BHARATHIAR UNIVERSITY:: COIMBATORE – 641 046
M.Sc. BIOTECHNOLOGY (UNIVERSITY DEPT.)
(For the students admitted during the academic year 2018– 2019 batch & onwards)
SCHEME OF EXAMINATION

Semester	Paper	Subject	Hrs / week	University examination			Total Marks	Credits
				Dur/ Hrs.	INT.	EXT		
SEMESTER I								
18BIOBC01	Paper-I	Biochemistry	4	3	25	75	100	4
18BIOBC02	Paper - II	Cell and Molecular Biology	4	3	25	75	100	4
18BIOBC03	Paper - III	Microbiology	4	3	25	75	100	4
18BIOBC04	Paper – IV	Genetics	4	3	25	75	100	4
18BIOGE01A	Elective - 1	Biodiversity and Bioprospecting	4	3	25	75	100	4
18BIOGE01B	”	Bioinstrumentation						
18BIOGS01	Supportive-1	Tools in Biotechnology	2	2	12	38	50	2
18BIOBCP1	Practical - I	Basic Biotechnology	6	6	25	75	100	4
SEMESTER II								
18BIOBC05	Paper - V	Developmental Biology and Physiology	4	3	25	75	100	4
18BIOBC06	Paper – VI	Immunology	4	3	25	75	100	4
18BIOBC07	Paper - VII	Recombinant DNA Technology	4	3	25	75	100	4
18BIOBC08	Paper VIII	Plant Biotechnology	4	3	25	75	100	4
18BIOGE02A	Elective 2	Pharmaceutical Biotechnology	4	3	25	75	100	4
18BIOGE02B	”	Environmental Biotechnology						
18BIOGS02	Supportive-2	Medical Biotechnology	2	2	12	38	50	2
18BIOBCP2	Practical –II	Advanced Biotechnology	6	6	25	75	100	4
		Summer Training*					50	2
SEMESTER III								
18BIOBC09	Paper IX	Animal Biotechnology and Stem Cell Biology	4	3	25	75	100	4
18BIOBC10	Paper X	Bioprocess Technology	4	3	25	75	100	4
18BIOBC11	Paper XI	Bioinformatics and Systems Biology	4	3	25	75	100	4
18BIOBC12	Paper - XII	Biosafety Bioethics and IPR	4	3	25	75	100	4
18BIOGE03A	Elective -3	Herbal Technology	4	3	25	75	100	4
18BIOGE03B	”	Molecular Diagnostics and Clinical Testing						
18BIOGS03	Supportive- 3	Food Biotechnology	2	2	12	38	50	2
18BIOBCP3	Practical III	Applied Biotechnology	6	6	25	75	100	4
SEMESTER IV								
	Project Work***			-	-	-	250	10
	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.

****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.

Additional Credits:

Course	Total Marks	Credits
Professional Certification (online certification NPTEL, SWAYAM)	50	2

** **Professional Certification:**

Students have to undertake Professional Certification course.

BIOCHEMISTRY

Course Number: 18BIOBC01 **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.

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.

Carbohydrates classification; 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.

Course outcome:

CO1: 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.

CO2: Students can able to recognize the structures and functions of biomolecules that form the basis of what we understand to be living organisms.

CO3: By the end of the course students could able to understand the principles of biochemical pathways which regulate the cellular mechanisms.

CO4: Further, the students will be exposed to the limitations of biomolecules in regulation of molecular functions in mammals especially in humans.

CELL AND MOLECULAR BIOLOGY

Course Number: 18BIOBC02 **Number of Credits: 4 (Four)**

Scope: Cell and Molecular Biology is the branch of biology that deals with the study of the structure and function of living systems at the molecular level. The branch focuses mainly on DNA, RNA, Protein Synthesis and their regulatory mechanism. A molecular biologist aims to understand the functions of cells at molecular level. This paper provides a thorough knowledge about structure and function of cells, cellular energetic, protein trafficking, bio molecules and cellular development.The academic programs include instruction on the molecular basis of gene regulation in cells.

Objective: The objective of the Postgraduate students in cell and molecular biology is to produce graduates whose knowledge of biology, biological engineering and/or biologically-inspired design.Understanding of interactions between the various systems of a cell and cell organelles including the interactions between DNA, RNA and protein biosynthesis and to understand biological phenomena in cytological terms.These courses include organic chemistry, biochemistry, cell and molecular biology, genetics, development, and neuroscience.Through course work and directed research in the lab of a faculty member, students have many opportunities to develop a deep knowledge of specific fields within biology.

