**BHARATHIAR UNIVERSITY:: COIMBATORE – 641 046**
**M.Sc. BIOTECHNOLOGY (UNIVERSITY DEPT.)**
(For the students admitted during the academic year 2017– 2018 batch & onwards)
**SCHEME OF EXAMINATION**

| Semester | Paper | Subject | Hrs / week | University examination | | | Total Marks | Credits |
|---|---|---|---|---|---|---|---|---|
| | | | | Dur/ Hrs. | INT. | EXT | | |
| **SEMESTER I** | | | | | | | | |
| 17BIOBC01 | Paper-I | Biochemistry | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOBC02 | Paper - II | Cell and Molecular Biology | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOBC03 | Paper - III | Microbiology | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOBC04 | Paper – IV | Genetics | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOGE01A | Elective - 1 | Bio prospecting / | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOGE01B | ” | Bioinstrumentation | | | | | | |
| 17BIOGS01 | Supportive-1 | Tools in Biotechnology | 2 | 2 | 12 | 38 | 50 | 2 |
| 17BIOBCP1 | Practical - I | Basic Biotechnology | 6 | 6 | 25 | 75 | 100 | 4 |
| **SEMESTER II** | | | | | | | | |
| 17BIOBC05 | Paper – V | Pharmaceutical Biotechnology | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOBC06 | Paper – VI | Immunology | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOBC07 | Paper - VII | Bioprocess Technology | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOBC08 | Paper VIII | Bioinformatics and Systems Biology | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOGE02A | Elective - 2 | Developmental Biology and Physiology | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOGE02B | ” | Environmental Biotechnology | | | | | | |
| 17BIOGS02 | Supportive-2 | Medical Biotechnology | 2 | 2 | 12 | 38 | 50 | 2 |
| 17BIOBCP2 | Practical –II | Advanced Biotechnology | 6 | 6 | 25 | 75 | 100 | 4 |
| | | Summer Training* | | | | | 50 | 2 |
| **SEMESTER III** | | | | | | | | |
| 17BIOBC09 | Paper IX | Animal Biotechnology and Stem Cell Biology | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOBC10 | Paper X | Recombinant DNA Technology | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOBC11 | Paper XI | Plant Biotechnology | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOBC12 | Paper - XII | Research Methodology and Biostatistics | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOGE03A | Elective -3 | Molecular Diagnostics and Clinical Testing | 4 | 3 | 25 | 75 | 100 | 4 |
| 17BIOGE03B | ” | Biosafety Bioethics and IPR | | | | | | |
| 17BIOGS03 | Supportive- 3 | Plant Molecular Farming | 2 | 2 | 12 | 38 | 50 | 2 |
| 17BIOBCP3 | Practical III | Applied Biotechnology | 6 | 6 | 25 | 75 | 100 | 4 |
| **SEMESTER IV** | | | | | | | | |
| | Professional Certification** | | | | | | 50 | 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.

** **Professional Certification:**

Students have to undertake Professional Certification course.

*****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: 17BIOBC01** **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 metabolized 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 the structure and functions of biomolecules, 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-Hasselbalch Equation, biological buffer solutions.

Concept of free energy: Principles of thermodynamics; Kinetics, dissociation and association constants; energy rich bonds and weak interactions;Coupled reactions; group transfer; biological energy transducers; Bioenergetics.

Carbohydratesclassification;Occurrence, isolation, purification, properties and biological reactions of polysaccharides; Glycoproteins and proteoglycans:Structural features of homoglycans, heteroglycans and complex carbohydrates; Carbohydrate metabolism: Glycolysis and TCA cycle;Glycogenesis; Glycogenolysis; Gluconeogenesis; interconversion of hexoses and pentoses; Coordinated control of metabolism; Oxidative phosphorylation;.

