock's Biology of Microorganisms. 13^{th} Edition. Benjamin Cummings, San Francisco, CA.

GENETICS

Course Number: 15BIOBC04 **Number of Credits: 4 (Four)**

Scope: This paper in genetics has been structured to give the student an in depth knowledge of the organization of the genome in prokaryotes and eukaryotes, the principles of genetic inheritance and other vital aspects such as Hardy Weinberg law, pedigree analysis and the genetic basis of disease inheritance.

Objective: The major objective of the paper is to envisage thorough knowledge in genetics and genome organizations in organisms.

Goal: After successful completion of the paper the students will get an overall view about genetic makeup of organisms and can take up a career in research.

UNIT I

Genome Organization in prokaryotes: genome of bacteria, bacteriophage and viruses, plasmids. The fine structure of a prokaryote gene; Genetics of bacteria: transformation, conjugation, transduction; the genetic map of *E.coli* genetic recombination. Genetics of viruses: Life cycle of virulent bacteriophages, temperate phages and prophage; genetic recombination in phages; mapping genes in phage lambda; The RNA phages, tumor viruses and cancer; viroids.

UNIT II

Genome Organization in Eukaryotes, variation in chromosome number: haploidy, polyploidy, aneuploidy. Variation in chromosome structure: deficiency of deletion, duplication, translocation, inversion and B-chromosome. The fine structure of Eukaryote gene; complementation test, pseudo alleles, split genes, overlapping genes; transposons. Linkage and

crossing over; The three point cross; double crossing over, cytological basis of crossing over; sex linkage; recombination in neurospora.

UNIT III

Principles of Mendelian inheritance; Mendel's experiments-monohybrid, dihybrid, trihybrid and multihybrid crosses. Interaction of genes: incomplete dominance, codominance, epistasis, complementary genes, duplicate genes, polymeric genes, modifying genes; Pleotrophy, genome imprinting, inheritance and lethal genes. Environment and gene expression: penetrance and expressivity; temperature, light, phenocopies. Quantitative or polygenic inheritance: Inheritance of kernel color in wheat; corolla length in tobacco skin color inheritance in man, transgressive and regressive variation. Multiple alleles; Sex determination; Non-mendelian inheritance and their effects - maternal effect, epigenetic and extra nuclear inheritance.

UNIT IV

Human Genetics: Introduction to Human Genetics. Human Chromosomes: Structure and organization of DNA; Normal human karyotype: Paris Nomenclature; Chromosomal changes resulting in abnormal phenotype: Numerical (Aneuploidy) changes resulting in genetic syndromes eg: Turner, Down & Klinefelter Syndromes. Structural changes resulting in genetic diseases: eg: Cri-du-chat syndrome, Retinoblastoma, Chronic granulocytic leukemia. Others: Mosaic, Chimera [Individual with two cell lines] Mendelian Traits: Straight hair, Curly hair, Blue and Brown colour of the eyes, Rolling of the tongue, attached and free ear lobes and Hypertrichosis.

UNIT V

Clinical genetics: Genetic Diseases and Inheritance Pattern: Autosomal inheritance – Dominant (Eg: Adult polycystic kidney, Achondroplasia & eurofibromatosis.); Autosomal inheritance – Recessive (Eg: Albinism, Sickle Cell Anemia, Phenyl Ketonuria); X-linked : Recessive (Eg: Duchenne muscular dystrophy – DMD); X-linked : Dominant (eg. **Xg** blood group); Y-linked inheritance (Holandric – eg. Testes determining factor); Multifactorial inheritance (Eg: Congenital malformations – Cleft lip & palate, Rheumatoid arthritis and Diabetes. Pedigree studies: Symbols used in pedigree analysis. Pedigree analysis of important genetic diseases like Haemophilia, Color blindness, Duchenne Musculat Dystrophy (DMD). Mitochondrila disorders like LHON, DAD, MERRF and MELAS. Diagnosis of disease: cytogenetics; Molecular cytogenetics, molelcular genetics ; cancer genetics. Prevention of disease: Prenatal diagnosis; Genetic counseling.

References:

1. The science of Genetics by Alan G. Atherly, Jack. R, Girton, Jhon. F, Mc Donald. Sounders college publishers.
2. Genes VII by Benjamin Lewin
3. Hartl. D.L. A primer of population genetics. III edition, Sinauer associates inc. Sunderland, 2000
4. Molecular cell Biology, Darnell, Lodish, Baltimore, Scientific American Books, Inc., 1994.
5. Molecular and cellular Biology, Stephen L.Wolfe, Wadsworth Publishing Company, 1993.
6. Human genetics, A.Gardner, R.T.Howell and T.Davies, Published by Vinod Vasishtha for Viva Books private limited, 2008.

(ELECTIVE - 1)
BIOPROSPECTING

Course Number: 15BIOGE01A **Number of Credits: 4 (Four)**

Preamble:

Bioprospecting is basically the search for commercially valuable biochemical and genetic resources in plants, animals and microorganisms. These resources may be used in food production, pest control, and the development of new drug and for other related biotechnological applications.

UNIT I

Major area of Bioprospecting : Chemical prospecting, Bionic prospecting and Gene prospecting. Bioresources mapping, inventorisation and monitoring of biological diversity. Biodiversity –conservation biology, endangered specie The convention on biological diversity and benefic sharing, historical context of present bioprospecting, biodiversity prospecting – the INBio experiences, contracts for bioprospecting, natural products research partnerships with multiple objectives in global diversity hotspots.

UNIT II

Natural products from plants, Volatile , pigments and biosynthesis of terpenes, Phenols, nitrogenous compounds and their role. Drugs derived from plants, Antitumor agent - Etoposide, Colchicine, Taxol, Vinblastine, Vincristine. Cardiotonic – Convallatoxin, Acetyldigoxin, Adoniside. Antiinflammatory – Aescin, Bromelain. Choleretic – Curcumin. Quinine-*Cinchona*-Antimalarial Morphine-Opium plant- analgesic.

UNIT III

Screening for bioactivity, antimicrobials, pharmacologically active agents of microbial origin, bioprospecting for industrial enzymes, plant growth promoting agents, biotreatment, bioprospecting novel antifoulants and anti-biofilm agents from microbes. Extinction and the loss of evolutionary history. Biofuels. Bioprospecting of marine organisms.

UNIT IV

Drug discovery and product development: Discovery from traditional medicine. Modern tools in drug discovery Role of chromatography in drug analysis including HPLC, GC and LC and GC Mass spectrometry, FT IR, -NMR their principles and merits. Product development procedures and policies.

UNIT V

Regulatory legistlation and convention in Bioprospecting: rules and regulations in patenting of products and process development and various conventions pertaining to Bioprospecting of products from microorganism, plant and animal products. Bioprospecting policies. Approval and IPR , protection policies of Bioprospecting.

References

1. http://apps.who.int/medicinedocs/en
2. When Nature Goes Public: The Making and Unmaking of Bioprospecting in Mexico By Cori Hayden, Princeton University press.
3. Plants and Empire By Londa L Schiebinger Harvard University Press, 2004
4. *Biotechnology explorations: Applying the fundamentals*, Judith A. Scheppler, Patricia E. Cassin and Rosa M. Gambier.

(ELECTIVE - 1)
BIO-INSTRUMENTATION

Course Number: 15BIOGE01B **Number of Credits: 4 (Four)**

Scope: As a result of the increased demands for physics by students whose primary interests lie in the biological sciences, this course has been written with the hope that it may lead to a fuller appreciation and understanding of the applications of physics to biological problems.

Objectives: The overall objective of this bioinstrumentation is to enrich the student intelligentsia in all the biological observations which are explainable in terms of physical principles as biophysical phenomena.

