PROGRAMME OBJECTIVE:

Biotechnology is a multidisciplinary area on the educational scene and programmes have been developed to meet the growing demand for trained manpower for any meaningful Biotechnology activity in the country. The courses of the programme are designed to expose the students to recent exciting developments in the area of genetic engineering and biotechnology and their exploitation in industry, agriculture and medicine.

PROGRAMME OUTCOME:

By the end of the programme students will:

1) gain an in-depth understanding of the basic and recent development in the field of Biotechnology

2) Acquire skills of critical, analytical and problem solving in order to enable them to be successful in various national and international examinations,

3) acquires practical skills in handling the laboratory equipment and capable of independent thinking and in writing scientific proposal and presentation and

4) be capable of becoming successful academicians/researchers and/or entrepreneurs.

S.No.	Code	Course Title	H/S	Credits	Page No.
Semester I					
1.	BIOT 401	Basic Cell Biology	H	**3**	1
2.	BIOT 402	General Microbiology	H	**3**	2
3.	BIOT 414	Biochemistry	H	**3**	4
4.	BIOT 415	Techniques in Biotechnology	H	**3**	5
5.	BIOT 521	Radiation Biology	S	**3**	6
6.	BIOT 403	Basic Cell Biology Lab	H	**1**	7
7.	BIOT 404	General Microbiology Lab	H	**1**	8
8.	BIOT 464	Biochemistry Lab	H	**1**	9
9.	BIOT 465	Techniques in Biotechnology Lab	H	**1**	10
10.	BIOT 575	Radiation Biology Lab	S	**1**	11
Semester II					
11.	BIOT 421	Molecular Genetics	H	**3**	12
12.	BIOT 459	Molecular Immunology	H	**3**	13
13.	BIOT 425	Molecular Plant Breeding	H	**3**	15
14.	BIOT 484	Animal Biotechnology	H	**3**	16
15.	BIOT 416	Bioprocess Engineering and Technology	H	**3**	17
16.	BIOT 426	Stem Cell Biology	S	**3**	18
17.	BIOT 427	Environmental Biotechnology	S	**3**	19
18.	BIOT 471	Molecular Genetics Lab	H	**1**	20
19.	BIOT 460	Molecular Immunology Lab	H	**1**	21
20.	BIOT 475	Molecular Plant Breeding Lab	H	**1**	22
21.	BIOT 481	Animal Biotechnology Lab	H	**1**	23
22.	BIOT 466	Bioprocess Engineering and Technology Lab	H	**1**	24
23.	BIOT 476	Stem Cell Biology Lab	S	**1**	25
Semester III					
24.	BIOT 512	Genetic Engineering	H	**3**	26
25.	BIOT 514	Marine Biotechnology	H	**3**	27
26.	BIOT 477	Plant Biotechnology	H	**3**	28
27.	BIOT 523	Medical Biotechnology	H	**3**	29
28.	BIOT 482	Microbial Biotechnology	S	**3**	30
29.	BIOT 424	Immunotechnology	S	**3**	32
30.	BIOT 501	Applied Microbiology	S	**3**	33
31.	BIOT 524	Proteomics and Genomics	S	**3**	34
32.	BIOT 562	Genetic Engineering Lab	H	**1**	35
33.	BIOT 564	Marine Biotechnology Lab	H	**1**	36
34.	BIOT 566	Medical Biotechnology Lab	H	**1**	37
35.	BIOT 480	Microbial Biotechnology Lab	S	**1**	38
36.	BIOT 474	Immunotechnology Lab	S	**1**	39
37.	BIOT 552	Applied Microbiology Lab	S	**1**	40
38.	BIOT 574	Proteomics and Genomics Lab	S	**1**	41
39.	BIOT 588	Project Phase I	H	**2**	-
Semester IV					
40.	BIOT 525	Pharmaceutical Biotechnology	S	**3**	42
41.	BIOT 526	Nanobiotechnology	S	**3**	43
42.	BIOT 527	Biosafety, Bioethics and Bioentrepreneurship	S	**2**	44
43.	BIOT 577	Nanobiotechnology Lab	S	**1**	46
44.	BIOT 578	Pharmaceutical Biotechnology Lab	S	**1**	47
45.	BIOT 597	Credit Seminar	H	**1**	-
46.	BIOT 589	Project Phase II	H	**4**	-

In addition, students are advised to choose "Physical Sciences for Biologists (CBIO 607)" and "Introduction to Bioinformatics (BINF 419)" as compulsory courses from Centre for Bioinformatics.

BIOT 401 **BASIC CELL BIOLOGY** **CREDITS: 3**

Course Objectives: *To provide an overview of structural and functional aspects of cells and basic mechanisms underlying cell signalling and cell division.*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **10 h**

Basic properties of cell, Major types of cell: Prokaryotic, animal and plant cell, their characteristics, cell wall, composition, function of bacterial cell wall. Plasma membrane, structure, function, fluid mosaic model, membranes, lipids and proteins transport across the membrane – passive and active.

UNIT II **10 h**

Endoplasmic reticulum, golgi complex – exocytosis; Lysosomes: phagocytosis, endocytosis, autophagy, Peroxisomes, Role of clatherin coated vesicles, Plant cell vacuoles; Structure of mitochondria and organization of respiratory chain; Structure of chloroplast and photophosphorylation; Structure of nucleus, nucleolus, nuclear membrane, transport across nuclear membrane.

UNIT III **8 h**

Molecular aspects of normal and cancer cell cell division: cell cycle stages, cyclins, cyclin dependent kinases (Cdks), Cdk inhibitors, transcription factors, tumor suppressors, checkpoints proteins, etc., cell death; apoptosis events and related proteins, necrosis and senescence.

UNIT IV **8 h**

Organic and inorganic constituents of cell: Water, minerals, polysaccharides, proteins, lipids, nucleic acid, vitamins and enzymes and their role(s) in cell function.

UNIT V **9 h**

Extracelluar matrix, collagen, proteoglycans, fibronectin, laminins, integrins, selectin, cadherins, role of tight junctions and gap junctions, Signal transduction; cell signalling; cAMP, Role of G-proteins coupled receptors, Tyrosine kinases, etc.