**UNIT II**

Proteins: Classification and physico-chemical properties of amino acids and peptides; Peptide bond; Primary, secondary, tertiary and quaternary structures of proteins; Ramchandranplot;Silkfibroin, coiled coils, collagen triple helix and hemoglobin; Denaturation and renaturation of proteins; Protein metabolism; Peptide hormones.

**UNIT III**

Enzymology: 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; Lysozyme: structure, enzymatic activity and mechanism of action.Ribozymes(Hammer head, Hair pinand other ribozymes).Bioluminescence.

**UNIT IV**

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

**UNIT V**

Nucleic acids: Structure of double stranded DNA (A, B and ZDNA). 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.Purines and pyrimidines biosynthesis.

**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: 17BIOBC02** **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**

Cytoskeleton of cells.Mitochondria – structure, biogenesis; Chloroplast – structure, biogenesis, 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**

Nucleosome, the supranucleosomal structures.DNA replication; transcription and translation. Gene regulation: prokaryotic gene regulation- Operon concept; lacoperon and tryptophanoperon; Eukaryotic gene regulation: transcriptional and translational regulations.

**UNIT IV**

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: .Types of Cancer: Benign Tumors Vs. Malignant Tumors, Common Symptoms, tumor suppressor and oncogenes.Causes of Cancer: Chemical Carcinogenesis; Irradiation Carcinogenesis; Oxygen Free Radicals, Aging and Cancer.

**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: 17BIOBC03** **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 and Anaerobic Microbiology:** 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.

Culturing Techniques for Anaerobes: Roll tube method, Culture conditions in Glove box - requirements - prospects

### 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.
16. Anaerobic Microbiology: A Practical Approach by P.N. Levett 1992.
17. Anaerobic Bacteria, **Holland**, K. T. 1987.

## GENETICS

**Course Number: 17BIOBC04** **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 viruses, prokaryotes and eukaryotes: Organization of nuclear and organellar genomes; C-value paradox, Repetitive DNA-satellite DNAs and interspersed repeated DNAs, Transposable elements, LINES, SINES, Alu family and their application in genome mapping. Concept of gene: Conventional and modern views. Fine structure of gene, split genes, pseudogenes, non-coding genes, overlapping genes and multi-gene families. Genome mapping: Physical maps -an overview and approaches. Genome evolution.

**UNIT II**

Chromatin structure: Histones, DNA, nucleosome morphology and higher level organization;
Chromosome organization: Metaphase chromosomes: centromere and kinetochore, telomereand its maintenance; Holocentric chromosomes; Heterochromatin and euchromatin. Chromosomal anomalies: variation in chromosome number: haploidy, polyploidy, aneuploidy. Variation in chromosome structure: deficiency of deletion, duplication, translocation, inversion and B-chromosome.Techniques in the study of chromosomes and their applications: Short term (lymphocyte) and long term (fibroblast) cultures, chromosome preparations, karyotyping, banding, chromosomelabeling, in situ hybridization, chromosome painting, comparative genome hybridization (CGH),somatic cell hybrids and gene mapping, premature chromosome condensation.

**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;Linkage and crossing over.

**UNIT IV**

Human Genetics: Introduction to Human Genetics. 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.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. Mitochondrila disorders like LHON, DAD, MERRF and MELAS. Cancer genetics.

**UNIT V**

Analysis of interitance pattern:Pedigree analysis; Pedigree analysis; Diagnosis of disease: cytogenetics; Molecular cytogenetics, molelcular genetics-DNA markers -VNTR, STR, microsatellite, SNP and their detection techniques - RFLP, genotyping, RAPD, AFLP ; Prevention of disease: Prenatal diagnosis; Genetic counseling.

Population genetics: Organization and measure of genetic variation: Random mating population, Hardy-Weinberg principle, complications of dominance, special cases of random mating – multiple alleles, different frequencies between sexes (autosomal and X-linked). Linkage and linkage disequilibrium.Sources responsible for changes in gene frequencies: Mutation, selection, migration and isolation; random genetic drift; insights into human migration, natural selection and evolution. Population substructure: Hierarchical population, Isolate breaking, Inbreeding, Assortive mating.