Goal: To provide a thorough understanding of the analytical techniques and equipment used in biological and medical sciences is an absolute requisite for any student of

life sciences. However, a complete insight into these techniques is possible only when the student understands the basic principles of biophysical chemistry.

UNIT I

Physical techniques in separation of biomolecules:

Centrifugation: Preparative and Analytical Centrifuges, Sedimentation analysis RCF, Density Gradient Centrifugation and ultra centrifugation.

Chromatography Techniques: Theory and Application of Paper Chromatography, TLC, Gel Filtration Chromatography, Ion Exchange Chromatography, Affinity Chromatography, GLC, HPLC and HPTLC.

UNIT II

Electrophoretic Techniques: Theory and Application of PAGE, SDS PAGE, Agarose Gel Electrophoresis 2DE, Iso-electric Focusing, isotachophoresis, pulse field gel electrophoresis, Immuno diffusion, Immuno Electrophoresis , ELISA and RIA.

Cell analysis: Principles and Applications of Light, Phase Contrast, Fluorescence Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Confocal Microscopy and Electron Cryo microscopy.

UNIT III

Structural analysis of Biomolecules: UV, IR, NMR, LASER Raman Spectroscopy, Mass Spectroscopy, Fluorescence Spectroscopy. Differential colorimetry, X ray crystallography, X ray computer tomography and patch clamping

UNIT IV

PCR, Real Time PCR, Cytophotometry, Flow Cytometry, FACS, MACS and Microarray. Circular dichroism and optical rotatory dispersion, Polarography and Manometry – theory and application, Biosensors.

UNIT V

Tracer and other techniques – Radioactive decay, units of radioactivity, detection – Geiger Muller counter, Scintillation counter, Autoradiography. Applications of radio isotopes in biological and medical sciences.

References:

1. Instrumental methods of chemical analysis – P.K. Sharma
2. Biophysical chemistry – Upadhyay., Upadhyay and Nath
3. A Biologist's guide to principle and techniques of practical biochemistry – Brigan L. Williams.
4. Handbook of Biomedical Instrumentation – R.S. Khandpur, Tata McGraw Hill
5. Practical Biochemistry – Principles and techniques -Wilson. K and Walker. J,
6. Experimental methods in Biophysical chemistry- Nicolau, C.
7. Chromatographic methods- Alan Braithwaite, Frank J. Smith
8. Gel Electrophoresis of Nucleic acids-A Practical approach. Rickwood D and BD Hames.
9. Introduction to Spectroscopy- DonaldL.Pavia Gary M.Lipman, George S Kriz.

DEVELOPMENTAL BIOLOGY AND PHYSIOLOGY

Course Number: 15BIOBC05 **Number of credits: 4 (Four)**

Scope: This paper encodes information on the physiology of various eukaryotic systems.

Objective: To enable the students to know the actual path of physiological metabolism of different living system.

Goal: The information gained will help the students to understand the various living system which will help in the future to develop the drugs.

UNIT I

Basic concepts of development:

Production of gametes, cell surface molecules in sperm and egg recognition in animals; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; Morphogenesis and organogenesis in animals (Drosophila, Amphibia and Chick). Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting. Embryogenesis in plants (Arabidopsis).

UNIT II

Plant physiology:

Photosynthesis: Mechanism of photosynthesis, Photorespiration; Plant hormones: biosynthesis, storage, breakdown and transport; physiological effects and mechanism of action. Structure, function and mechanisms of action of phytochromes, cryptochromes and phototropins; stomatal movement; photoperiodism. Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photoassimilates, biosynthesis of terpenes, phenols and nitrogenous compounds and their roles.

UNIT III

Animal physiology:

Digestion and Cardio vascular systems:

Homeostasis, nutrition, structure and functions of digestive system. Physiology of digestion. Blood corpuscules, haemopoiesis, plasma function, blood volume, haemostasis. Comparative anatomy of heart structure, myogenic heart, ECG- its principle and significance, cardiac cycle, blood pressure, neural and chemical regulation of all above.

UNIT IV

Respiration and Excretion:

Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration. Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, electrolyte balance and acid-base balance.

UNIT V

Neuro, muscular and endocrine systems:

Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system. Types, structure and functions of muscles, Physiology of musle contraction. Sense organs: vision, hearing and tactile response. Endocrine glands, basic mechanism of hormone action, hormone and diseases; reproductive processes, neuroendocrine regulation. Thermoregulation.

Reference:

1. An introduction to embryology- Balinsky
2. Developmental biology- Gilbert
3. Chordate embryology- Verma, Agarwal and Tyagi
4. Plant physiology by Delwin and Withem
5. Plant physiology by Lincoin Taiz, Eduardo Zeiger Publishers, Sinauer

IMMUNOLOGY

Course Number: 15BIOBC06 **Number of Credits: 4 (Four)**

Scope: Understanding the immune system, antigen antibody reactions, applications of immunological techniques, humoral and cell mediated immunity, hypersensitivity reactions and hybridoma technology.

Objective: To expose the students with various immune systems of human body.

Goal: This course will provide the student insights into the various aspects of Immunology such as classical immunology, clinical immunology, Immunotherapy and diagnostic immunology.

UNIT I

The Immune System: Innate Immune response and its role in protection. Adaptive Immune response, the humoral and cellular component of the Immune response, Overlap between Innate and adaptive immunity. Cells involved in the Immune response: Macrophages, B and T lymphocytes, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast cells. The lymphoid organs: Bone marrow, Spleen, lymph nodes, MALT. Haemopoiesis and differentiation, lymphocyte trafficking.

UNIT II

Antigen recognition by the immune system: Antigenicity and Immunogenicity. Superantigens. The epitopes seen by B Cells and T Cells. Antibody Molecule: Structure of antibody molecules; Function of antibody molecules; Antibody-Antigen interactions; Immunization protocol; The various immunotechniques for detection and quantification of antigens/antibodies: RID, ODD, immunoelectrophoresis, rocket immunoelectrophoresis, RIA, ELISA, western blot, floweytometry and immunofluorescence microscopy including *in situ* localization techniques such as FISH and GISH. Generation of antibody diversity. Antibody engineering: Hybridoma secreting monoclonal antibodies-Recombinant antibody molecules. Catalytic Antibodies.

UNIT III

Major Histocompatibility Complex: MHC molecules and organization of their genes; Structure and function of MHC gene products. Antigen Presentation: Antigen processing; Role of MHC and non-MHC molecules in antigen presentation. Structure of TCR and its interaction With MHC-I and MHC-II peptide Complex - T cell selection. Organization of TCR gene segments and their rearrangement. Activation of T-cells; Activation T_H and T_C cells; Generation of T memory cells; Apoptosis in T cells. B-Cell maturation: Activation of B Cells; Regulation of B-Cell mediated effector functions. Minor histocompatibility complex and its importance.

UNIT IV

Cytokines: structure of Cytokines; function of Cytokines. The Complement System. Cell mediated effector responses. Immune suppression and immune tolerance. Transplantation immunology- MLR, HLA Typing, Bone marrow transplantation, Organ transplants.

UNIT V

Hypersensitivity reactions, Autoimmune disorders, Immunity to Infectious agents - Bacteria, Viruses, Malaria, Anthrax and Helminthes. Tumor immunology, Tumor antigens, immune response to tumors, Immune escape of tumors. Cancer immunotherapy, Vaccine technology.