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 supranucleosomalstructures.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

Course outcome:

On completion of the Cell and Molecular biology course, students shall be able to,

- Understand and apply the principles and techniques of molecular biology which prepares students for further education and/or employment in teaching, basic research, or the health professions.
- To conduct independent work in a laboratory with basis of cell biology

- Exhibit a knowledge base in genetics, cell and molecular biology, anatomy and physiology and biomedical sciences
- Advanced laboratory practices in cell and molecular biology will render them chose their techniques in molecular biology research and further will help them to get job opportunities in Diagnostic labs.
- The theoretical knowledge gained from this paper will help the student to apply these concepts in their future research.

MICROBIOLOGY

Course Number: 18BIOBC03 **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– Classification of Fungi andViruses – Cultivation of bacteria, fungi, virus - Pure culture -Polyphasic taxonomy – Preservation and maintenance of microbes – Microbial Culture Collection centers – India and International organizations – Modern methods to study microbial diversity: NGS – MiSeq

UNIT II

Molecular Taxonomy: Microbial Identification through physiological and biochemical methods (BIOLOG, Vitex); MALDI TOF- 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, quinines

UNIT III

Metagenomics and Anaerobic Microbiology: Molecular methods to study complex microbial communities: DGGE, SSCP, T-RFLP, FISH – Cloning for functional metagenomics: Construction of small insert and large insert metagenomic libraries – Microbiomes - Extremophiles

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

UNIT IV

Food and Agricultural Microbiology: Spoilage of food – Principles and types; Fresh fruits, vegetables and processed foods – Food preservation: physical and chemical- Food sanitation – Indication of food safety- Food poisoning – Food borne pathogens – Quality control and Food laws

Microorganisms in soil processes – role of microorganisms in soil fertility – carbon cycle – nitrogen cycle: Biological nitrogen fixation, microbial transformation of Phosphorus – Plant microbe interaction: Biopesticides –Biofertilizer -PGPR -Micorrhizae

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

REFERECES:

1. Lansing M. Prescott. Microbiology. McGraw-Hill Higher Education.
2. Bergey's Manual of Systematic Bacteriology. Volumes 1-5. Williams & Wilkins.
3. OladeleOgunseitan. Microbial Diversity - Form and Function in Prokaryotes.
4. Wolfgang R. Streit and Rolf Daniel. Metagenomics: Methods and Protocols.
5. A. Mark Osborn and Cindy J. Smith. Molecular Microbial Ecology.Taylor and Francis Group.
6. ErkoStackebrandt. Molecular identification, systematics, and population structure of prokaryotes. Springer-Verlag Berlin Heidelberg.
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. (4th Edition of Soil microbiology and Plant growth). Oxford & IBH, New Delhi.

10. Paul EA (2007) Soil Microbiology, Ecology and Biochemistry. III Edition. Academic Press, Oxford, UK.
11. Baron, Peterson and Finegold. Diagnostic Microbiology.
12. S. Rajan. Medical Microbiology by MJP Publishers.
13. Stephen H. Gillespie and Kathleen B. Bamford. Medical Microbiology and Infection at a Glance.
14. Madigan, M.T., Martinko, j. M., Stahl, D.A., and Clark, D.P. 2012. Brock‟s Biology of Microorganisms. 13th Edition. Benjamin Cummings, San Francisco, CA.
15. Anaerobic Microbiology: A Practical Approach by P.N. Levett 1992.
16. Anaerobic Bacteria, Holland, K. T. 1987.

Course outcomes:

CO1: Gain knowledge on importance of microbial taxonomy and systematics
CO2: Discuss various techniques involved in Molecular taxonomy and Phylogeny
CO3: Understand various modern diversity study methods and get idea on Anaerobic microbiology
CO4: Integrate the theoretical knowledge on microbiology for applications
CO5: Apply the appropriate tools in Medicine and Human health.

GENETICS

Course Number: 18BIOBC04 **Number of Credits: 4 (Four)**

Scope: This paper in genetics has been structured to give the student an in depth knowledge 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.

UNIT I

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. Multiple alleles; Sex determination;

UNIT II

Quantitative or polygenic inheritance: Inheritance of kernel color in wheat; corolla length in tobacco skin color inheritance in man, transgressive and regressive variation. Non-mendelian inheritance and their effects - maternal effect, epigenetic and extra nuclear inheritance; Linkage and crossing over.Chromosomal anomalies: variation in chromosome number: haploidy, polyploidy, aneuploidy. Variation in chromosome structure: deficiency of deletion, duplication, translocation, inversion and B-chromosome.

UNIT III

Prevention of disease: Prenatal diagnosis; Genetic counseling. Analysis of interitance pattern: Pedigree analysis; Diagnosis of disease: cytogenetics; Molecular cytogenetics;Techniques in the study of chromosomes and their applications: lymphocyte culture, chromosome preparations, karyotyping, banding, chromosomelabeling, in situ hybridization, chromosome painting, comparative genome hybridization (CGH).