**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, Sinauerassociatesinc. 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 VinodVasishtha for Viva Books private limited, 2008.

## (ELECTIVE - 1)
## BIOPROSPECTING

**Course Number: 17BIOGE01A** **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: 17BIOGE01B** **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.

## PHARMACEUTICAL BIOTECHNOLOGY

**Course Number: 17BIOBC05** **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.

## IMMUNOLOGY

**Course Number: 17BIOBC06** **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: 17BIOBC07** **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

**Introduction to Bioprocess Technology:** History of fermentation industry - Fermentation process: General requirements and product range; Microbial biomass, microbial enzymes, microbial metabolites, recombinant products, transformation processes.

**Media for industrial fermentation:** Essential criteria for media, Media components, Media formulation, Media optimization.

**Sterilization:** Significance, Types of sterilization – Batch and continuous; filter sterilization.

**Inoculum development:** Inoculum source – Seed culture; development of inocula for yeast, bacteria and fungi.

### UNIT II

**Microbial growth kinetics**: Phases of cell growth, Factors affecting cell growth, Kinetic model for cell growth: Monod's model, Mass balances for bioreactors, Design equations.

**Production Kinetics**: Multiple reactions: Simple reaction, parallel reaction, series reaction, series- parallel reactions; homologous and heterologous reaction system, Stoichiometry – Order of reactions.

### UNIT III

**Bioreactors:** Introduction to bioreactors - Aerobic and anaerobic fermentation; solid state and submerged fermentation; Types of Bioreactors: Batch, continuous and fed-batch (variants), Specialized bioreactors (fluidized bioreactors, photo bioreactors, immobilized cell reactors, airlift bioreactor, packed bed bioreactor).

**Design and construction of Bioreactors:** Monitoring and control of bioreactor: Online and off line control, Controlling systems: Temperature, flow rate, pressure, pH, DO, gas analysis.

### 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.
   Industrial microbiology by L. E. Cassida Jr.

## BIOINFORMATICS AND SYSTEMS BIOLOGY

**Course Number: 17BIOBC08** **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)
## DEVELOPMENTAL BIOLOGY AND PHYSIOLOGY

**Course number: 17BIOGE02A** **Number of credits: 4 (Four)**

**Scope:** This paper encodes information on the development and physiology of various animal systems.

**Objective:** To enable the students to know the actual pathway of physiological metabolism of mammals including humans.

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

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**Unit I**:

**Introduction to developmental biology:**

Structure and function of reproductive system: Male reproductive system, Female reproductive system. Production of gametes: Spermatogenesis, Oogenesis. Cell surface molecules in sperm - egg recognition in animals; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals.

**Unit II**:

**Basic concepts of development**:

Morphogenesis and organogenesis in animals (Drosophila, Amphibia and Chick). Embryonic fields, potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; genomic equivalence and the cytoplasmic determinants; imprinting.

**Unit III**

**Animal system physiology:**
**Digestion and Haematology**:

Homeostasis, nutrition, structure and functions of digestive system. Physiology of digestion. Blood corpuscles, haemopoiesis, plasma function, blood volume, hemostasis. Comparative anatomy of heart structure, myogenic heart, ECG- its principle and significance, cardiac cycle, heart as a pump, 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**:

**Nervous system**:

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

**References:**

1. An introduction to embryology- Balinsky
2. Developmental biology- Gilbert
3. Chordate embryology- Verma, Agarwal and Tyagi
4. Textbook of Medical Physiology – Guyton and Hall

## (ELECTIVE - 2)
## ENVIRONMENTAL BIOTECHNOLOGY

**Course Number: 17BIOGE02B** **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 & STEM CELL BIOLOGY

**Course Number: 17BIOBC09** **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. It also offers the knowledge of stem cells and how they 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.