References:

1. J.Kuby, 2003, Immunology 5th edition, W.H. Freeman and Company, Newyork..
2. C.V.Rao. 2002, An Introduction to Immunology, Narosa Publishing House, Chennai.
3. K.M.Pavri. 1996, Challenge of AIDS, National Book Trust, India.
4. I.R.Tizard, 1995, Immunology: An Introduction , 4th edition , Saunders College Publishers, New York.
5. I.Roitt, 1994, Essential Immunology, Blackwell Science, Singapore.
6. A. Bul and K.Abbas, 1994, Cellular and Molecular immunology

BIOPROCESS TECHNOLOGY

Course Number: 15BIOBC07 **Number of Credits: 4 (Four)**

Scope: This paper provides the thorough knowledge about types of microorganisms and their applications and there by producing various products of industrial and commercial uses.

Objective: In order make the students to understand the applications and uses of microorganisms.

Goal: Students will get the idea of fermentation technology and to produce economically important products and help to find out new methods and applications of microorganisms.

UNIT I

Fundamentals of Bioprocess engineering: Introduction to bioprocess engineering.
Media design and usage in fermentation: Types of media, composition of media – carbon sources, nitrogen sources, vitamins and growth factors, mineral, inducers, precursors and inhibitors.

Microbial Growth: Isolation, Preservation and Maintenance of Industrial Microorganisms.

Inoculum development: Development of inocula for yeast, bacterial, mycelial and vegetative fungal processes; aseptic inoculation of the fermentor.
Proteins as enzymes, Immobilized enzymes: methods, Industrial enzymes.

UNIT II

Sterilization methods: Moist heat; dry heat, flame, filter, gas (ethylene oxide), HTST (high temperature/short time) treatments – continuous sterilizers and pasteurizers - Sterility, asepsis– medium sterilization, batch sterilization, contiuous sterilization, filter sterilization.

Microbial growth kinetics: Factors affecting microbial growth. Fermentation kinetics: Quantitative description of cellular process, Mass balances for bioreactors, Kinetic modeling, Population models.

Production Kinetics: Design for single and multiple reactions - size comparisons of single reactor for single reactions, multiple reactor systems for single reaction, reactions in parallel, in series, and series-parallel reactions of first order. Heterogeneous reactions, kinetics and mechanism of heterogeneous, non catalytic, and catalytic reactions.

UNIT III

Bioreactors: Introduction to bioreactors; Batch and Fed-batch bioreactors, Continuous bioreactors; solid state and submerged; aerobic and anaerobic fermentation; mixed microbial populations; immobilization of cells and co-immobilization; immobilized cell reactors; Bioreactor operation; Sterilization; Aeration; Sensors; Instrumentation; Analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photobioreactors etc.,).

Design of Bioreactors: Construction material; Basic components – Agitator, aerator, Valves and steam traps, seals, stirrer glands; measurement and control of parameters (online and off line sensors) – temperature, flow rate, pressure, pH, DO, gas analysis, control pathways, computer in controlling; Air-lift, stirred tank, tower, fluidized bed, packed bed, pulsed, photo bioreactors.

UNIT IV

Downstream Processing: Biomass removal: separation of microbial cells and solid matter; Centrifugation; Sedimentation; Flocculation; Microfiltration; Disintegration of microorganism: Sonication; Bead mills; Homogenizers; Chemical lysis; Enzymatic lysis; Membrane based purification: Ultrafiltration ; Reverse osmosis; Dialysis ; Diafiltration ; Adsorption and chromatography: size, charge, shape, hydrophobic interactions, Biological affinity; Process configurations (packed bed, expanded bed, simulated moving beds); Precipitation (Ammonium Sulfate, solvent); Electrophoresis(capillary); Extraction(solvent, aqueous two phase, super critical), Drying – spray driers, drum driers and freeze driers.

UNIT V

Microbial products in pharmaceutical, food and agriculture industry: Production, harvest, recovery and uses – enzymes, Antibiotics (penicillins, tetracycline, streptomycin), vitamins (B_2, B_{12}), Aminoacids (lysine, glutamic acid, arginine, threonine), Organic solvents (acetone, butanol, ethanol, glycerol); Organic acids (acetic acid, citric acid, lactic acid). Use of microbes in mineral beneficiation and oil recovery.

Production, harvest, recovery and uses – Baker's yeast, milk products, edible mushrooms. Single Cell Protein (algae/fungi), beverages (Beer, Wine and Brandy).

Formulation of Biofertilizer (Rhizobium, Pseudomonas) and Biopesticides (*Bacillus thruingiensis*)

Reference:

1. Principles of fermentation technology by P.F. Stanbury and A.Whitaker, Pergamon press. Second edition. 2005.
2. Fermentation microbiology and Biotechnology. Second edition, edited by El-.Mansi, C.F.A. Bryce, A.L. Demain, A.R. Allman. Taylor and Francis, 2007.
3. Introduction to Biochemical engineering by D.G.Rao, McGraw-Hill publications, I edition, 2007.
4. Industrial Microbiology by Prescott and Dunns 4th edition edited by Gerald Reed, Chapman & Hall publications 2007.
5. Industrial microbiology by L. E. Cassida Jr.

SYSTEMS BIOLOGY

Course Number: 15BIOBC08 **Number of Credits: 4 (Four)**

Scope: Biology is fast becoming an interdisciplinary science. There is accumulation of large amount of information in different areas of biology - on genome sequences of many organisms, genetic and biochemical interaction networks, cell interactions during development, and organism response to environmental stimuli, along with molecular understanding of diseases. This has led to the emerging need for a holistic description of the working of biological systems at different scales.

Objectives: Gain an appreciation for the field of systems biology. Understand and learn the technical details of several current experiments or technologies used in the field of systems biology. Understand some of the larger questions and issues with systems biology and large-scale data collection and analysis.

Goal: This paper has been designed to give the students comprehensive training in the emerging exciting upcoming area of Systems Biology, which will help students to get a career in both industry/R&D.

UNIT I

Introduction: Databases and Retrieval tools: Nucleic acid and protein sequence databases; data mining methods for sequence analysis, web-based tools for sequence searches, motif analysis and presentation. Systems Biology: Definition, Hypothesis driven research in systems biology, Wet experiments-Dry experiments: predictions and simulations. Molecular databases: accessibility, compatibility, comprehensive database, portability, quality and navigability. Reductionist and Integrative approach.

UNIT II

Genes and Genomes: Interpreting expression data using Gene Ontology; Evolution of modularity and transcriptional networks, Riboswitches, metabolite sensing and translational control; Microarrays-types and applications, Importance of non-coding sequence

UNIT III

Pathway Bioinformatics: Protein-carbohydrate metabolism; Biochemical cycles; Interconnection of pathways-metabolic regulation; Translating biochemical networks into linear algebra; KEGG: theory and practice.

UNIT IV

OMICS Concepts: Genomics, Proteomics, Metabolomics, transcriptomics, intactomics, Phenomics, localizomics; Gene networks - Integration of Networks. Combination of omics approaches: data integration, modeling; Synthetic biology

UNIT V

Introduction to Tools for Systems Biology: SimTK ; Gaggle; Systems Biology Workbench; Systems Biology Markup Language; The CellML language; The little b Modeling Language; Copasi (Version 4 of Gepasi); E-Cell System; StochSim; Virtual Cell; JigCell (John Tyson Lab); Python Simulator for Cellular Systems; Ingenuity Pathways Analysis; BIOREL; SAVI Signaling Analysis and Visualization; JSim; BioNetGen; SBML-PET.