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

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.IIIedition, 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.

Course Outcome:

CO1: The students will gain knowledge about the inheritance pattern of the genes and genetic diseases and also about the gene frequencies in the population.
CO2: The students can take up career in research or clinical molecular genetics labs .

(ELECTIVE - 1)
BIODIVERSITY AND BIOPROSPECTING

Course Number: 18BIOGE01A **Number of Credits: 4 (Four)**

Scope:
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.

Course Objectives:
The course objectiveof this paper is to impart students an in-depth knowledge and make them competent in the field of biodiversity and bioprospecting. The specific objectives include- to introduce major areas of bioprospecting and biodiversity to the students;to impart sufficient information and scientific knowledge about natural products from plants; to facilitate the students to understand about the bioprospecting aspects related to microorganisms and plants;to familiarize the students in drug discovery and product development and know about modern tools involved in drug discovery; to educate the students in regulatory legislation and convention in bioprospecting.

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 species 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*-AntimalarialMorphine-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 legislation 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.

Course Outcomes:

On successful completion of the course, the students will be able to
CO 1–Defineabout the major areas of bioprospecting and biodiversity.
CO 2–Obtain a comprehensive knowledge about natural products from plants.
CO 3–Apprehendthe bioprospecting aspects related to microorganisms and plants.
CO 4–Gain information's on drug discovery, product development,and modern tools involved in drug discovery.
CO 5–Be familiar with regulatory legislation and convention in bioprospecting.

(ELECTIVE - 1)
BIO-INSTRUMENTATION

Course Number: 18BIOGE01B **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.

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.

Course outcome:

CO1: On the successful completion of this course, the students would understand the analytical techniques and the principles of equipment used in biological and medical field.

CO2: Further, studentswill have complete insight in these techniques for the possible applications in various research areas of biological and medical sciences.

DEVELOPMENTAL BIOLOGY AND PHYSIOLOGY

Course number: 18BIOBC05 **Number of credits: 4 (Four)**

Objective: This paper encodes information on the development and physiology of various animal systems. To enable the students to know and understand the actual pathway of physiological metabolism of mammals including humans. 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:

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

Course Learning Outcomes

The students will be able to:

1. Learn the importance of embryology (historical review) and more recently developmental biology as an emerging discipline and science.
2. Identify several unifying themes and differences in developmental biology with respect to anatomy, physiology and evolution in selected Invertebrates and Vertebrates species.
3. Learn the process and the mechanisms of early embryonic development (fertilization, early cleavage, blastula, gastrula, neurula) in Vertebrates including frog, chicken and mouse and Invertebrates e.g. Drosophila melanogaster and sea urchin.
4. Identify the molecular pathways controlling axis formation (anterior-posterior, dorsal-ventral and left-right axes) in amphibians (frog), mammals (mouse, humans) and fly (Drosophila) including the signaling molecules and key gene regulators.
5. To be able to communicate scientific information about key concepts in developmental biology.
6. To describe and explain the normal function of the cells, tissues, organs, and organ systems of the human body to help prepare you for a career in your chosen field (e.g. to gain content knowledge and comprehension in Biotechnology and Healthcare).
7. Describe and apply theory to explain the physiology of: individual systems and/or an integrated system response

IMMUNOLOGY

Course Number: 18BIOBC06 **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.

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

Course outcome:

CO1: This course will provide the student insights into the various aspects of Immunology such as classical immunology, clinical immunology, Immunotherapy and diagnostic immunology.

CO2: By the end of the course students might understand the principles and limitations of immune system and their functions against various infectious diseases and other critical immunological disorders.

CO3: Students will develop the attitude to apply an understanding of the roles of immunology in protection against disease and autoimmune disorders to choices in their daily lives.

CO4: The students will also be expected to have clear knowledge in the diagnostic methods based on immunotechniques to limelight new approach to develop new technology in clinical settings.

RECOMBINANT DNA TECHNOLOGY

Course Number: 18BIOBC07 **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.

Course 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). 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. The specific objective of course is-to impart adequate knowledge about principles and methods in genetic engineering andenzymes in molecular biology; to expeditethe students to understand the techniques involved in gene cloning and cDNA synthesis; to expand their understanding towards latest technologies in DNA sequencing; to impart sufficient information about expression strategies for heterologous genes; to enrich the students' knowledge with respect to genome mapping and gene therapy.

UNIT I
Principles and methods in genetic engineering: Isolation and purification of Nucleic Acids and protein. Southern, Northern, Western, 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. 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,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 DNA, RNA and protein level. **Expression strategies for heterologous genes:**vector engineering and codon optimization, Host engineering, 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 deletion 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. 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.