**Objective:** The major objective is to provide a world-class training experience for these students in an interdisciplinary research program on animal reproduction and biotechnology and also to offer wide ranging topics related to stem cells, regenerative biology and tissue engineering.

**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. It also offers updated fundamental knowledge, technological advancements and potential applications of stem cells and tissue engineering.

### 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, 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. Types of cell culture: anchorage dependent and suspension cultures; Steps involved in Primary cell culture: Isolation of Tissue, Subculture, Propagation and maintenance.

### UNIT II

Cell Line Characterization: based on Morphology, Chromosome Analysis, DNA, RNA and Protein Content, cell surface markers, DNA finger printing. 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.

Cytotoxicity: Measurement of Cytotoxicity: cell Viability; Cell Proliferation Assays; Metabolic Cytotoxicity 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.

**UNIT III**

Transgenic animals- methods of transgenic animal production- retroviral, embryonic stem cell and microinjection methods ; applications of transgenic animals.*In Vitro* Fertilization and Embryo Transfer: Composition of IVF media, Steps involved in IVF, Fertilization by means of micro insemination, PZD, ICSI, SUZI, MESA. Ethical issues in animal biotechnology.

**UNIT IV**

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; 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.

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 and ethical approaches on stem cells.

**UNIT V**

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

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

## RECOMBINANT DNA TECHNOLOGY

**Course Number: 17BIOBC10** **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 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 information on the latest advances in recombinant DNA technology, which is a powerful tool needed for modern biotechnology research.

**UNIT I**

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

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

**UNIT II**

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; mRNA enrichment, Reverse transcription,DNA primers,Linkers and Adaptors. Library construction and screening; Two and three hybrid systems.

**UNIT III**

DNA sequencing methods, strategies for genome sequencing, NGS,microarrays:gene expression analysis at RNA and protein level. 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 analysis, chromosome micro detection and micro cloning.

**UNIT V**

Gene Therapy: Strategies for gene delivery gene replacement/augmentation, gene correction, gene editing, gene regulation and silencing, siRNA, miRNA, antisense RNA, non-coding RNAs. Gene therapy for inherited diseases, ADA, FH, Cystic Fibrosis. Somatic Cell Gene therapy, Triple helix therapeutics and Aptamers. 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. Textbok of Biotechnology 4 ed., H. K. Das, Wiley India.
8. DNA Science, A First Course in Recombinant Technology, D.A.Mickloss and G.A.Freyar, Cold Spring Harbor Laboratory Press, New York, 1990.
9. Molecular Biotechnology (2nd Edition), S.B.Primrose, Blackwell Scientific Publishers, Oxford, 1994.
10. Milestones in Biotechnology. Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
11. Route Maps in Gene Technology, M.R.Walker and R.Rapley, Blackwell Science Ltd., Oxford, 1997.
12. Genetic Engineering. An introduction to gene analysis and exploitation in Eukaryotes, S.M. Kingsman and A.J. Kingsman, Blackwell Scientific Publications, Oxford, 1998
13. Human Molecular Genetics, Tom Strachan and Andrew P.Read, Bios Scientific Publishers, 1996.
14. LEWIN‟S Gene X, J E. Krebs, E.S. Goldstein and S.T. Kilpatrick, Jones and bartlett Publishers, London.

## PLANT BIOTECHNOLOGY

**Course Number: 17BIOBC11** **Number of Credits: 4 (Four)**

**Objective:** To equip students with theoretical knowledge regarding the techniques and applications of Plant Biotechnology and Genetic Engineering.

**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 Industry/R&D/Academic.

**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 known as plant molecular farming.

**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, Allele mining for crop improvement.

**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 Techniques:** 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, Reverse genetics and CRISPR/Cas9: A powerful tool for crop genome editing.