References:

1. Bioinformatics and Functional Genomics by Pevsner, J**.** A John Wiley & Sons, Inc., USA**.**
2. Kitano, Systems Biology: A Brief Overview. Science, 2002, 295: 1662-1664.
3. Ideker et al. A new approach to decoding life: Systems Biology. Annual Review on Genomics and Human Genetics 2001, 2: 343-372.
4. Ideker et al. Integrated Genomic and Proteomic Analyses of a Systematically Perturbed Metabolic Network. Science, 2001, 292: 929-934
5. Ge et al. Integrating 'omic' information: a bridge between genomics and systems biology. Trends in Genetics, 2003, 19, 10: 551-560.
6. Chong et al. Wholistic Biology, Science, 2002, 295:1661.
7. Catherine et al. The European Bioinformatics Institute's data resources: towards systems biology. Nucleic Acids Research, 2005, 33:46-53.

(ELECTIVE - 2)
PHARMACEUTICAL BIOTECHNOLOGY

Course Number: 15BIOGE02A **Number of Credits: 4 (Four)**

Scope: This paper aims to cover all the latest and outstanding developments in Pharmaceutical Biotechnology.

Objective: To enable the students to understand biopharmaceutical development.

Goal: The information gained will help the students to understand sources, formulation, manufacturing and delivery of novel biopharmaceuticals.

UNIT I

Introduction To Pharmaceuticals

Introduction-Biopharmaceuticals and pharmaceutical biotechnology; Sources of drug-plant, animals, microbes and minerals; Physico-chemical properties of the drugs; Drug isolation and evaluation; Delivery of biopharmaceuticals-Oral, Pulmonary, Nasal, Transmucosal and Transdermal delivery system; Drug metabolism-Pharmacokinetics: Absorption, Distribution, Metabolism and Excretion (ADME) and Pharmacodynamics; Mechanism of drug action; Drug receptors.

UNIT II

Sources Of Biopharmaceuticals

Sources of Biopharmaceuticals-*E.coli*; Animal cell culture system; Yeast (*Saccharomyces cerevisiae)*; Fungus; Transgenic animals; Transgenic plants and Insect-based systems. Nucleic acids of therapeutic interest; Biosimilar drugs- Growth Hormones, Blood products; Therapeutic enzymes.

UNIT III

Drug Development Processes

Discovery of biopharmaceuticals-Impact of genomics and related technologies upon drug discovery; Gene chips; proteomics; structural genomics; pharmacogenetics; Initial product characterization; Pre-clinical studies-Toxicity (Reproductive toxicity and Teratogenicity, Mutagenicity, Carcinogenicity and Other tests); Clinical trials - Clinical trial design, Trial size design and study population.

UNIT IV

Dosage Forms And Manufacturing Principles

Chemical reactions-Protein (Proteolysis, deamidation, Oxidation, disufide exchange), reduction, hydrogenation, dehydrogenation; Stabilizing excipients; Manufacturing principles-Compressed tablets, Controlled and sustained release dosage forms-enteric-coated tablets and capsules, Pills, Liquids, Parental injections, Ointments and Creams, Emulsion and Suspensions; Quality control; Packing and packing techniques; Good Manufacturing Practice (GMP).

UNIT V

Regulatory Aspects

Regulatory authorities - Food and drug administration (USA)- Investigational new drug application, New drug application; European regulations-National regulatory authorities, European medicines agency and the new EU drug approval system, Centralized procedure, Mutual recognition; Drug registration in Japan; World harmonization of drug approvals.

Reference:

1. Gary Walsh (Ed) 2005. Pharmaceutical Biotechnology – Concepts and Application.
2. Andrew Sinclair 2006. A Practical Guide to Biopharmaceutical Manufacturing.
3. Goodman & Gilman's The Pharmacological Basis of Therapeutics, 2006, Permagon Press, New York Lachman L Lieberman, HA, Kanig, J., 1986, "Theory and Practice of Industry pharmacy", 3rd Edition, Varghese Publishing & Co, New Delhi.

(ELECTIVE - 2)
ENVIRONMENTAL BIOTECHNOLOGY

Course Number: 15BIOGE02B **Number of Credits: 4 (Four)**

Scope: To understand the energy sources, environmental pollution and remediation using biotechnology and its control.

Objective: Students will get an idea about the hazards to our environment, solutions to protect and for sustainable development.

Goal: This course is important in the era of industrialization leading to environmental hazards and hence will help students to take up a career in tackling industrial pollution and also who is willing to take up the research in areas like development of biological systems for remediation of contaminated environments (land, air, water), and for environment-friendly processes such as green manufacturing technologies and sustainable development.

UNIT I

Bio-Fuels and Bio-Energy: Biofuels and sources, Advantages, Genetic improvement through metabolic engineering; Commercial success of Biofuels, Future energy needs and direction of research.

UNIT II

Environmental pollution: Types of pollution, methods for the measurement of pollution, air pollution and its control, Global environmental problems: ozone depletion, green house effect and acid rain, principles of conservation and application of biotechnology, remote sensing and GIS (Principal and applications in ecological mapping and environmental hazard predictions), ecological modeling, bioindicators and biosensors for detection of pollution. Solid waste: Sources and management (composting, vermiculture and methane production).

UNIT III

Water Pollution and control: Need for water management, measurement and sources, water pollution. Waste water treatment: waste water collection, physico-chemical properties of waste water, physical, chemical and biological treatment processes. activated sludge, oxidation ditches, trickling filter, rotating discs, rotating drums, oxidation ponds. Anaerobic digestion,

anaerobic filters, up flow anaerobic sludge blanket reactors. Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries.

UNIT IV

Xenobiotics: Ecological considerations, degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. biopesticides; bioremediation and Phytoremediation.

UNIT V

Environmental Impact Assessment and Environmental Acts: Ecoplanning and sustainable development: Indian standards IS: 2490, IS:3360, IS:3307, IS:2296, ISO: 14000 series, MINAS for industries and Ecomarks, Public liability insurance act, ElA guidelines and assessment methods, Agenda 21 and Carbon credit.

Disasters Management: Introduction to Disasters: Concepts, and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks). Disaster Risk Management in India Hazard and Vulnerability profile of India Components of Disaster Relief: Water, Food, Sanitation, Shelter, Health, Waste Management Institutional arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other policies, plans, programmes and legislation)

References

1. Environmental Biotechnology by Alan Scragg. Pearson Education Limited, England.
2. Environmental biotechnology by S.N. Jogdand. Himalaya Publishing House. Bombay.
3. Wastewater Engineering – Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., Tata Mc Graw Hill, NewDelhi
4. Environmental chemistry by A.K. De Wiley Eastern Ltd. NewDelhi.
5. Introduction to Biodeterioration by D. Allsopp and k.J. Seal, ELBS/Edward Arnold.
6. Environmental Science (5th Edition) by WP Cunninghum & BW Saigo., Mc Graw Hill. 1999.
7. Biotechnology for Wastewater Treatment. P Nicholas Cheremisinoff. Prentice Hall Of India. 2001
8. Biotechnological Methods of Pollution Control. SA Abbasi and E Ramaswami. Universities Press.
9. Environmental Biotechnology, Concepts and Applications. Hans-Joachin Jordening and Josef Winter. Winter-VCH. 2005
10. Biology of wastewater Treatment. N F Gray. Mc Graw Hill . 2004.
11. Environmental Biotechnology: Principles and Applications. Bruce Rittmann and Perry McCarty, Mc Graw Hill.
12. Document on World Summit on Sustainable Development 2002.
13. Govt. of India: Disaster Management Act 2005, Government of India, New Delhi.
14. Government of India, 2009. National Disaster Management Policy,

ANIMAL BIOTECHNOLOGY

Course Number: 15BIOBC09 **Number of Credits: 4 (Four)**

Scope: The study of animal cells has helped us gain an insight not only in the structure and function of cells and tissues but also in different physiological, biochemical and immunological processes. Biotechnologists explore and develop new technologies using molecular biology, embryo manipulation and cell and tissue culture. Research on gene regulation and early embryo development has resulted in novel techniques to manipulate and explore the genomes of domestic animals for ways to increase healthier food production as well as to develop biomedical applications.