Course Outcomes:

On successful completion of the course, the students will be able to

CO 1– Obtain an in-depth knowledge in nucleic acid isolation, protein isolation and blotting techniques.
CO 2– Understand the importance of enzymes used in the molecular biology.
CO 3– Acquire a complete knowledge in methods used for gene cloning and cDNA synthesis.
CO 4– Know the latest information on DNA sequencing methods.
CO 5– Gain information's more information's related to heterologous gene expression.
CO 6– Describe about important aspects in genome mapping and gene therapy.

PLANT BIOTECHNOLOGY

Course Number: 18BIOBC08 **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 willlearn 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 and 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; greenhouse 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. UK.
2. *In Vitro* culture of higher plants, Pierik, 1987. MartinusNijhoff Publisher, Germany.
3. Plant cell culture. A practical approach. Second edition. Edited by R.A. Dixon and R.A. Gonzales.1994. Oxford University Press. UK.
4. Plant Molecular Biology by Grierson and Convey.1984. Blackie and Son Limited. USA.
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, Henry,1997. Chapmans and Hall. UK.
8. Plant Biotechnology, 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. USA.
10. Plant Biotechnology: The genetic manipulation of plants. Slater, Scott and Fowler, 2008, 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

Course Outcomes:

CO1:Describe thegenome organizations in plants
CO2: Elaborate on the plant cell and tissue culture systems
CO3: Explain the genetic transformation techniques in plants
CO4: Demonstrate the application of genetic transformation techniques in plants
CO5: Evaluate the importance of metabolic engineering and molecular farming in plants

PHARMACEUTICAL BIOTECHNOLOGY

Course Number: 18BIOGE02A **Number of Credits: 4 (Four)**

Scope: This paper encodes information on drug designing and drug discovery and drug metabolism.

Objective: This paper will help students to get an overview about pharmaceutical drugs and how they are discovered and developed for commercial use.

UNIT I: INTRODUCTION TO PHARMACEUTICALS

Biopharmaceuticals and pharmaceutical biotechnology. Source of drugs – plant, animals, microbes and minerals. Drug isolation and evalution. Drug metabolism – Pharmacokinetics – Absorbtion, Distribution, Metabolism and Excretion (ADME), Pharmacodynamics – Mechanism of drug action. Physico – chemical properties of the drugs. Drug receptors.

UNIT II: SOURCES OF BIOPHARMACEUTICALS

Prokaryotic and Eukaryotic Cells in Biotech Production: Use of Bacteria and Actinomycetes in Biotech Production, *Saccharomyces cerevisiae* and Other Fungi in Biotech Production, Plants in Biotech Production, Plants and Plant Cell Culture as Bioreactors for pharmaceuticals. Use of animal cell culture system in biopharmaceutical production. Biopharmaceutical products – Hormones, vitamins, enzymes and coenzymes, laxatives, analgesics, antipyretics and anti-inflammatory agents, antibiotics, antiseptics, antacid, non-steroidal contraceptives, blood products, nucleic acids of therapeutic interest, adjuvantsfrom biological organisms.Application of Biopharmaceuticals as Therapeutic enzymes.

UNIT III: DRUG DEVELOPMENT AND DELIVERY

Discovery of biopharmaceuticals. Impact of genomics and related technologies upon drug discovery. Initial product characterization. Gene chips, proteomics, structural genomics, pharmacogenetics. Pre-clinical studies. Toxicity studies – reproductive toxicity and teratogenicity, mutagenicity, carcinogenicity and other tests, clinical trials, clinical trial design, trial size design and study population. Delivery of biopharmaceuticals – oral delivery systems, pulmonary delivery, nasal, transmucosal and transdermal delivery system.

UNIT IV: MANUFACTURING PRINCIPLESAND REGULATORY ASPECTS

Good Manufacturing Practice (GMP).:Chemical reactions that affect pharmaceutical products – Oxidation, reduction, hydrogenation, dehydrogenation. Preservatives and phenolic compounds in drug formulations. Manufacturing principles –. Quality control. Guidelines for packing procedure and use of different techniques.Regulatory authorities –Central drug standards control organisation, food and drug administration, European regulations.

UNIT V:

Applications of Nano-biotechnology in drug development and delivery.Polymeric and metallic nanoparticles for drug delivery. Nanotechnology for Cancer Diagnostics and Treatment.

References:

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.
4. Nanobiotechnology Concepts, Applications and Properties by Christef M. Niemeyer, C.A.Mirkin. Wiley – VCH Publishers

Course Outcome:

OC 1: The students will be able to acquire knowledge about natural sources of drugs, interaction of drugs with different types of biological molecules to mediate physiological effects, metabolism and removal of drugs from the system.
OC 2: The students will get an insight about how prokaryotic and eukaryotic systems can be used with the help of biotechnology in biopharmaceutical production.
OC 3: The paper will enable students to get an overview of intricate steps involved in identifying and development of new drug entity.
OC 4: Students will learn about principles and ethics to be followed in production and processing of pharmaceutical products.
OC 5: Students will learn about emerging powerful technologies used to promote efficient and safe delivery of drugs into the host system.