**UNIT-V**

**Metabolic Engineering and Plant Molecular Farming:** 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. MartinusNijhoff 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, Springer Verlag, UK.
9. Plant Biotechnology and Transgenic Plants, Edited by Kirsi-MarjaOksman-Caldentey and Wolfgang Barz. 2002, Marcel Dekker, Inc. New York.
10. Plant Biotechnology: The genetic manipulation of plants by Slater, Scott and Fowler, 2008, Second edition, Oxford University press, UK.
11. Molecular Plant Biology: A practical approach (Vol. I and II), Edited by Gilmartin and Bowler, 2002, Oxford University press, UK.
12. Song et. al. (2016) CRISPR/Cas9: A powerful tool for crop genome editing, The Crop Journal, 4: 75-82

## RESEARCH METHODOLOGY AND BIOSTATISTICS

**Course Number: 17BIOBC12** **Number of credits: 4 (Four)**

**Scope:** To equip the students with the knowledge about the basic research methods. To create awareness among students about various methods of data collection and applications in conducting research. To introduce the students to different statistical analysis techniques and its importance.

**Objectives:** To provide knowledge on a wide ranging of topics related to Research methodology, Experimental design, Hypothesis testing, Statistical data analysis and interpretation, Report/Manuscript writing for biotechnology students.

**Goal**: To acquire knowledge on applications of statistics in research. To gain knowledge in experimental design and data collection techniques. To develop the technical art of writing research report and presentations.

**Unit-I**

**Introduction to Research Methodology**: What is research? - Objectives of research - motivation of research - Types, approaches and significance of research - Methods versus methodology - Research in scientific methods – Essential steps in the research processes - Criteria for good research.

**Unit-II**

**Experimental/Research Design:** Research Problem: Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem - Research design - Needs and features of good design - Different research design - Basic principles of experimental designs.

**Unit-III**

**Statistics in Research:** What is Biostatistics? - Measurement and scaling techniques (Types of biological data/variables in biology) - Data collection methods - Data types - Processing and presentation of data -Techniques of ordering data - Meaning of primary and secondary data - Measures of central tendency and dispersion.

**Unit – IV**

**Data analysis and Hypothesis testing:** Sampling distribution; difference between parametric and non-parametric statistics; confidence interval; errors; levels of significance; regression and correlation; t-test; analysis of variance (ANOVA); $X^2$ test; Hypothesis testing: Null and Alternate hypothesis.

**Unit – V**

**Research Communication:** Meaning of research report - Logical format for writing thesis and Manuscript – Essentials of the scientific report: abstract, introduction, review of literature, materials and methods, results and discussion - Write up steps in drafting report - Effective illustrations: tables and figures - Reference styles: Harvard and Vancouver systems. Citation index of journals, H-factor; Writing research hypothesis (grant), Funding agencies. Presenting research: oral and poster.

**Self study:** The uses of computers in research - The library and internet - Uses of search engines - virtual libraries - common softwares for documentation and presentation of data.

**References:**

1. C.R. Kothari, 2nd edition (2004) Research methodology, Methods and techniques, New Age Internation (P) Ltd, Publishers, New Delhi.
2. Jerrod H. Zar (1999) Biostatistical analysis by, Prentice Hall International, Inc. Press, London.
3. How to write and publish a scientific paper - R.A. Day - Cambridge University Press.
4. Thesis and Assignment writing - Anderson - Wiley Eastern Ltd.

## MOLECULAR DIAGNOSTICS AND CLINICAL TESTING

**Course Number: 17BIOGE03A** **Number of credits: 4 (Four)**

**Scope:** Precise diagnoses of diseases are of paramount importance to overcome false diagnosis based on symptoms. Further, diagnosing asymptomatic diseases are impending challenge that health care field faces very often. Molecular diagnostics is the most rapidly expanding subspecialty of pathology that uses detection and analysis of nucleic acids and other biomarkers to diagnose disease, predict prognosis, guide to therapy and evaluate the susceptibility to disease before clinical presentation of the diseases is evident. The advances in the field of molecular biology has provided powerful molecular techniques that can be employed for precise diagnosis of disease overcoming subjective decisions made by pathologists. Molecular diagnostics and clinical testing has become the most important process in the work flow of clinical management of diseases in modern world.