Objective: The major objective is to provide a world-class training experience for these students in an interdisciplinary research program connecting animal genomics with animal reproduction and biotechnology**.**

Goal: This paper will help students interested in careers as laboratory, research or animal care technicians in the fields of veterinary and human health or biotechnology.

UNIT I

Introduction to Animal Tissue Culture: Background, Advantages, Limitations, and applications. Culture Environment, Cell Adhesion, Cell Proliferation and Cell differentiation. Essential Equipments required for animal tissue culture, Aseptic Technique, Objectives, Elements, Sterile Handling, Risk Assessment and General Safety. Media: Physicochemical Properties, Balanced Salt Solutions, Complete Media, Serum, Disadvantages of Serum supplemented media, Serum-Free Media, Advantages of Serum-Free media.

UNIT II

Steps involved in Primary cell culture: Isolation of Tissue, Subculture, Propagation and maintenance. Cell Line: Characterization, Morphology, Chromosome Analysis, DNA, RNA and Protein Content. Transformation of animal cell, Immortalization, Aberrant Growth Control, Cell counting, Plating Efficiency, Labeling Index, Generation Time of established cell line; Recent issues on research in cell lines.

Contamination: Sources, Type of microbial contamination, Monitoring, Eradication of Contamination, Cross-Contamination. Cryopreservation: Need of Cryopreservation, Preservation, Cell banks, Transporting Cells.

UNIT III

Cytotoxicity; Measurement of Cytotoxicity: Viability; Survival and Variable Parameters; Cell Proliferation Assays; Metabolic Cytotoxicity Assays; Microtitration Assays; Microtitration and Clonogenic Survival; Drug Interaction; Mutagenesis Assay by Sister Chromatid Exchange; Applications of Cytotoxicity Assays. Apoptosis and its determination; Necrosis; Difference between apoptosis and necrosis. Application of animal cell culture; Vaccine production; Tissue engineering; Engineered cell culture as source of valuable products and therapeutic protein production.

UNIT IV

Methods for gene transfer: Viral, Non- viral and Embryonic Stem Cell method Transgenic animals: Mouse, Fish, Goat, Pig, Cattle, Sheep, Rabbit, Birds, Silkworm and Mosquitoes.

UNIT V

In Vitro Fertilization and Embryo Transfer: Composition of IVF media, Steps involved in IVF, Fertilization by means of micro insemination, PZD, ICSI, SUZI, MESA. Stem cell culture, embryonic stem cell and their applications. Ethical issues in animal biotechnology.

References:

1. Animal cell culture; A practical approach, 4th Edition, by Freshney. R.I. John Wiley publication.
2. Methods in cell biology; Volume 57, Animal cell culture methods, Ed. Jennie P.Mather, David Barnes, Academic press.
3. Mammalian cell biotechnology; A practical approach, Ed. M. Butler, Oxford university press.
4. Exploring genetic mechanism; Ed. Maxine Singer and Paul Berg.
5. Principles of genetic manipulation; Ed. Old and Primrose, 6th Edition. Blackwell science publication.

RECOMBINANT DNA TECHNOLOGY

Course Number : 15BIOBC10 **Number of Credits: 4 (Four)**

Scope: This paper provides the student a thorough knowledge in principles and methods in genetic engineering, vectors in gene cloning, transformation in higher organisms, Human Genome Project and gene therapy. Techniques employed are carved as self study.

Objective: The main objective of the paper is to expose students to application of rDNA technology to various fields of biotechnology.(medicine and research areas).

Goal: This paper will help the student to get a grasp on the latest advances in recombinant DNA technology, which is a powerful tool in modern Biotechnology

UNIT I

Principles and methods in genetic engineering: Isolation and purification of Nucleic Acids - Agarose Gel Electrophoresis - Southern, Northern and South-Western blotting techniques - Principles and techniques of nucleic acid hybridization and cot curves - Polymerase Chain Reaction: Variations and advancements.

Enzymes in Molcular Biology: Nucleases, Restriction endonucleases, DNA Ligases, topoisomerases, gyrases, methylases, other modifying enzymes – Bacterial Transformation: Principles and methods.

UNIT II

Vectors in Gene Cloning: Plasmids, Bacteriophages, Phagemids, Cosmids - Artificial Chromosomes: PAC, BAC, YAC. Cloning in Prokaryotes (*E.coli).* Cloning in Organisms other than *E.coli*: (Pseudomonas, *Bacillus subtilis*, Yeast and Fungi). cDNA synthesis and cloning; mRNA enrichment, Reverse transcription,DNA primers,Linkers and Adaptors. Library construction and screening: Alternative strategies for gene cloning:cloning interaction genes. Two and three hybrid systems - Gene expression in Prokaryotes: merits and demerits – examples.

UNIT III

DNA sequencing methods, strategies for genome sequencing; methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques Expression strategies for heterologous genes.: vector engineering and codon optimization, host engineering, *in vitro* transcription and translation, expression in bacteria , yeast, insect, insect cells, mammalian cells, phage display.

UNIT IV

Genome Mapping: Genetic and physical maps, physical mapping and map based cloning, choice of mapping population, simple sequence repeat loci, southern and fluorescence *in situ* hybridization for genome anlalysis, chromosome micro decection and micro cloning ,molecular markers in genome analysis.

UNIT V

Gene Therapy: Strategies for gene delivery gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing, Si/micro RNA, antisense RNA, non coding RNAs regulation of genes. Gene therapy for inherited diseases, ADA, FH, Cystic Fibrosis, DMA, Neoplastic disorders, infectious diseases. Somatic Cell Gene therapy, Triple helix therapeutics and qAptamers. Targeted gene replacement, chromosome engineering.

References:

1. Primrose. S.B., Twyman R.M., Old. R.W. (2001) Pricinciples of Gene Manipulation. Blackwell Science Limited.
2. Molecular and cellular methods in Biology and Medicine, P.B. Kaufman, W.Wu, D.Kim and L.J: Cseke, CRC Press, Florida, 1995.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA.
4. Bernard R. Glick, Jack J. Pasternak, Asm Press.
5. Methods in Enzymology Vol.152, guide to molecular cloning Techniques, S.L. Berger and A.R.Kimmel, Academic Press, Inc. San Diego, 1998
6. Methods in Enzymology Vol 185, Gene Expression Technology, D.V. Goeddel, Academic Press, Inc., San Diego, 1990
7. DNA Science, A First Course in Recombinant Technology, D.A.Mickloss and G.A.Freyar, Cold Spring Harbor Laboratory Press, New York, 1990.
8. Molecular Biotechnology (2^{nd} Edition), S.B.Primrose, Blackwell Scientific Publishers, Oxford, 1994.

9. Milestones in Biotechnology. Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
10. Route Maps in Gene Technology, M.R.Walker and R.Rapley, Blackwell Science Ltd., Oxford, 1997.
11. Genetic Engineering. An introduction to gene analysis and exploitation in Eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998
12. Human Molecular Genetics, Tom Strachan and Andrew P.Read, Bios Scientific Publishers, 1996.
13. LEWIN'S Gene X, J E. Krebs, E.S. Goldstein and S.T. Kilpatrick, Jones and bartlett Publishers, London.

PLANT BIOTECHNOLOGY

Course Number: 15BIOBC11 **Number of Credits: 4 (Four)**

Objective: To equip students regarding the techniques and applications of Plant Biotechnology.