References:

1. Cell Biology, 3rd Edition.Elsevier. Thomas Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, Graham Johnson. 2017. International Edition.
2. Cell Biology. 7th Edition. 2013. Wiley. Gerald Karp. International Student version.
3. The Cell. A molecular approach. Seventh edition. 2015. Geoffrey M. Cooper & Robert E. Hausman.
4. Molecular Biology of the Cell, 6th edition, 2014, W. W. Norton & Company, Alberts. B, Johnson. AD, Lewis. J, Morgan. D, Raff. M, Roberts. K and Walter. P.

Course Outcome: *Students will understand the fundamentals of cell biology and cell signalling.*

BIOT- 402 **GENERAL MICROBIOLOGY** **CREDIT – 3**

Course Objective:
The main objective of "Microbiology" course is to introduce basic principles and applications. In order to provide fundamental knowledge to students, this course was designed to provide insights on microscopy, microbial diversity, nutrition, growth and host-interaction.

UNIT I **10h**

Introduction to microbiology: Scope, relevance, discovery and origin of microbial world, theories-spontaneous generation and conflict, germ theory of diseases. Interaction of light with objects. Microscopy and applications. Types and applications of microscopy, Bright field, Dark field, Fluorescence, Phase-contrast, Confocal microscopy, Scanning and Transmission electron microscopy.

UNIT II **10h**

Microbial diversity: Early evolution, complex metabolism and microbial diversity based on energy and carbon sources and distribution of microbes. Phylogeny of procaryotes and eucaryotes. Classification of bacteria, algae and fungi. General characteristics of virus, groups of viruses, viroids, prions, bacteriophage structure and life cycle.

UNIT III **10h**

Microbialnutrition : Heterotrophs, autotrophs. Macro and micro nutritionalrequirements. Nutritional sources and types. Enrichment culture techniques-Isolation and selection of specific groups such as sporulatingbacteria, propionicbacteria, chemoheterotrophs, chemoautotrophs and photosynthetic microbes. Transformation of elements. Microbial transformation. Carbon, Nitrogen, Phosphorous and Sulphur cycles.

UNIT IV **10h**

Microbial growth: Growth phases: Measurement, Mean Generation time, Factors affecting growth. Effect of temperature, pH, osmotic pressure, hydrostatic pressure and radiation on microbial growth.Synchronous culture. Kinetics of microbial growth; Batch culture, continuous culture, types of continuous culture system-turbidostat, chemostat.

UNIT V **10h**

Host-microbe interaction: Microbial ecology, molecular plant microbe interaction, molecular biology of disease resistance, gene-for-gene interaction, plant chemicals and defense pathways. Biological control of microbes. Plant growth-promoting rhizobacteria and their mechanisms for growth promotion and antagonism.

TEXT BOOKS

1. Bauman, RW, Microbiology. 2nd edition. Pearson Benjamin Cummings, 2009.
2. Prescott, LM. Prescott, Harley and Klein's Microbiology. 6thEdition, McGraw-Hill, 2007.
3. Tortora GJ, Funke BR, Case CL. Microbiology: An introduction 8th Edition. San Francisco: Pearson, 2004.
4. Joan L. Slonczewski and John W. Foster. Microbiology: An evolving science. W. W. Norton & Company, 2013.
5.

REFERENCES

1. Madigan, MT, Martinko, JM, Parker J. Brock Biology of Microorganisms. 10th Ed., Prentice-Hall, 2003.
2. Matthai,W, Berg, CY, Black, JG. Microbiology, Principles & Explorations. John Wiley&Sons, 2005.
3. Black, JG.Microbiology. 8th Edition, Wiley John Wily & Sons, Inc. Singapore, 2013.
4. Journal reviews and research articles.

Course Outcome: *The students will understand the basics of microscopy, microbial diversity, nutrition, growth and host-interaction etc.*

BIOT 414 **BIOCHEMISTRY** **CREDITS: 3**

Course Objectives: *The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **7 h**

Historical Basis and overview of Biochemistry, Biochemical basis of life, Biomolecules - Classification, Structure, Function and Significance of macromolecules – Carbohydrates, Proteins, Lipids and Nucleic Acids. Biomolecular hierarchy, Molecular assemblies and Molecular interactions in understanding cellular processes.

UNIT II **8 h**

Enzymes – Nomenclature and classification of enzymes – protein & non-protein enzymes (ribozymes, DNAzymes); Mechanisms of enzyme action – specificity of enzyme action, single and multienzymes, isoenzymes, coenzymes and cofactor; Factors affecting enzyme activity-Michaelis-Menten Equation, Lineweaver-Burk Equation; Enzyme kinetics- single and multisubstrates; Enzymes inhibition-competitive, non-competitive, uncompetitive and allosteric inhibition; Enzyme Regulation and their relevance in metabolic pathways; Biological role of enzymes.

UNIT III **10 h**

Introduction to Metabolism- Anabolic and catabolic reactions, Integrated approach to metabolism**;** Metabolism of Carbohydrates, glycogen & starch – Glycolysis and gluconeogenesis, Energetics and ATP production, glucose homeostasis and its regulation. TCA cycle and its regulation, its role in energy generation and biosynthetic intermediates, HMP pathway and its significance.Synthesis and breakdown of glycogen and its regulation mediated by hormones. Metabolic disorders associated with carbohydrate metabolism.

UNIT IV **10 h**

Lipid Metabolism:Metabolism of Fatty acids - α,β,ω oxidation, fatty acid biosynthesis, saturated and unsaturated, endogenous synthesis of triacylglycerols, phospholipids, cerebrosides, gangliosides. Synthesis and degradation of cholesterol.Transport and storage of cholesterol. Arachidonic acid metabolism-Significance and synthesis of prostaglandins, leucotrienes and thromboxanes. Metabolic disorders associated with lipid metabolism.