**Goal:** To give a broad overview of molecular theory and exposure to molecular techniques, a forum to understand clinical applications of various molecular tests.

**Objective:** The main objectives of this paper is to introduce students to different techniques that are commercially used in molecular diagnosis of diseases and give an account of different diseases that are routinely diagnosed using molecular testing.

### UNIT I

***Introduction to molecular diagnostics***

Definition - History – Diseases- infectious, physiological and metabolic errors, and inherited diseases. Biomarkers- types, potential uses and limitations. Diagnostics – types and importance in clinical decision making. Benefits of molecular diagnostics over conventional diagnostics. Ethical issues related to molecular diagnostics. Clinical specimens: National and International guidelines for Sample collection- method of collection, transport and processing of samples, Personal safety and laboratory safety. GLP for handling highly infectious disease samples and documentation.

### UNIT II

***DNA based molecular techniques for diagnosis***

DNA based molecular techniques: DNA sequencing:Next generation sequencing methods in diagnosis- whole genomic sequencing (WGS), whole transcriptomic sequencing (WTS), exome sequencing, SNP chromosomal microarrays, relative-quantitative PCR, methylation analysis, MLPA, mutation screening panels (xTAG, Luminex), and SNP testing.PCR-based SNP detection: single-stranded conformational polymorphism analysis, heteroduplex analysis, allele-specific and multiplex PCR, competitive oligonucleotide priming. In situ nucleic acid hybridization and amplification: ISH, FISH, ISA.

### UNIT III

**Proteomic assays for diagnostics**

Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability,denaturation; amino acid sequence analysis. Proteomics- introduction to clinical proteomics. Gel based techniques: 1D and 2D PAGE. High throughput multidimensional protein identification

technology: Protein microarray, LC-MS, MALDI-TOF, Isotope coated affinity tag (ICAT), SILAC, i-TRAQ, Multiple Reaction Monitoring (MRM), Shotgun proteomics, 2D-DIGE. Single cell methodologies: Flow cytometry. Immunoassays –RIA, ELISA, Chemiluminescent IA, FIA, Immunohistochemistry.

**UNIT IV**

**Applications of molecular diagnostics**

Major Histocompatibility Complex (MHC), HLA typing- RFLP, PCR based methods, SSO, SSP and SBT methods. Role of Molecular diagnostics in Blood banking, bone marrow transplantation and organ transplantation. Bone marrow transplant engrafment analysis.

Diagnosis of genetic diseases- Thalassemia, Fanconi anemia, Sickle Cell anemia, Fragile-X syndrome, Cystic Fibrosis.Neonatal and Prenatal disease diagnostics- Prenatal and pre-implantation diagnosis. Noninvasive: Triple test, Ultrsonography (USG), Invasive: Amniocentesis (AC), chorionic villi sampling. Quantification of analytes for the diagnosis and management of patients with inborn errors of metabolism and for patients identified with abnormal newborn screens. Molecular diagnosis for early detection of cerebral palsy, Down syndrome.

**UNIT V**

***Molecular diagnosis of degenerative diseases and infectious disorders***

Neurological and skeletal diseases: Alzheimer's disease, Duchenne Muscular Dystrophy/ Becker's Muscular Dystrophy, Huntington's disease. Cardiovascular diseases: CVD gene mutations- LDL and LDL receptor, Lecithin cholesterol acyl transferase (LCAT), Hepatic triglyceride lipase (HTGL), Cholesterol ester transfer protein (CETP), Common polymorphisms of predisposition to CVD. Pharmacogenomic testing for cardiovascular diseases. Malignant diseases: Molecular oncology testing in malignant disease (lymphoproliferative and myeloproliferative disorders and solid tumours lung, Retinoblastoma,colorectal and endometrial cancer). Circulating tumour cell testing (CTC). Role of long non-coding RNA (lncRNA) in disease diagnostics.