(ELECTIVE -2)
ENVIRONMENTAL BIOTECHNOLOGY

Course Number: 18BIOGE02B **Number of Credits: 4 (Four)**

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

Course Objective: Students will get an idea about the hazards to our environment and solutions to protect for sustainable development.Thus the course objectivewas framed- to impart adequate informationto the students about bio-fuel and bio-energy and its future needs; to expedite students to recognize the dangerous effects of environmental pollution and its methods of control and management;to impart appropriate information and adequate knowledge about environmental impact assessment and environmental acts; to acquaintstudent’s in the area of disasters management.

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-JoachinJordening and Josef Winter. Winter-VCH. 2005
10. Biology of wastewater Treatment. N F Gray. Mc GrawHill . 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.

Course Outcomes:

On successful completion of the course, the students will be able to

CO 1–Acquire a complete knowledge about bio-fuel and bio-energy and its future needs.

CO 2–Understand dangerous effects of environmental pollution and its methods of control and management.

CO 3–Describe the important aspects about environmental impact assessment and environmental acts

CO 4–Obtain a comprehensive knowledge about disasters management.

CO 5–Know about the role of remote sensing and GIS in ecological mapping and environmental hazard predictions.

ANIMAL BIOTECHNOLOGY& STEM CELL BIOLOGY

Course Number: 18BIOBC09 **Number of Credits: 4 (Four)**

Scope: The animal biotechnology & Stem cell biology paper provides knowledge on the animal cell culture lab design, required equipments, aseptic techniques, animal cell culture techniques and their applications to research and industry. It also provides knowledge on assisted reproductive technology, transgenic animal production and 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 biotechnologyand also to offer wide ranging topics related to stem cells, regenerative biology and tissue engineering.

UNIT I

Introduction to Animal Tissue Culture: Background, Advantages, Limitations and applications. 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. 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, Cell banks, Transporting Cells.

Cytotoxicity: Measurement of Cytotoxicity: Cell viability; Cell proliferation assays; Metabolic Cytotoxicity assays; plating efficiency; Drug Interaction; Mutagenesis Assay by Sister Chromatid Exchange; 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.

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.

Course Outcome:

CO1: It also offers updated fundamental knowledge, technological advancements and potential applications of stem cells and tissue engineering.

CO2: Provides opportunities for the students to have careers in laboratory research or animal care technicians in the fields of veterinary and human health or biotechnology.

BIOPROCESS TECHNOLOGY

Course Number: 18BIOBC10 **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.

Course Outcomes:

CO1: Explain the essentials for Bioprocess Technology in microbiologists perspective
CO2: Discuss the theory and mathematics behind microbial growth
CO3: Construct the framework to establish a Bioreactor set up.
CO4: Integrate Downstream processing after up scale execution.
CO5: Apply the appropriate tools in Industry, Agriculture and Human health.

BIOINFORMATICS AND SYSTEMS BIOLOGY

Course Number: 18BIOBC11 **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: Togain an appreciation for the field of systems biology. To understand and learn the technical details of several current experiments or technologies used in the field of systems biology. To 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 and exciting upcoming filed of Systems Biology, which will help students to get 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. Molecular databases: accessibility, compatibility, comprehensive database, portability, quality and navigability. Systems Biology:Definition, Hypothesis driven research in systems biology, Wet experiments-Dry experiments: predictions and simulations. 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, interactomics, Phenomics, localizomics; Gene networks - Integration of Networks. Combination of omics approaches: data integration, modeling; Synthetic biology

UNIT V

Introduction to Tools used in 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(2009).
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.
8. Introduction to Systems Biology by Choi, S. Humana Press, USA (2007).

Course outcomes:

CO1: Explain the importance of bioinformatics in systems biology
CO2: Discuss the use of genes and genomes data in systems biology
CO3: Construct the metabolic pathway networks
CO4: Integrate the omics data for networking
CO5: Apply the appropriate tools in systems biology for modelling

BIOETHICS, BIOSAFETY AND IPR

Course Number: 18BIOBC12 **Number of Credit Hours: 4 (Four)**

Course Objectives

- To provide basic knowledge on intellectual property rights and their • implications in biological research and product development;
- To become familiar with India's IPR Policy;
- To learn biosafety and risk assessment • of products derived from biotechnology and regulation of such products;
- To become familiar with ethical issues in biological research. is course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modi cations, DNA testing.

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, copyrights, trade marks, design rights, geographical indications – importance of IPR – patentable and non patentable – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO).