UNIT V **10 h**

Metabolism of proteins, nucleic acids and protein turnover- disposal of ammonia, urea cycle, non-protein aminoacids and amines and their role in cellular function; Metabolism ofessential and non-essential amino acids- Purine and Pyrimidine biosynthesis and degradation, salvage pathways, regulation. Metabolic disorders associated with aminoacid and nucleotide metabolism.

Text Books:

1. Lehninger's Principles of Biochemistry by David L. Nelson and Michael M. Cox, Macmillan worth publisher, 6th Edition 2013.
2. Murray, R.K., Granner, B.K., Mayes. P.A., Rodwell, V.W., Harper's Biochemistry Prentice Hall International, 32nd edition, 2016.

References:

1. Voet and Voet's Biochemistry, D.Voet and J.Voet5th edition, 2016, John Wiley and Sons Inc., 2005.
2. Biochemistry 8th edition by Jeremy M Berg, LubertStryer, John L.Tymoczko, 2015

Course Outcome: *Students would be able to: Gain fundamental knowledge in biochemistry; Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions to apply for translational research.*

BIOT415 TECHNIQUES IN BIOTECHNOLOGY CREDITS: 3

Course Objectives: *To understand the principles and basics of all Instruments used in a biotechnology lab*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **10 h**

Acid, base and buffers: Definition and theories proposed for acids and bases, titration curves of amino acids, Henderson-Hasselbalch equation and its application. Determination of pH - standard hydrogen electrode, glass electrode. Definition of colloids: types and properties of colloids, colloidal state of membrane.

UNIT II **8 h**

Colorimetry: Principle, Beer and Lambert laws, instrument and techniques. Spectrophotometry: Description of the instrument - photometer, single beam and dual beam spectrophotometers; FTIR, ESR,NMR. Polarimetry, ORD and CD spectrophotometers. Flame and Atomic absorption Spectrophotometer.

UNIT III **8 h**

Centrifugation: Principle, types of centrifugation, description of the analytical and ultracentrifuge. Determination of molecular weight by sedimentation velocity method, separation of cell organelles and sarcolemma.

UNIT IV **9 h**

Electrophoresis: Principle, types of electrophoresis, separation of serum proteins: (i) moving boundary electrophoresis, (ii) paper electrophoresis, (iii) starch gel electrophoresis, (iv) agar gel electrophoresis. Ag-Ab reaction – Immuno electrophoresis; DNA electrophoresis, DNA ladders, PFGE; Staining methods.

UNIT V **10 h**

Chromatography: Principle, types of chromatography: (i) Paper chromatography – separation of amino acids by ascending chromatography, (ii) Adsorption chromatography: Principle and separation of phospholipids, (iii) Ion-exchange chromatography: Principle, resin types and separation of amino acids, proteins, (iv) Affinity chromatography: Principle and separation of enzymes and (v) Gel filtration chromatography: Principle, estimation of Mw of biological macro-molecules; Mass Spectrometry: basic principle, Hard and soft ionization, ICP, photo-ionization; LCMS, MALDI-TOF/QTOF, ICPMS, GCMS/MS.

Text Books:

1. Wilson, K. and Walker, J. Principles and Techniques of Biochemistry and Molecular Biology Cambridge University Press. 2010.
2. Morris and Morris Separation methods in Biochemistry. Pitman London, 1960.

References:

1. Brawer, I M., Perce, A.M., Experimental techniques in Biochemistry. Prentice Hall Foundation, New York, 1974.

Course Outcome: *The students acquires the basic knowledge in handling of equipments and its principles*

BIOT 521 **RADIATION BIOLOGY** **CREDITS: 3**

Course Objectives: *This course addresses the biological effects of different radiations, free radical interactions in DNA at cellular and organism level. The details pertaining to utilization and mechanism of radiation both ionizing and non ionizing radiation leading to biological manifestations. As a result of nuclear fallout the different radiation syndromes and the recovery. The course addresses the DNA lesions associated with radiation damage, cataractogenesis and provides mechanistic details.*

Pre-requisite: Bachelor's level course in Life Sciences, Physics & Chemistry.

Unit I **9 h**

Physics of ionizing radiation interactions α, β, ϒ, n and plasma. Radiolytic events leading to formation of free radicals. LET, Absorption dosimetry. Units of radiation dose measurements. The radiation levels and limits. Direct and indirect effects of radiations. Gamma-irradiation induced free radicals produced in water, G-values, Fricke's dosimetry. Radioisotopes for biological applications, ^{14}C dating, radioisotopes in water resources and environment.

Unit II **9 h**

Cell survival curves, Target theory, RBE, Dose response relationship model, Laws of Bergoneau and Tribondeau, Applications of radiation therapy, differential response, mitotic cycle and radiation sensitivity, Heritable effect of radiations. Dose rate-effects, dose fractionation, oxygen-effect, Post-irradiation oxygen effect in plants, radio protectors, radio sensetisers, radiation hormesis. Biological effects of dose fractionation.

Unit III **9 h**

Acute radiation effects of whole body irradiation, late somatic effects, effect on the immune responses, LD50, radiation syndrome, bone marrow, gastrointestinal and cerebrovascular acute radiation syndrome, Leukemia and other cancer, Radiation cataractogenesis, Dose response relationship in model normal tissue. Effect of radiation on Embryo and Foetus.

Unit IV **9 h**

Radiation damage to DNA, RNA and proteins. DNA strand breaks, Chromosomal aberrations, Methods of detecting the damage caused by ionizing radiation and UV radiations.DNA cluster damage.DNA damage caused by heavy ionizing radiations, DNA repair mechanisms and Xenoderma Pigmentosum, Ataxia Telengiectasia disorders

Unit V **9 h**

Radiation Carcinogenesis, biology and exploitation of tumor hypoxia, heritable effects of radiations, chemotherapeutic agents, Effect of non-ionizing radiations, ultrasound, optical radiations, microwave radiations.

Text Book

1. Eric J Hall and Amato J Giaccia. Radiation Biology for the Radiation Biologist Seventh Edition, J B Lipincott Company, UK, 2012.