Diagnosis of infection caused by Streptococcus, Coliforms, Salmonella. Diagnosis of fungal infections. Major fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Molecular diagnostic of various viral diseases: HIV, Herpes, HPV, Dengue, Chickgungunya, Ebola and Influenza (H1N1).

**References**

1. Tietz textbook of clinical chemistry and molecular diagnostics. Carl Burtis, Edward Ashwood, David Bruns, Elsevier Press. 2011.
2. Molecular Diagnostics: Current Technology and Applications. Juluri R Rao, Colin Craig Fleming . Horizon Scientific Press.
3. Medical Diagnostics and Procedures: M. Singh Narosa
4. Genetic Analysis of Complex Disease Jonathan L. Haines Margaret A. Pericak John Willey
5. Techniques in diagnostic Human Biochemical Genetics Frist A. Homes. Wiley-Blackwell
6. Molecular Diagnostics: Fundamentals, Methods, & Clinical Applications (2011). Lela Buckingham, Ph.D. and Maribeth L. Flaws, Ph.D.

## (ELECTIVE – 3)
## BIOSAFETY, BIOETHICS AND IPR

**Course Number: 17BIOGE03B** **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 mankind.

**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: 17BIOGS01** **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: 17BIOGS02** **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: 17BIOGS03** **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: 17BIOBCP1** **Number of Credits: 4 (Four)**

**Translational Research Laboratory – Dr. V. Vijayapadma**

1. Lymphocyte Culture
2. Separation of PBMC
3. DNA isolation & Amplification of a gene by PCR (from human blood)

**Molecular Toxicology Laboratory - Dr. P. Ekambaram**

1. Hematology: RBC and WBC total counts, WBC differential count.
2. Mitotic index.
3. Mounting of polytene chromosome from Chironomous larvae.

**Plant Genetic Engineering Laboratory – Dr. R. Sathiskumar**

1. Introduction to Plant Tissue Culture- Media Preparation, Callus and Suspension cultures
2. Induction of somatic embryogenesis and analysis of different stages.
3. Plant Genomic DNA extraction by CTAB method and quantification

**Metabolic Engineering Laboratory – Dr. S. Girija**

1. $C_3$ $C_4$ plant identification
2. Citric acid estimation from fruit sample.
3. Genome mapping by ISSR marker

**Molecular Microbiology Laboratory – Dr. S.R. Prabagaran**

1. Isolation of anaerobic Microorganisms from various environmental sources
2. Cultivation of Bacteria, Actinomycetes andFungi from soil samples.
3. Staining techniques and Biochemical observations of Bacteria (Antibiotics/Enzymes).

**Dr. V. Thirunavukkarasu Lab**

1. Total protein extraction and Protein estimation by Lowry's method.
2. Determination of protein molecular weight by SDS-PAGE AND Native PAGE
3. Mammalian cell lines: Freezing and thawing.

**Dr. S. Velayuthaprabhu Lab**

1. Estimation of blood glucose and glucose tolerance test
2. Estimation of SGOT and SGPT in serum
3. Elution of protein by gel filtration column chromatography

**Dr. M. Arun Lab**

1. Citric acid estimation from the fruit sample
2. Isolation of Viable protoplast from leaf tissue
3. Seed priming using nitrogenous compounds to improve abiotic stress tolerance

## PRACTICALS – II
## ADVANCED BIOTECHNOLOGY

**Subject code: 17BIOBCP2** **Number of Credits: 4 (Four)**

**Translational Research Laboratory – Dr. V. Vijayapadma**
1. Demonstration of ELISA.
2. Determination of antigen concentration by Rocket immunoelectrophoresis.
3. Quantative gene expression by RT-PCR