Goal: This paper has been designed to give the students comprehensive training in the plant biotechnology and its application for increasing agricultural production, environment improvement, human, nutrition and health. Also to help students to get a career in both industry/R&D.

Scope: Students will learn about genome organization in plants, basic techniques in tissue culture and its applications, Genetic transformation in plants, metabolic engineering, production of pharmaceuticals and industrial products.

UNIT I

Genome organization in Plants: Nucleus, Chloroplast and Mitochondria, Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, Microsatellites, SCAR (Sequence Characterized Amplified Regions), SSCP (Single Strand Conformational Polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection.

UNIT II

Plant Cell and Tissue Culture: Tissue culture media (composition and preparation), Totipotency, Callus and suspension culture; Somaclonal variation; Micropropagation; Organogenesis; Somatic embryogenesis; transfer and establishment of whole plants in soil; green house technology. Embryo culture and embryo rescue. Artificial seeds. Protoplast fusion and somatic hybridization; cybrids; anther, pollen and ovary culture for production of haploid plants. Cryopreservation and DNA banking for germplasm conservation.

UNIT III

Plant Genetic Transformation methods: Features of Ti and Ri plasmids and its use as vectors, binary vectors, viral vectors, 35S and other promoters, use of reporter genes and marker genes, Gene transfer methods in plants: direct and indirect DNA transfer. Chloroplast transformation and its advantages.

UNIT IV

Application of Plant Genetic Transformation: Herbicide resistance: phosphoinothricin, glyphosate, sulfonyl urea and atrazine. Insect resistance: *Bt* genes, non-*Bt* genes like protease inhibitors, alpha amylase inhibitor. Disease resistance: chitinase, 1,3-beta glucanase, RIP, antifungal proteins, thionins, PR proteins; Virus resistance: coat protein mediated, nucleocapsid gene. Nematode resistance. Abiotic stress: Drought, cold and salt. Post-harvest losses: long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase, RNAi and Reverse genetics.

UNIT V

Metabolic Engineering and Biopharmaceuticals: Plant secondary metabolites, control mechanisms and manipulation of phenylproponoid pathway, shikimate pathway; alkaloids,

industrial enzymes, biodegradable plastics, polyhydroxybutyrate, therapeutic proteins, lysosomal enzymes, antibodies, edible vaccines, purification strategies, oleosin partitioning technology.

References:

1. An introduction to genetic engineering in plants, Mantel, Mathews and Mickee, 1985. Blackwell Scientific Publishers. London.
2. *In Vitro* culture of higher plants by Pierik, 1987. Martinus Nijhoff Publisher, Dordrecht.
3. Plant cell culture. A practical approach. Second edition. Edited by R.A. Dixon and R.A. Gonzales.1994.Oxford University Press. Oxford.
4. Plant Molecular Biology by Grierson and Convey.1984. Blackie and Son Limited. New York
5. Plant Biotechnology by Mantell and Smith, 1983. Cambridge University press, UK
6. Plants, genes and agriculture by Chrispeels and Sadava, 2000. The American Scientific Publishers, USA.
7. Practical Application of Plant Molecular Biology by Henry.1997. Chapmans and Hall.
8. Plant Biotechnology by Hammond, Mc Garvey and Yusibov 2000
9. Springer Verlag, UK.
10. Plant Biotechnology and Transgenic Plants, Edited by Kirsi-Marja Oksman-Caldentey and Wolfgang Barz. 2002, Marcel Dekker, Inc. New York.
11. Plant Biotechnology (The genetic manipulation of plants) by Slater, Scott and Fowler, 2003, Oxford University press, UK.
12. Molecular Plant Biology: A practical approach (Vol. I and II), Edited by
13. Gilmartin and Bowler, 2002, Oxford University press, UK.

STEM CELL BIOLOGY AND TISSUE ENGINEERING

Course Number: 15BIOBC12 **Number of credits: 4 (Four)**

Scope: The course is to offer the student state of the art education of stem cells and how the pluripotent and multipotent cells can be used to treat the neurodegenerative disorders, cardiovascular disorders and diabetes. This course will also review the current scenario of tissue engineering applications in bioartificial organs development and transplantation.

Objectives: The course will provide students with knowledge of wide ranging topics related to stem cells, regenerative biology and tissue engineering.

Goal: The course goal is to introduce students to updated fundamental knowledge, technological advancements and potential applications of stem cells and tissue engineering.

UNIT I

Introduction to Stem Cells – Definition, Classification, characteristics, Differentiation and dedifferentiation, Stem cell niche, stem cell Vs Somatic cells; Mechanism of pleuripotency in stem cells. Basic culture procedures: Isolation, culture methods, identification, stem cell markers, feeder layer; Instrumentations in stem cell biology.

UNIT II

Different kinds of stem cells – Adult Stem cells, Embryonic stem cells, Embryonic Germ cells, Heamtopoietic stem cell, Neural stem cells, muscle and cardiac stem cells, Umbilical cord blood stem cells, cancer stem cells, Mesenchymal stem cells, Induced pluripotent Stem cells.

UNIT III

Therapeutic applications: stem cells and neurodegenerative disorders, stem cells and diabetes, stem cells and cardiac disorders, regeneration of epidermis, Success stories of stem cell

therapy. Stem cell banking around the world. Current status of Stem cell research; World federal fundings for stem cell research; Public view and ethical approaches on stem cells.

UNIT IV

Principles of Tissue Engineering – History and scope, Basics of Tissue Engineering, Tissue Engineering triangle, Cell-ECM interaction, wound healing mechanism, Tissue Engineering Bioreactors, Models of Tissue Engineering, Biomaterials in Tissue Engineering.

UNIT V

Bioartificial organs – source of cells, choosing the right scaffold material, mode of transplantation. Epidermal Tissue engineering, Bladder reconstruction, Skin equivalents, Liver reconstruction, Bone regeneration through tissue engineering, Tissue Engineering and future perspectives – commercial products.

Reference:

1. Stem cells: Scientific progress and future research directions – NIH report. Available @ www.stemcells.nih.gov/index ; www.stembook.org.
2. Essentials of Stem cell Biology – Robert Lanza, John Gearhart, Brigid Hogan.
3. Stem cell now – Christopher Thomas Scott.
4. Principles of Tissue Engineering – Robert Lanza.
   Tissue Engineering – B.Palsson, J.A.Hubbell.

(Elective - 3)
CANCER BIOLOGY

Course Number: 15BIOGE03A **Number of credits: 4 (Four)**

Scope: This paper has been designed to educate students on various genetic and molecular changes behind the transformation of normal cells into malignant cancer cells. These modifications include unregulated cell proliferation, evasion of cell death, and metastasis. This paper will describe factors that contribute to cancer development and discuss cancer diagnosis and currently available therapeutic treatments.

Objective: On the finale of the course, the students will be able to show core knowledge of the molecular and genetic basis of cancer.

Goal: The paper helps to generate novel mechanistic insight into the processes of tumor development and translate these results for the diagnostic and therapeutic strategies.

UNIT I

Introduction to Cancer

Cancer: Definition; Cancer incidence and mortality; Origin of neoplastic cells; Cancer as cellular disease; Types of Cancer: Benign Tumors Vs. Malignant Tumors, Common Symptoms, Causes of Cancer: Chemical Carcinogenesis; Irradiation Carcinogenesis; Oxygen Free Radicals, Aging and Cancer; Genetic Susceptibility and Cancer; Multiple Mutations in Cancer; DNA repair defects and their relationship to cancer; Viral Carcinogenesis.