Reference:

1. Richard P Baum. Therapeutic Nuclear Medicine, Springer-Verlag, Berlin Heidelberg, 2014.

Course Outcome: *The students will develop interest in the radiation utilization for the cold sterilisation and value addition. The development of procedures for effective radiolysis. The Govt of India and also in many countries the radiation biology and radiation physics for effective usage is feasible and the students could use for entrepreneurship by quantifying the radiation dose and standardization for raw and processed food materials by cold sterilisation.*

BIOT 403 **BASIC CELL BIOLOGY LAB** **CREDIT: 1**

32 h

1. Culturing of various cancerous cell lines.
2. Observation of eukaryotic cancer cell lines under microscope; live, dead, starved, etc. and staining methods; trypan blue and DAPI, etc.
3. Observation of drug induced differentiation process of K562 leukemic cell lines
4. Observation of drug induced apoptosis process of cancerous cell lines
5. Overexpression of desired protein with fluorescence tag in eukaryotic cells; transfection and fluorescence microscopy.
6. Isolation of genomic DNA, RNA and proteins from eukaryotic cell lines and detection methods; OD, agarose gel, western blotting, staining of SDS –PAGE gels, etc.
7. Isolation of mono nuclear and RBC from peripheral blood samples.
8. Preparation of bacterial competent cell by calcium chloride method.

Suggested Reading:

1. Current protocols in Cell biology- March 2019- Wiley

BIOT 404 **GENRAL MICROBIOLOGY LAB** **CREDIT: 1**

30 h

1. Microbial isolation techniques. Isolation of bacteria and fungi
2. Establishment of pure cultures - streak, pour and spread plating techniques
3. Identification of microbes. Simple, differential, negative staining and spore staining methods.
4. Establishment of bacterial growth curve
5. Bacteriophage plaque assay to enumerate phage titer.
6. Test for *in vitro* antibiosis
7. Screening of microbes for the production of enzymes and hormones
8. Biochemical and genetic fingerprinting of microbes
9. Phylogenetic analysis of microbes
10. Microbial preservation techniques- patch plate, slant, water stock, glycerol stock and lyophilization.

Suggested Reading:

1. Handbook of Microbiological Media (2010). Ed.Atlas, Ronald, CRC Press, USA.
2. Bergey's Manual of Systematic Bacteriology. 2005. Ed. Brenner, Don, J. Vol. 2, Springer Publisher, USA.
3. Basic Practical Microbiology : A Manual (2006). Society for General Microbiology (SGM),ISBN 0 95368 383 4.
4. Microbiology: A Laboratory Manual (2013). Eds. James G. Cappuccino and Natalie Sherman. Publisher-Pearson Benjamin Cummings; 10th Edition.

BIOT 464 **BIOCHEMISTRY LAB** **CREDIT: 1**

30 h

1. Qualitative analysis of Simple sugars and Carbohydrates.
2. Qualitative analysis of Amino acids and Proteins.
3. Isolation / Extraction of biochemical metabolites (Carbohydrates, Protein and Lipids) from various tissues (plant & animals).
4. Estimation of glucose by Benedict's method.
5. Estimation of protein by Lowry's/Bradford's method.
6. Estimation of cholesterol by Zak's method.
7. Estimation of enzyme activity.(salivary amylase/LDH)
8. Estimation of enzyme activity under various conditions – pH, temperature and substrate.
9. Estimation of ascorbic acid/Tocopherol
10. Assay of enzyme/hormone by ELISA.

Suggested Reading:

1. Jayaram,J Laboratory manual in Biochemistry. Wiley Eastern 1981.
2. Mu P, Plummer DT. Introduction to practical Biochemistry. Tata Mcgraw-Hill Education: 2011

BIOT 465 **TECHNIQUES IN BIOTECHNOLOGY LAB** **CREDIT: 1**

30 h

1. Buffer Preparation: Determination of *pKa*
2. Spectrophotometry: Determination of λmax
3. Centrifugation: High speed centrifugation, density gradient centrifugation
4. Chromatography: IEC / Adsorption / GFC for purification of an enzyme
5. Electrophoresis: Agarose and SDS - PAGE
6. FTIR, ESR & NMR
7. Biological applications of radioisotopes: ^{3}H labeling of liver tissue
8. Polymerase Chain Reaction.
9. Real-time PCR (Demonstration)

Suggested Reading:

1. Alexander J. Ninfa, David Ballou, and Marilee Benore (1998). Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Wiley
2. S. Harisha(2007) Biotechnology Procedures and Experiments Handbook. Infinity Science Press LLC, Hingham, Massachusetts New Delhi, India

BIOT 575 RADIATION BIOLOGY LAB CREDIT: 1

30 h

1. Fricke's dosimetry for calculating the dose rate of gamma-rays and comparing it with source.
2. Agarose gel electrophoresis of gamma-irradiated plasmid DNA.
3. Determination of death rate of the gamma-irradiated bacterial cells.
4. Calculation of seedling injury in irradiated seedlings with different doses of radiation.
5. Effect of dose rate on the seedling injury for a given dose of radiation.
6. Identification of chromosomal damage in the root tips as a result of gamma irradiation.
7. Determination of catalase activity in plant seedlings irradiated with various doses of gamma-irradiation.
8. Effect of electron scavengers on post-irradiation treatment of the seeds
9. Determination of total peroxides obtained after various treatments in 7day old seedlings.
10. FT-IR spectroscopic investigations on the gamma-irradiated biological materials

Suggested Reading:

1. Eric J Hall and Amato J Giaccia. Radiation Biology for the Radiation Biologist Seventh Edition, J B Lipincott Company, UK, 2012.

BIOT421 MOLECULAR GENETICS CREDITS: 3

Course Objectives: *The course aims to provide students a basic understanding on(i) Genome organization of Prokaryotes and Eukaryotes, (ii) Mendelian and Non-Mendelian Genetics (iii) DNA Replication, Transcription & Translation, (iv) DNA repair mechanisms and (v) Regulation of gene expression*

Pre-requisite: Master level courses in Biochemistry, Cell Biology and Microbiology

UNIT I **6 h**

Mendelian inheritance, Non-Mendelian inheritance, Sex linked inheritance, Experimental evidences for DNA as the genetic material, Organization of prokaryotic and eukaryotic genome, DNA supercoiling, Chromatin organization-histone and DNA interactomes.