**Molecular Toxicology Laboratory – Dr. P. Ekambaram**
1. Micrometry
2. Isolation & Quantification of DNA from animal tissues.
3. Identification of Barr bodies from Buccal smear

**Plant Genetic Engineering Laboratory – Dr. R. Sathishkumar**
1. Particle gene gun mediated genetic transformation of GFP in tobacco.
2. Identification of WT/ Transgenic plant by PCR.
3. DNA barcoding for plant and herbal product authentication

**Metabolic Engineering Laboratory – Dr. S. Girija**
1. Determination of Free radical scavenging activity by DPPH assay.
2. Quantification of active compounds from plants using HPLC.
3. *Agrobacterium rhizogenes* for hairy root culture and estimation of phenoic compound

**Molecular Microbiology Laboratory – Dr. S. R. Prabagaran**
1. Isolation of plasmid DNA from bacteria by salt lysis method.
2. Transfer of genetic material through bacterial conjugation.
3.Electrocompetent cell preparation and Electroporation.

**Dr. V. Thirunavukkarasu Lab**
1. Total RNA isolation and quantification using NanoDrop
2. Identification of optimum restriction site for gene cloning, restriction digestion of vector, purification of restriction digested DNA using gel elution method
3. Oligonucleotide primers designs for cloning, sequencing, and detection experiments (Demonstration)

**Dr. S. Velayuthaprabhu Lab**
1. Active Immunization for antibody production (Demo)
2. Identification of estrous cycle in mice
3. Human pregnancy test

**Dr. M. Arun Lab**
1. Restriction Digestion of plasmid vectors and genomic DNA
2. Optimization of DNA ligation reactions
3. Preparation of *E.Coli* competent cells and transformation of plasmid vectors

## PRACTICALS – III
## APPLIED BIOTECHNOLOGY

**Subject code: 17BIOBCP3** **Number of Credits: 4 (Four)**

**Translational Research Laboratory – Dr. V. Vijayapadma**

1. Checking the cell viability by MTT assay.
2. LDH Assay
3. ROS Generation

**Molecular Toxicology Laboratory - Dr. P. Ekambaram**

1. Primary cells Preparation from animal tissues/organs/ embryos.
2. Fluoride Estimation in water samples
3. *Insitu* hybridization in Zebrafish embryo

**Plant Genetic Engineering Laboratory – Dr. R. Sathishkumar**

1. Transient gene expression of GFP in tobacco by Agroinfiltration technique
2. Recombinant protein analysis by Western blot.
3. PCR-RFLP analysis for detection of adulteration in aromatic rice by non-aromatic rice

**Metabolic Engineering Laboratory - Dr. S. Girija**

1. FRAP Assay
2. *Agrobacterium tumifacience* mediated transformation
3. Screening of secondary metabolites from medicinal plants

**Molecular Microbiology Laboratory - Dr. S.R. Prabagaran**

1. Metagenomic DNA isolation from problem soils.
2. Determinattion of generation time of bacteria by standard growth curve
3. Optimization of bacterial media through Resource Surface Methodology (RSM)

**Dr. V. Thirunavukkarasu Lab**

1. cDNA preparation from total RNA and qualitative PCR analysis of a mutant gene expression
2. Diagnosis of virus (dengue, chickungunya) infected samples using PCR
3. Northern Blotting (Demonstration)

**Dr. S. Velayuthaprabhu**

1. Antibody titer test using ELISA
2. Membrane receptor identification by IHC
3. Detection of Protein expression by ECL in WB (Demo)

**Dr. M. Arun**

1. Sonication and Vacuum infiltration assisted transformation of meristem using *Agrobacterium tumifacience* and histochemical localization of GUS expression in transformed tissue
2. Extraction and quantification of plant pigments
3. Southern blot analysis to confirm copy mumber integration in transformed plants