UNIT II

Cell Cycle Regulation and Cell Signalling in Cancer

Growth Characteristics of Malignant Cells; Cell Cycle Regulation; Evasion of Apoptosis (Programmed Cell Death); Growth Factors; Signal Transduction Mechanisms - G protein-linked receptors, The phosphoinositide 3-kinase pathway, mTOR, Tyrosine kinase pathways, JAK-STAT pathway, Estrogen receptor pathway, Hypoxia-inducible factor, Tumor necrosis factor receptor signaling, Tumor growth factor-β signal transduction, Heat shock protein-mediated events; Angiogenesis; Invasion and Metastasis; Biology of Tumor Metastasis.

UNIT III

Molecular Genetics of Cancer

Molecular Basis of Cancer: DNA Methylation and Cancer; Loss of Heterozygosity; Telomeres and Telomerase; Molecular Genetic Alterations in Cancer Cells - Translocations and

Inversions, Chromosomal Deletions, Gene Amplification, Point Mutations, Aneuploidy, Disomy, Trinucleotide Expansion, Microsatellite Instability, Mismatch DNA Repair Defects, Gene Derepression in Cancer Cells, Oncogenes, Tumor Suppressor Genes: pRb and p53, DNA Tumor Viruses - V40 and Polyoma, Papilloma Viruses E6 and E7, Adenoviruses E1A and E1B, Hepatitis B Virus and Herpes Viruses.

UNIT IV

Tumor Immunology

Mechanisms of the Immune Response to Cancer: Antigen Presenting Cells; Antigen Processing; T Lymphocytes and T Cell Activation; The Immunological Synapse; B Lymphocytes and B Cell Activation; Natural Killer Cells; Cell-Mediated Cytotoxicity; Role of Gene Rearrangement in the Tumor Response; Heat Shock Proteins as Regulators of the Immune Response; Inflammation and Cancer; Immunotherapy

UNIT V

Cancer Diagnosis

Tumor Markers; Gene Expression Microarrays; Proteomic Methods; Circulating Epithelial Cells; Circulating Endothelial Cells and Endothelial Progenitor Cells; Molecular Imaging; Haplotype Mapping.

Diet and Cancer Prevention: Chemoprevention; Antiproliferative Agents; Antioxidants; Protease Inhibitors; Histone Deacetylase Inhibitors; Statins; Multiagent chemoprevention

Treatment: Surgery, Radiotherapy, Chemotherapy, Hormone therapy, Biological therapies, Bisphosphonates.

References:

1. Cancer Biology, Raymond W. Ruddon, 2007, 4th edition, Oxford University Press,
2. Molecular Biology of Cancer by F. Macdonald, C.H.J. Ford, and A.G. Casson; Garland Scien ce / Bios Scientific Publishers
3. The Biology of Cancer, Weinberg. Robert A, 2007, New York: Garland Science.
4. Molecular Biology of Human Cancers by Wolfgang Arthur Schulz Springer.
5. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics 2nd Edition by Lauren Pecorino. Oxford University Press.

(ELECTIVE – 3)
BIOSAFETY, BIOETHICS AND IPR

Course Number: 15BIOGE03B **Number of credits: 4 (Four)**

Scope: This course has been designed to provide the student insights into these invaluable areas of biotechnology, which play a crucial role in determining its future use and applications.

Objective: Students get an idea about the advantages and disadvantages of biotechnological applications, ethical implications, and intellectual property rights.

Goal: To study the diversity of plants and animal life in a particular habitat, ethical issues and potential of biotechnology for the benefit of man kind.

UNIT I

Introduction to biodiversity – levels of biodiversity –values of biodiversity – loss of biodiversity – Species concept – Classification and systematics: biological nomenclature – biological classification; Biodiversity conservation: *in situ* and *ex situ* - Magnitude and distribution of biodiversity - wild life biology – conservation strategies – measures of biodiversity – biodiversity in India and global level – biodiversity hot spots.

UNIT II

Introduction to ethics/bioethics – Framework for ethical decision making; biotechnology and ethics – biotechnology in agriculture and environment: benefits and risks – benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare.

UNIT III

Ethical implications of cloning: Reproductive cloning , therapeutic cloning ; Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research- GM crops and GMO's – biotechnology and biopiracy – ELSI of human genome project.

UNIT IV

Introduction to biosafety – biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations – types of biosafety containments.

UNIT V

Introduction to intellectual property and intellectual property rights – types: patents, copy rights, trade marks, design rights, geographical indications – importance of IPR – patentable and non patentables – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO)

References:

1. Principles of cloning, Jose Cibelli, Robert P. lanza, Keith H. S . Campbell, Michael D.West, Academic Press,2002Glimpses of Biodiversity – B.Bltosetti
2. Ehics in engineering, Martin. M.W. and Schinzinger.R. III Edition, Tata McGraw-Hill, New Delhi. 2003.
3. http://books.cambridge.org/0521384737.htm
4. http://online.sfsu.edu/%7Erone/GEessays/gedanger.htm
5. http://www.actahort.org/members/showpdf?booknrarnr=447_125
6. http://www.cordis.lu/elsa/src/about.htm
7. http://www.biomedcentral.com/content/pdf/1472-6939-2-2.pdf
8. http://lifesciences.cornell.edu/vision/accelerating_focus05.php
9. http://thompson.com/libraries/fooddrug/
10. http://assets.cambridge.org/0521792495/sample/0521792495WS.PDF
11. http://europa.eu.int/eurlex/pri/en/oj/dat/1998/I_213/I_21319980730en00130021.pdf
12. http://www.clubofamsterdam.com/content.asp?contentid=281
13. Biosafety issues related to transgenic crops, BT guidelines, Biotech Consortium India Limited, New Delhi.

SUPPORTIVE – I

TOOLS IN BIOTECHNOLOGY

Subject Code: 15BIOGS01 **Number of Credits: 2 (Two)**

UNIT I

Gene and Genomes

Prokaryotic and Eukaryotic Genomes - Structure of Gene - DNA as the genetic material; Extra chromosomal DNA: Plasmid, mitochondrial DNA and chloroplast DNA.

UNIT II

Cloning Vectors

Vectors: Plasmid, phagemid, cosmid, Artificial Chromosomes (BAC) - Transformation techniques: Electroporation, CaCl2 method.

UNIT III

Tools for Gene Manipulation

Enzymes: Gel Electrophoresis: AGE and PAGE; Restriction Enzymes, Ligases, Modifying Enzymes - Markers for Selection: selectable and scorable - Examples.

UNIT IV

Selection Strategy and Screening for Transformants

Selection of rDNA Clones: Blue-White Selection, Colony Hybridization, PCR, Molecular analysis: Western blotting, Southern Blotting and Northern Blotting.

UNIT V

Application of Cloning

Over expression of Biomolecules (Insulin) - Gene therapy – GMO – DNA Finger printing Application and Biosafety issues.

References

1. Primrose. S.B., Twyman R.M., Old. R.W. (2001) Principles of Gene Manipulation. Blackwell Science Limited.
2. Molecular Biotechnology. S.B Primrose, Blackwell Scientific Publishers,Oxford, 1994.
3. Principles of Gene Manipulation. T.A.Brown
4. DNA Science – A first course in rDNA technology, D.A. Mickloss nd G.A.Freyar, Cold Spring Harbor laboratory Press, New York, 1990.
5. Molecular Cloning. Maniatis, Fritsch and Sambrook.a

SUPPORTIVE - II

MEDICAL BIOTECHNOLOGY

Subject Code: 15BIOGS02 **Number of Credits: 2 (Two)**

UNIT I

Introduction to Biotechnology and medicine:

Medicine field of 21st century, Role of Biotechnology in medicine, rDNA technology, Vaccines, MoABS.