UNIT II **8 h**

Structure and assembly of prokaryotic and eukaryotic DNA polymerases, Experimental evidences for the semi conservative nature of replication, DNA replication mechanisms, Accessory proteins for the DNA replication, Regulation of replication initiation in prokaryotes and eukaryotes.

UNIT III **10 h**

Mechanism of transcription in prokaryotes and eukaryotes - RNA polymerases, Promoters and Enhancers, Transcriptional initiation, elongation and termination processes. Post-transcriptional processing events – capping, splicing of introns and polyadenylation, Processing of Pre-ribosomal RNA and the assembly of ribosomes, Structure and the maturation of tRNAs.

UNIT IV **8 h**

Genetic code, degeneracy of codons, Wobble hypothesis, codon bias, Mechanism and fidelity of amino acyl tRNAsynthetases, Mechanism of Translation – initiation, elongation and termination, Post-translational modifications, Antibiotics that target translation, Selenocysteine and Pyrrolysine.

UNIT V **8 h**

Regulation of gene expression in prokaryotes – Operon concept, lac and trp operon, positive and negative regulation of lac operon. Transcriptional attenuation of Trp operon, Regulation of gene expression in eukaryotes by chromatin structure - epigenetic modifications of chromatin-Writers, Readers and Erasers. Role of DNA methylation and histone modifications in the regulation of gene expression.

UNIT IV **5 h**

Spontaneous and Induced mutations, DNA repair pathways – Mismatch repair, Base excision repair, Nucleotide excision repair, Non homologous end joining pathway and Recombinational repair.

References:

1. Lehninger Principles of Biochemistry, 2017, Seventh Edition, W.H. Freeman. Authors: David L. Nelson and Michael M. Cox.
2. Principles of Genetics, 2015, Seventh Edition, Wiley. Authors: D. Peter Snustad and Michael J. Simmons.
3. Molecular Biology of the Gene, 2017, Seventh edition, Pearson. Authors: James D. Watson.
4. Lewin's Gene XII, 2017, Twelth edition, Jones & Bartlett Publishers. Editors: Krebs JE et al.

Course Outcome: *By the end of the course, the students will acquire the knowledge and thorough understanding on genome organization, concept of non-mendelian genetics and the major molecular information pathways and processes of the prokaryotic and eukaryotic cells*.

BIOT 459 MOLECULAR IMMUNOLOGY CREDITS: 3

Course Objectives:- *The course aim to understand fundamentals of immunology, Major components of Immune response and aim to study the Translational research* aspects like *Clinical immunology , vaccines and cancer immunotherapy*

UNIT I: Fundamental concepts and overview of the immune system 5h

Overview and Concepts, Components of innate and acquired immunity; phagocytosis; complemen and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); inflammatory response; mucosal immunity; antigens: immunogens and haptens

UNIT II: Components of Immunity 5h

Cells and Tissues of the Immune system: Different lineages. Organs of immune system, Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness & disease susceptibility

UNIT III: Immune Responses generated by B and T lymphocytes 10h

Structure and classes of Immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Signal transduction in lymphocytes; basis of self & non-self-discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity. T-cell maturation, activation and differentiation and T-cell receptors; functional T cell subsets; cell-mediated immune responses, ADCC; Cytokines and their therapeutic uses; Antigen processing and presentation- endogenous and exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system

UNIT IV: Antigen-antibody Interactions 10h

Precipitation, agglutination and complement mediated immune reactions; Immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, FACS, immunofluorescence microscopy and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand-receptor interaction; Memory and Death in Immune System. CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

UNIT V: Clinical Immunology and Vaccines 15h

Immunity to infection : bacteria, viral, fungal and parasitic infections (with e. g. from each group); co-evolution of microbes and host immune systems; hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC & TCR in autoimmunity; MHC genes and their role in autoimmune and infectious diseases, treatment of autoimmune diseases; HLA typing; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; Tumor immunology and Cancer immunotherapy.

Recombinant DNA vaccines; antibody genes and antibody engineering: Chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine and therapeutic vaccine. Immunodeficiency, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy

Text Books:

1. Tizard, Ian R. Immunology an introduction, Fourth Ed, Saunders college publishing, New Delhi, 2010
2. Coico R, Sunshine G. Immunology: A short course, Sixth Edition, Wiley-Blackwell publishers, Canada 2009.
3. Coleman, Lombard and Sicard. Fundamental Immunology, **McGraw-Hill Science** publishers 1999.
4. Kindt TJ, Goldsby RA, Osborne BA. Kuby Immunology, Seventh Ed, W.H. Freeman and company, New York, 2017.
5. Delves PJ, Martin SJ, Burton DR, Roitt IM. Roitt's Essential Immunology, Thirteenth Edition, Wiley-Blackwell publishers, USA, 2017.

References:

1. Elgert KD. Immunology: Understanding the immune system, Wiley-Blackwell publishers, Canada, 2009.
2. Hudson, L. and Hay, F.C. Practical Immunology, Black Well publishers 1989.
3. Dixon, F.J. Advances in Immunology, Academic Press 1986.

Course Outcome:- *Students will acquires knowledge on fundamentals of immunology, Major components of Immune response; gain knowledge in Translational research* aspects like *Clinical immunology , vaccines and cancer immunotherapy*

BIOT425 MOLECULAR PLANT BREEDING CREDITS: 3

Course Objectives: *To understand the Fundamentals and application breeding and molecular plant breeding methods for crop improvement*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **8 h**

Plant breeding- History; Genetic resources- centres of diversity and origin of crop plants, Law of homologous variation, genetics resources

UNIT II **10 h**

Mode of reproduction in plant: Principles and methods of breeding self, cross pollinated and vegetatively propagated plants, Heterosis breeding, Polyploidy and haploids in breeding, Wide hybridization, Mutation breeding, Breeding crops to contain useful and adaptive traits; seed production and variety development and its conservation.

UNIT III **7 h**

Plant genome mapping: Types of mapping population; RFLP and AFLP mapping. Marker assisted breeding using RFLP, AFLP, RAPD, SNP and CAPS marker.