References:

- Ganguli, P. (2001). *Intellectual Property Rights: Unleashing the Knowledge Economy.* New Delhi: Tata McGraw-Hill Pub.
- *National IPR Policy*, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
- *Complete Reference to Intellectual Property Rights Laws*. (2007). Snow White Publication Oct.
- Kuhse, H. (2010). *Bioethics: an Anthology*. Malden, MA: Blackwell.
- O ce of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
- Karen F. Greif and Jon F. Merz, *Current Controversies in the Biological Sciences - Case Studies of Policy Challenges from New Technologies*, MIT Press
- World Trade Organisation. http://www.wto.org
- World Intellectual Property Organisation. http://www.wipo.int
- International Union for the Protection of New Varieties of Plants. http://www.upov.int
- National Portal of India. http://www.archive.india.gov.in
- National Biodiversity Authority. http://www.nbaindia.org
- Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/ divisions/csurv/geac/annex-5.pdf
- Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). *Problem Formulation in the Environmental Risk Assessment for Genetically Modi ed Plants*. Transgenic Research, 19(3), 425-436. doi:10.1007/s11248-009-9321-9
- Craig, W., Tepfer, M., Degrassi, G., & Ripandelli, D. (2008). *An Overview of General Features of Risk Assessments of Genetically Modi ed Crops*. Euphytica, 164(3), 853-880. doi:10.1007/s10681-007-9643-8
- Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
- Guidelines and Standard Operating Procedures for Con ned Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp
- Alonso, G. M. (2013). *Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure "Fit for Purpose" Risk Assessments*. Retrieved from http://biosafety.icgeb.org/inhousepublicationscollectionbiosafetyreviews.

Course Outcomes

- On completion of this course, students should be able to:
- Understand the rationale for and against IPR and especially patents;
- Understand why India has adopted an IPR Policy and be familiar with broad outline of patent regulations;
- Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents;
- Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modi ed organisms, national and international regulations;
- Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

(ELECTIVE - 3)
HERBAL TECHNOLOGY

Course Number: 18BIOGEO3A **Number of Credits: 4 (Four)**

Scope: Herbal technology confines all the advancing technical frontiers meant to tap myriads of modes of manipulating plants around us. A large number of technologies have been developed to harvest the bountiful products that the plants manufacture.Therefore, a detailed understanding in these technologies is pivotal to make the students a future researchers and entrepreneurs in Herbal technology. In addition, a classical as well as advanced knowledge is also important to strengthen the caliber of the student's in this field. Thus the aim of this paper is to produce postgraduates with thorough knowledge and understanding of herbal drug technology to meet higher level expectations in herbal industries, research or take up entrepreneurial route.

Course Objective: The programme objective is to prepare the students skillful for research in academics or career in herbal industries.The specific objectives include-to impart adequate knowledge about herbal industryand general methods of processing herbs; to facilitate students to understand the technological aspects involved in the preparation of herbal extracts; to improve the understanding of techniques applied for analysis of phytopharmaceuticals; to impart sufficientinformationand scientific knowledge to develop and evaluate herbal formulations; to familiarize students in screening the efficacy of herbal formulations; to train students in safety, toxicity, and regulatory aspects of herbal drugs. to acquaint students about herbal products and its uses.

UNIT-I
Herbal Industry: Introduction,Staff requirement, Project profiles, Plant and equipment, Some hints on herbal formulations and Processing,Quality Control, Research and development, Regulatory requirements.**General Methods for Processing of Herbs:** Definition, sources, Key to identification of medicinal plants; Methods of processing- collection, harvesting, garbling, packing and storage conditions; Methods of drying- Natural and artificial drying methods-merits and demerits.

UNIT-II
Methods for Preparation of Extracts: Types of herbal extracts. Principles of extraction and selection of suitable extraction method; Different methods of extraction- Infusion, Decoction, Digestion, Maceration, Percolation, Successive solvent extraction,Soxhlet extraction, Supercritical fluid extraction, Stream distillation, Microwave assisted extraction, Headspace techniques, Sepbox, Hot continuous extraction, Pilot scale extraction with example.

UNIT-III
Phytopharmaceuticals and their Analysis: Introduction, Importance of Phytoconstituents in Therapy. Phytopharmaceuticals and their source herbs; Quantitative analysis of Crude Drug Extracts and Isolates- Carbohydrates, Proteins**,** Alkaloids, Essential Oils, Volatile Oils, Spices, Fixed Oils Fats, Waxes, Phenylpropanoids, Flavonoids, Resins and Resinous Plant Drugs, Tannins, Terpenoids, Glycosides, Fluorescent Substances, Coloring Matters, Steroids, Carotenoids, Oleoresins, Vitamins. Suggested dosage of natural plant products.