UNIT II

Molecular Diagnostics:

Importans of diagnosis-PCR based diagnosis for infections diseases (HIV, Hepatitis, Typoid, Filariasis) ,Cancer and genetic disorders

UNIT III

Cell and gene mediated therapy:

Introdcution to stem cells-History ofstem cell research-Classification of stem cells –Stem cell banking-applications of stem cells-importance of stemcells- regulations of stem cell research - Gene theraoy;outline and methods.

UNIT IV

Assisted reproductive techniques:

Introdcution-causes of infertility-methods;IVF-Intra uterine insemination-cryopreservaton of germcells.

UNIT V

Tissue Engineering

Introduction-Bioartificial organs-Historical backgrogund-liver-kidney-skin-pancreas-Urinary bladder-bone-Challenges and advantages.

Reference:

1. Medical Biotechnology-P.C.Trivedi(2008)

SUPPORTIVE - III

PLANT MOLECULAR FARMING

Subject Code: 15BIOGS03 **Number of Credits: 2 (Two)**

UNIT I
Production technologies

Efficient and reliable production of pharmaceuticals in alfalfa; Foreign protein expression using plant cell suspension and cultures; Novel sprouting technology for recombinant protein production, monocot expression systems for molecular farming.

UNIT III

Plant viral vectors: history and new developments; Stable and transient expression system; Agroinfiltration technique and its advantages.

UNIT III
Pharmaceuticals

Production of pharmaceutical proteins in plants and plant cell suspension cultures; chloroplast expression system, biopharmaceuticals and edible vaccines; production of secretory IgA in transgenic plants.

UNIT IV
Production

Host plants, systems ad expression strategies for molecular farming; Downstream processing of plant-derived recombinant therapeutic proteins.

UNIT V
Product issues

Biosafety aspects of molecular farming in plants.

Reference:

1. Molecular Farming: Plant made pharmaceuticals and technical proteins (2004) Eds. Rainer Fischer and Stefan Schillberg, Wiley publishers, USA.

PRACTICALS - I : BASIC BIOTECHNOLOGY

Subject code: 15BIOBCP1 **Number of Credits: 4 (Four)**

Students are advised to collect the practical protocols well in advance from the respective faculty

Translational Research Laboratory – Dr. V. Vijayapadma
1. Separation of peripheral mononuclear cells from the blood.
2. Culturing Lymphocytes from Peripheral blood samples.
3. Determination of Lipid peroxidation.
4. Assessing genotoxicity by COMET assay.

Molecular Toxicology Laboratory - Dr. P. Ekambaram
5. Hematology: RBC and WBC total counts, WBC differential count.
6. Mitotic index.
7. Micrometry.
8. Mounting of polytene chromosome from Chironomous larvae.

Plant Genetic Engineering Laboratory – Dr. R. Sathiskumar
9. Introduction to Plant Tissue Culture- Media Preparation, Callus and Suspension cultures
10. Induction of somatic embryogenesis and analysis of different stages.
11. Production of synthetic seeds.
12. Extract the plant genomic DNA by CTAB method and quantify using Nanodrop.

Metabolic Engineering Laboratory – Dr. S. Girija

12. Isolation of genomic DNA from medicinal plant by SDS method.
13. *In planta* transformation in plants.
14. Isolation of *Ri* plasmid from *Agrobacterium rhizogenes.*
15. Quantification of flavanoid content in fruit sample.

Molecular Microbiology Laboratory – Dr. S.R. Prabagaran

16. Isolation of Microorganisms from various environments (food, effluent, soil/sea, Glaciers).
17. Cultivation of Bacteria, Actinomycetes, Fungi.
18. Staining techniques and Biochemical observations of Bacteria (Antibiotics/Enzymes).
19. Detection of FAMEs through Gas chromatography.

Molecular Therapeutics laboratory – Dr. J. Mathivanan

20. Total protein extraction.
21. Protein estimation by Lowry's method.
22. Visualization of enzyme activity in Native PAGE.
23. Mammalian cell lines: Freezing and thawing.

PRACTICALS – II: ADVANCED BIOTECHNOLOGY

Subject code: 15BIOBCP2 **Number of Credits: 4 (Four)**

Translational Research Laboratory – Dr. V. Vijayapadma

1. Determination of antigen concentration by Rocket immunoelectrophoresis.
2. Passive heamagglutination assay for detection of soluble antigen.
3. Demonstration of ELISA.
4. Demonstration of Immunohistochemistry.

Molecular Toxicology Laboratory – Dr. P. Ekambaram

5. Isolation of DNA from animal cells.
6. Estimation of Iron in water samples.
7. Estimation of chromium in water samples.
8. Drug administration methods.

Plant Genetic Engineering Laboratory – Dr. R. Sathishkumar

9. Particle gene gun mediated genetic transformation of GUS/GFP gene in tobacco.
10. Analysis of GUS/GFP gene in transgenic plants by histochemical staining.
11. Identification of WT/ Transgenic plant by PCR.
12. Perform the restriction digestion for the given DNA sequence and comment.

Metabolic Engineering Laboratory – Dr. S. Girija

13. Micropropagation, callus induction and regeneration using different explants of Plants.
14. *Agrobacterium rhizogenes* for hairy root culture.
15. Qualitative analysis of transgenic using phenolics content.
16. Estimation of antioxidant activity from plant sample.

Molecular Microbiology Laboratory – Dr. S. R. Prabagaran

17. Mini prep of plasmid DNA.
18. Elution of DNA from gel.
19. Competent cell and Electrocompetent cell preparation.
20. Transformation and Electroporation.

Molecular Therapeutics laboratory – Dr. J. Mathivanan

21 Oligonucleotide primers designs for cloning, sequencing, and detection experiments
22. PCR optimization
23. Total RNA isolation and quantification using NanoDrop
24. Determination of protein molecular weight by SDS-PAGE

PRACTICALS – III: APPLIED BIOTECHNOLOGY

Subject code: 15BIOBCP3 **Number of Credits: 4 (Four)**

Translational Research Laboratory – Dr. V. Vijayapadma

1. Checking the cell viability by MTT assay.
2. Determination of cytotoxicity by Nitric oxide assay.
3. Determination of cytotoxicity by measuring lactate dehydrogenase activity.
4. Determination of Apoptosis through DNA fragmentation analysis.

Molecular Toxicology Laboratory - Dr. P. Ekambaram

5. Preparation of primary cells from chick embryo.
6. Cell counting and cell viability.
7. Trypsinization of monolayer and subculturing.
8. Sex chromatin identification from Buccal smear.

Plant Genetic Engineering Laboratory – Dr. R. Sathishkumar

9. Transient gene expression in tobacco by Agroinfiltration technique for molecular farming.
10. Determination of protein expression (transgene) by Western blotting.
11. Pairwise and multiple sequence alignment of nucleic acids.
12. DNA barcoding for plant authentication.

Metabolic Engineering Laboratory - Dr. S. Girija

13. Determination of Free radical scavenging activity by DPPH assay.
14. Identification of active principle compounds from plants using HPLC.
15. Determination of Iron chelating activity of plant extract.
16. ISSR marker analysis for plant identification.

Molecular Microbiology Laboratory - Dr. S.R. Prabagaran

17. Metagenomic DNA isolation from problem soils.
18. Southern Blotting.
19. Phylogenetic tree construction using MEGA.
20. Bacterial Conjugation

Molecular Therapeutics laboratory – Dr. J. Mathivanan

21. cDNA preparation from total RNA
22. RNA secondary structure prediction using RNAfold web server
23. Protein domain identification
24. Heterologous protein expression in *E.coli*