UNIT IV **10 h**

Plant tissue culture and somatic cell genetics – role of growth regulators, Micropropagation, Germplasm storage *in vitro*; Embryo rescue, Haploids and triploids, Secondary products, Protoplast culture and fusion, Cybrids, Somaclonal variation, Mutant selection *in vitro* and by transposon tagging.

UNIT V **10 h**

Plant genetic engineering using recombinant DNA techniques: Genetic engineering for abiotic stress, quality improvement; Strategies for Marker Gene Removal from Transgenic plants; Transgene silencing, Strategies to avoid gene silencing and improve gene expression in transgenic plants, Description and uses of antisense RNA, ribozymes in plants; Gene editing by CRISPR-Cas technology, Ethics and plant genetic engineering.

Text Books:

1. Acquaah, G. Principles of Plant Genetics and Breeding, John Wiley sons, 2012.
2. Xu Y, Molecular Plant Breeding, CAB International, 2010.
3. Bhojwani SS, Razdan MK. Plant Tissue culture. Theory and Practice. Elsevier B. V. Publications, 2009.

References:

1. Sambrook, J and Russell, D, Molecular Cloning: A Laboratory Manual, Third Edition, Cold Spring Harbor Laboratory Press, NY, 2001
2. Sleper, DA and Poehlman, JM. Breeding Field Crops, Wiley-Blackwell, NJ. 2006
3. Allard RW, Principles of Plant Breeding. 2nd Edition, John Wiley & Sons, NJ, 1999.

Course Outcome: *The students will acquires the knowledge on Fundamentals and application breeding and molecular plant breeding methods for crop improvement*

BIOT 484 ANIMAL BIOTECHNOLOGY CREDITS: 3

Course Objectives: *The students will learn about basics function of Animal Cell Culture application, production of transgenic animals, Animal diseases and Biotechnology in animal production*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **10 h**

Animal Cell culture primary and established cell line cultures, functions of different constituents of culture media, serum and protein free media and their applications ,scaling up of animal cell culture, cell synchronization, cell cloning and micro manipulation. Organ and histotypic culture. Application of animal cell culture for virus application and *in vitro* testing of drugs, testing of toxicity of environmental pollutants in cell culture. Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

UNIT II **10 h**

Reproductive Biotechnology- structure of sperm and ovum, cryopreservation of gametes and embryos in mammals. Embryo transfer-Artificial insemination, ICSI, super ovulation, embryo recovery, In- vitro fertilization, embryo splicing and embryo transfer technology. Production of transgenics birds, mammals and knockout mice. Application of transgenic animals models for diseases, oncogenes, drug screening and gene farming. Animal cloning –basic concept, cloning for conservation of endangered species.

UNIT III **10 h**

Integrated insect pest management using biocides, hormone analogues, pheromones and genetic manipulations. Biotechnology of silk worms-Life cycle, culture of silk worm, diseases of silk worm ,improvement of silk production and quality, Biology of viral vectors-SV40,adeno virus, retro virus, vaccina virus papiloma virus, and baculoviruses. Insect as a bioreactor.

UNIT IV **8 h**

RFLP, RAPD and its applications in domestic animals. Molecular diagnostics of pathogens in animals. Detection of meat adulteration using DNA based methods. Biotechnological approaches to vaccine production Development of animal vaccines for Reinderpest, foot and mouth disease, blue tongue disease, rabies and anthrax. Peptide vaccines, fusion protein vaccines, synthetic peptide vaccines, anti-idotype antibody vaccines.

UNIT V **7 h**

Biotechnology in animal production-manipulation of growth using hormones and probiotics, manipulation of lactation, manipulation of wool growth in sheep and rabbits. Ethical issues in animal biotechnology: animal usage, CPCSEA and IAEC guidelines, Management aspects of biotechnology and genetic engineering.

Text Books:

1. Animal Biotechnology (1989): Comprehensive Biotechnology First Supplement: (Ed.)L.A. Babink and J.P.Phillips. Pregamon press, Oxford,

2. Gordon (2005) Reproductive techniques in Farm Animals,Oxford CAB International

3. Portner, R. (2007) Animal Cell Biotechnology:Methods and Protocols.Totowa.NJ:Human Press.

References:

1. Future Developments in the Genetic Improvements of Animals. Ed. J.S.F.Barrer, K.Hammond and A.E.McClintock, Academic Press, 1992.

2. Human Genetics: Concept and Applications. Ricki Lewis .McGraw Hill. 2003.

Course Outcome: *the students will know about basics function of Animal Cell Culture application, production of transgenic animals, Animal diseases and Biotechnology in animal production*

BIOT 416 BIOPROCESS ENGINEERING AND TECHNOLOGY CREDITS: 3

Course Objectives: *Bioprocess Technology is a course that offers real solutions for the problems of food, medicine, and fuels. The models of microbial growth, the Design, Principles of fluid mechanics, gas–liquid mass transfer Lab fermentor to large scale fermentation and dynamics a special case study of the fermentation of penicillin, beer with special reference to downstream processing*.

Pre-requisite: Bachelor's level course in Life Sciences, physics and chemistry

UNIT I **9 h**

Fermented foods and beverages, food ingredients and additives prepared by fermentation, fermentation as a method of preparing and preserving foods, microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products, process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products, bacteriocins from lactic acid bacteria, production and applications in food preservation, biofuels and biorefinery. Isolation, screening and maintenance of industrially important microbes, strain improvement for increased yield and other desirable characteristics, preservation- history.

UNIT II **9 h**

Mechanism of enzymatic reactions, Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions and applications in starch and sugar conversion processes, preparation of high-fructose corn syrup, hydrolyzed protein, baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing, cheese making by proteases and various other enzyme catalytic actions in food processing, large scale animal and plant cell cultivation, fermentation economics.