UNIT-IV
Standardization of herbal formulation: Importance of Standardization and Problems Involved; Standardization for Single Drugs and Compound Formulations; WHO Guidelines for standardization of Quality Herbal Formulations; Estimation of the Parameter used for formulation;**Screening Methods Used for Herbal Drugs:** Introduction**;** Screening for Anti-diabetic, Anti-hypertensive, Antipyretic, Hepatoprotective, Anti-ulcer, Anti-asthmatic, and Antidiarrhoeal drugs. Evaluation of Antioxidant, and Wound healing agents.Screening for antimicrobial and antiviral activity.

UNIT-V
Toxicity and Regulations: Importance of Herbal Therapies, Herbals versus Conventional Drugs, Efficacy of Herbal Medicinal Products, Validation of Herbal Therapies, Safety in Herbal Drugs, Toxicity in Herbals and Their Interactions, Adverse Reactions and Safety in Herbal Medicine, General Concepts of Evaluation and Quality Control. **Herbal Products:** Cosmetics-The sources and description of raw materials of herbal origin used in fixed oils, waxes, gums, hydrophilic colloids, colors, perfumes, protective agents, bleaching agents, preservatives, antioxidants and other ancillary agents. Taste Enhancers, Colors and Food supplements.

References:

1. Quality Control of Herbal Drugs by Dr. Pulok K. Mukherjee. 2002. Business Horizons; Reprint 2012 edition
2. Herbal Drug Technology by S. S. Agrawal and M. Paridhavi, 2013. Orient Blackswan
3. Herbal Drugs Industry: A Practical Approach to Industrial Pharmacognosy. 1996. Eastern Publishers; 1st edition

Course Outcomes:

On successful completion of the course, the students will be able to

CO 1–Describe the important aspects and components of herbal industries.
CO 2–Identify the herb, collect, process, and store.
CO 3–Acquire a complete knowledge in extraction techniques used for herbal drugs.
CO 4–Understand the techniques for standardization of herbal formulation and their screening methods.
CO 5–Obtain a comprehensive knowledge in analysis of phytopharmaceuticals and suggest the dosage of natural products.
CO 6–Formulate herbal formulations and screen its efficacy.
CO 7–Gain information's on safety, toxicity, and regulatory aspects of herbal drugs.
CO 8– Know about the value added information of herbal products.

(ELECTIVE - 3)
MOLECULAR DIAGNOSTICS AND CLINICAL TESTING

Course Number: 18BIOGE03B **Number of Credits: 4 (Four)**

Scope: Precise diagnosis 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.

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

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.

UNIT III

Proteomic assays for diagnostics
Proteomics- introduction to clinical proteomics. 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 based analysis. Immunoassays in diagnostics – Applications of RIA, ELISA, Chemiluminescent IA, FIA, Immunohistochemistry in disease diagnosis.

UNIT IV

Applications of molecular diagnostics
Role of Molecular diagnostics in Blood banking, bone marrow transplantation and organ transplantation.Major Histocompatibility Complex (MHC), HLA typing- RFLP, PCR based methods, SSO, SSP and SBT methods. Bone marrow transplant engrafment analysis.
Diagnosis of genetic diseases- Thalassemia,Sickle Cell anemia, Cystic Fibrosis.Neonatal and Prenatal disease diagnostics- Prenatal and pre-implantation diagnosis. Noninvasive: Triple test, Ultrsonography (USG), Invasive: Amniocentesis (AC), chorionic villi sampling.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, 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).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).
Diagnosis of infection caused by Streptococcus, Salmonella. Diagnosis of fungal infections. Major fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. Diagnosis of Protozoan diseases: Amoebiosis, Malaria, Leishmaniasis. Molecular diagnosis of various viral diseases: 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.

Course Outcome:

CO 1-The main outcome of this paper is to familiarize 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.

CO2- The students will be able to learn about the commercially used tests in molecular diagnosis and when combined with practical knowledge they will be well equipped to meet the demands of job opportunities in the field of health care.

SUPPORTIVE –I
TOOLS IN BIOTECHNOLOGY

Subject Code:18BIOGS01 **Number of Credits:2 (Two)**

Scope:
The term biotechnology is often used to refer to genetic engineering technology with history of procedures for modifying biological organisms according to the needs of humanity. With the development of new approaches and modern techniques, Biotechnology has a strong emphasis in every part of life. The current paper is designed to open up ideas about tools of Biotechnology and its applications.

Course Objective:
The tools in Biotechnology forms a newest route in combining the science of molecular biology and genetic engineering in plant, animal, and microbiology. The core objective of the paper is- to introduce the concepts of gene and genomics for students; to familiarize student's in gene cloning vectors; to train student's about tools used for gene manipulation; to enhancestudents'knowledge about selection strategies and screening of transformants; to describe theapplications of gene cloning.