UNIT III **9 h**

Microbial growth kinetics and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms), Monod model, batch culture, Elemental balance equations, metabolic coupling – ATP and NAD+, yield coefficients, unstructured models of microbial growth, structured models of microbial growth, Batch and continuous fermenters, modifying batch and continuous reactors, chemostat with recycle, multistage chemostat systems, fed-batch operations, conventional fermentation v/s biotransformation, media formulation and optimization, sterilization, aeration, agitation and heat transfer in bioprocess, scale up and scale down measurement and control of bioprocess parameters

UNIT IV **9 h**

Ideal bioreactors, Batch, fed batch, CSTR, PFR, Multiphase bioreactors, packedbed, bubble column fluidized trickle bed, immobilization of cell systems. Aseptic, septic and anaerobic fermentors

UNIT V **9 h**

Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products,liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging

Text Books:

1. Bioprocess Engineering by M.Shuler & F.Kargi (Prentice Hall 2017)

2. Bioprocess Engineering Principles by P. M. Doran (Academic Press 2012)

Course Outcome: *The students will understand to determination of titer and identification of suitable strain for utilisation purpose. Working with low volumes, Microbial growth kinetics, Preparation of complex media, industrial operations for preparation of Beer, baking, large scale fermentation, different downstream processing methods for product purifications.*

BIOT 426 **STEM CELL BIOLOGY** **CREDITS: 3**

Course Objectives: *To understand the basics of stem cell, types of stem cells, identification, isolation and applications.*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **10 h**

Introduction to stem cells – Definition, History, Types and Sources of stem cells. Capacity of stem cells- Totipotent, Pluripotent, Multipotent, Unipotent. Embryonic stem cells and Adult Stem cells- Mesenchymal stem cell, Neuronal stem cell, Gut Epithelial Stem cells, Hematopoietic stem cells; Bone marrow, Peripheral blood and Cord blood stem cells, Cancer stem cells. Stem cell niche/microenvironment. Stem cell cryopreservation.

UNIT II **10 h**

Properties- Self-renewal and Differentiation. Regulation of stem cell: Cell cycle regulation, Gene expression, Chromatin modifications, Epigenetic regulation (DNA and Histone Methylation and Histone Acetylation, etc.), and miRNA roles. Cross talk betweenmiRNAs and epigenetic regulators during stem cell differentiation.

UNIT III **10 h**

Identification of stem cell using specific markers. Isolation of stem cells -Fluorescence based cell sorting. Culture and genetic manipulation of stem cells. Expansion of stem cells using molecular and biochemical approaches. Cloning and nuclear transfer technology. Genetic reprogramming and Induced Pluripotent Cells (iPCs). *In vitro* functional assays- Cobblestone Area-Forming Cell (CAFC), Colony Forming Cell (CFC),*In vivo* serial transplantation assay.

UNIT IV **10 h**

Stem cells and aging.Correlation between stem cells and cancer stem cells, Clinical applications of stem cells. Stem cell therapy and Regenerative medicine. Bone marrow and cord blood stem cell transplantation. Repair of damaged tissues and organs. Use of stem cells in heart and retinal diseases. Stem cell transplantation. Future prospects of stem cells.

UNIT V **5 h**

Ethical issues associated with stem cell research.Implication of human embryonic stem cell research, societal implications: religious vs. scientific views. Ethical guidelines for stem cell research (National (ICMR-DBT) & International).

Text Books:

1. Yanhong Shi, Dennis O.Clegg. Stem Cell Research and Therapeutics. Springer edition. 2010

2. C. S. Potten. Stem Cells. Academic Press. 2008.

References:

1. Julie Audet, William L. Stanford. Stem Cells in Regenerative Medicine. Methods and protocols (Springer edition) 2009.

2. Robert Lanza, Irina Klimanskaya. Essential Stem Cell Methods. (Elsevier- First edition) 2009.

Course Outcome: *The students acquire knowledge over basics of stem cells and its applications.*

BIOT 427 ENVIRONMENTAL BIOTECHNOLOGY CREDITS: 3

Course Objectives: *The students will understand the impact of pollution on the environment and the need for remediation with the use of microbes and biological methods and they also learn about the biorenewal fuels.*

Pre-requisite: Bachelor's level course in Life Sciences

Unit I Introduction to environment 8 h

Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.

Unit II Bioremediation 7 h

Bioremediation: Fundamentals, methods and strategies of application (biostimulation,bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides(U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects ofbioremediation (in situ, ex situ).

Unit III Role of microorganisms in bioremediation 8 h

Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria: examples, uses and advantages vs disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization).

Unit IV Biotechnology and agriculture 11 h

Bio insecticides: Bacillus thuringiensis, Baculoviruses, uses, genetic medications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (e.g. *Trichoderma, Pseudomonas fluorescens*);Biofertilizers: Symbioticsystems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungisymbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects andproblems in application.

Unit V Biofuels 11 h

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery(MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifers; Paper production: use of xylanases and white rot fungi.

Textbooks and References:

1. G. M. Evans and J. C. Furlong (2003), Environmental Biotechnology: Theoryand Applications, Wiley Publishers.
2. B. Ritmann and P. L. McCarty, (2000), Environmental Biotechnology: Principle &Applications, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.
4. J. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), Biofiltration for AirPollution Control, CRC Press.
5. H. J. Rehm and G. Reed, (2001), Biotechnology – A Multi-volume ComprehensiveTreatise, Vol. 11, 2nd Ed., VCH Publishers Inc
6. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, (2013), Environmental Engineering, McGraw-Hill Inc.

Course Outcome: *The student acquires the knowledge over nature of pollution, and basic of bioremediation and biofuels.*

BIOT 471 MOLECULAR GENETICS LAB CREDIT: 1

30 h

1. Electrocompetent cell preparation.
2. Transformation of *E.coli* by electroporation.
3. Transformation of S. *cerevisiae*.
4. Mating of S. *cerevisiae*.
5. Genomic DNA isolation from mammalian cells/tissue.
6. Total RNA isolation from mammalian cells/tissue.
7. Quantification of gene expression by quantitative RT-PCR.
8. Histone extraction from mammalian cells.
9. SDS-PAGE analysis of histones.