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: Plasmid, phagemid, cosmid, Artificial Chromosomes (BAC) - Transformation techniques: Electroporation, $CaCl_2$ method.

UNIT III
Tools for Gene Manipulation: 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 – Application and Biosafety issues.

References

1. Primrose. S.B., Twyman R.M., Old. R.W. (2001) Principles of Gene Manipulation.
1. 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. MicklossndG.A.Freyar, Cold Spring Harbor laboratory Press, New York, 1990.
5. Molecular Cloning. Maniatis, Fritsch and Sambrook.

Course Outcomes:

On successful completion of the course, the students will be able to

CO 1–Obtain a comprehensive knowledgeabout concepts of gene and genomics.
CO 2–Gain an in-depth knowledge about vectors used in gene cloning.
CO 3–Apprehend about the principle tools that are used for gene manipulation.
CO 4–Know about the importance of selection and screening of transformants.
CO 5–Be aware with the principal applications of gene cloning.

SUPPORTIVE - II

MEDICAL BIOTECHNOLOGY

Subject Code: 18BIOGS02 **Number of Credits: 2 (Two)**

Scope: This subject is aiming to understand and develop advanced technology to diagnose, treat or prevent human diseases by applying basic science, medical expertise and advanced methods to living cells.

Objectives: The overall objective of this medical biotechnology is to enrich the student skills in handling the advanced instruments for the diagnosis of various clinical disorders.

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)

Course outcome:

CO1: Medical Biotechnology will equip the students with broad theoretical knowledge and critical understanding of advanced principles in biotechnology.
CO2: The students will also gain the practical knowledge required to support a career within a research environment.
CO3: Successful completion of this course will provide a sound platform for further study in a research setting in the bio-molecular sciences.

SUPPORTIVE - III

FOOD BIOTECHNOLOGY

Course Number: 18BIOGS03 **umber of Credits: 2 (Two)**

Scope: This paper provides knowledge of food types and sources micro organisms required in production of food products, Food processing technology and preservation of food.

Objective: Designed to provide a theoretical knowledge on the conversion of raw materials into processed, packaged, shelf-stable food products and intermediate products. To learn about various types and technologies involved in ***food*** preservation and explore in depth about the concept.

UNIT I: Introduction to Foot Technology
The Importance and Source of Food. Classification of foods. Constituents of food and dietary sources of food – Carbohydrates, Lipids, Proteins, Water, Vitamins and Minerals.

UNIT II: Food Microbiology
Food and beverage- yeast: Bread, Alcoholic beverages-wine, beer. Dairy products – cheese. Vegetable and fruit products - Sauerkraut, Pickles. Microbial Pigments, SCP-bacteria, algae and fungi.

UNIT III: Food Biotechnology
Transgenic plants in quality modifications - nitrogen fixation and Nif genes. Plant growth regulators from soil microbes. Plants derived vaccines.

UNIT IV: Basic Food Process Technology
Principles and methods of food preservation: Asepsis removal, High temperature, Low temperature, Drying, Irradiation , Chemical and Biopreservatives.

UNIT V: Food Packaging Technology
Role and functions of food packaging. Food packaging materials –properties and types. Food sanitation, food control agencies and their regulations. Safety evaluation of novel food products. GMP.

Reference Books:
1. Byong H Lee. (2016). Fundamentals of food Biotechnology, 2nd Edition, Wiley - Blackwell
2. Ravishankar Rai V. (2016). Advances in Food Biotechnology, Wiley- Blackwell
3. Kalidas shetty . (2005). Food Biotechnology, Taylor & Francis group.

Course outcome:

CO1: This course will provide the students about the principles and concepts of technology to overcome the problems in food handling and processing,
CO2: Students will be able to understand the interrelationships between the properties of raw materials and the changing methods of producing them in cost effective manner.
CO3: Provides opportunities to be an entrepreneur in food processing companies /Agricultural units

PRACTICALS - I
BASIC BIOTECHNOLOGY

Subject code: 18BIOBCP1 **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. Seed priming using nitrogenous compounds to improve abiotic stress tolerance.
2. Extraction and quantification of chlorophyll in leaf samples.
3. Biochemical analysis of peroxidase in leaf samples.

PRACTICALS – II
ADVANCED BIOTECHNOLOGY

Subject code: 18BIOBCP2 **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 Isolation of plasmid and Restriction Digestion of plasmid vectors.
2. Optimization of DNA ligation reactions.
3. Preparation of *E.Coli*competent cells and transformation of plasmid vectors.

PRACTICALS – III
APPLIED BIOTECHNOLOGY

Subject code: 18BIOBCP3 **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*.
2. Histochemical localization of GUS expression in transformed tissue.
3. Southern blot analysis to confirm copy number integration in transformed plants.