Suggested Reading:

1. Gene Cloning & DNA Analysis, 2016, Seventh edition, Wiley-Blackwell. Author: T. A. Brown.
2. Molecular Cloning: A Laboratory Manual, 2012, Fourth edition, Cold Spring Harbor Laboratory Press. Author: Michael R. Green.

BIOT 460 MOLECULAR IMMUNOLOGY LAB CREDIT: 1

30 h

1. Immunization and generation of Anti-sera in rabbit against antigen
2. Microscopic analysis of immune cells by Giemsa stain
3. Separation of immunoglobulin G fractions using affinity chromatography
4. Diffusion methods of Immunoelectrophoresis
5. Rocket electrophoresis
6. Titer value determination
7. ELISA for detection of Antigens/Antibodies
8. Blood group mapping
9. Separation of mononuclear cells by Ficoll-hypac method and their cryopreservation
10. Demonstration of FACS

Suggested Reading: -

1. Immunochemical Protocols, Editors: **Burns, Robert** (Ed.) Humana Press Springer Inc., 2005

2. Current Protocols in Immunology Editors: **John E. Coligan** et al., Volume 124, A Wiley Grand publications, 2014.

BIOT 475 MOLECULAR PLANT BREEDING LAB CREDIT: 1

30 h

1. General Breeding Techniques: Emasculation, pollination and tagging.
2. Selection of parents for hybridization and embryo rescue.
3. Tissue culture techniques: Preparation of various tissue culture media.
4. Tissue culture of explants.
5. Isolation and culture of protoplasts
6. Isolation and culture of microspores.
7. Application of RFLP technique in plant breeding.
8. Demonstration of AFLP technique in plant breeding.
9. Detection of multiple genes by employing SNP primers.

Suggested Reading:

1. Breeding Field Crops, David A. Sleper, 5th edition (2006).
2. Handbook of Agriculture, ICAR, 6th edition, 2011.

BIOT 481 **ANIMAL BIOTECHNOLOGY LAB** **CREDIT: 1**

30 h

1. Animal cell culture.
2. Protein profile of silk gland and haemolymph of larval forms of silk worm.
3. Morphology of male gametes of different animals-bull, goat and sheep:

   Cryopreservation of gametes of bull.
4. *Invitro* fertilization of fish and hatching.
5. Gene transfer in animal cells –Electroporation.
6. Biopesticide effect on mosquitoe larvae.
7. Identification and partial characterization of Lactic Acid Bacteria.
8. Field visit to semen bank.
9. Field visit to silk worm rearing.

Suggested Reading:

1. Animal Cell Biotechnology: Methods and Protocols by Portner, R.(2007).Totowa NJ:Humana Press
2. Sericulture Manual by R. K. Patnaik (2008). Biotech books, Delhi
3. Cryoconservation of Animal Genetic Resources –Training *manual* for embryo transfer in cattle, by G.E. Seidel, Jr. & S. Moore Seidel.-FAO manual

BIOT 466 BIOPROCESS ENGINEERING AND TECHNOLOGY LAB CREDIT: 1

30 h

1. Microbial culture streaking from frozen vial to agar plate
2. Preparation of inoculum and growth kinetics of microbes
3. Whole cell immobilization of microbes and media utilization studies
4. Batch, CSTR and Fed-batch fermentation.
5. Isolation of microorganisms from soil samples.
6. Assembly of bioreactor and sterilization.
7. Microfiltrations and separation of cells from broth by vacuum method.
8. Demonstration of analytical techniques HPLC
9. Demonstration of GC-MS spectroscopy
10. Bioseparations using chromatographic techniques and extractions.

Suggested Reading:

1. Encyclopedia of Industrial Biotechnology: Bioprocess, Bioseparation, and Cell Technology, Edited by Michael C. Flickinger Wiley, New York, Volumes 1-7, 2010,

BIOT 476 **STEM CELL BIOLOGY LAB** **CREDIT: 1**

30 h

1. Isolation of mononuclear cells from blood sample.
2. Isolation of Hematopoietic stem cells (CD34+) from peripheral and cord blood.
3. Isolation of Mesenchymal stem cell from cord blood.
4. Identification of CD34+ cells using Fluorescence Activated Cell Sorter.
5. Maintenance of Hematopoietic stem cells.
6. Culture of hematopoietic CD34+ cells.
7. Nuclear transfection of CD34+ cells.
8. Functional assays of Hematopoietic stem cells (CAFC&CFC).

Suggested Reading:

1. Current protocols in stem cell biology-March 2019- Wiley

BIOT512 GENETIC ENGINEERING CREDITS: 3

Course Objectives: *The course aims to provide students a thorough understanding on various vectors, different cloning strategies and selection methods, mutagenesis strategies, genomic and cDNA library construction methods and applications of genetic engineering in different disciplines.*

Pre-requisite: Master level course in Molecular genetics, Biochemistry & Cell Biology

UNIT I **6 h**

Polymerase Chain Reaction, guidelines for PCR Primer design, degenerate and specific primers, PCR optimization strategies, co-solvents in PCR. Different types of PCR: Hot Start PCR, AP-PCR, Nested PCR, Error-prone PCR and Touch down PCR, Quantitative real time PCR: Principle and Probe chemistry.

UNIT II **8 h**

Essential features of plasmid based vectors, Restriction endonucleases and DNA Ligase, Cloning strategies: Non directional cloning: Use of alkaline phosphatase, Directional cloning, End filling and polishing, Use of Linkers and adapters, Homopolymer tailing and TA cloning. Concept of Insertional inactivation in plasmid based vectors, Transfer of DNA into cells: Transformation, Electroporation, Microinjection and Transfection, Screening and identification of recombinant clones.

UNIT III **10 h**

Lambda Phage based vectors: insertional vector and replacement vector and cosmid. M13 Phage based vectors and phagemid. Random mutagenesis and site directed mutagenesis: Different strategies and methods. Vectors for *S. cerevisiae*: YEP, YRP,YIP and YAC, Plasmid based vector for *B. subtilis*. Investigating the Protein-protein interactions: yeast two-hybrid system, phage display system, ribosome display method and immunoprecipitation, Introduction to high-throughput biology and biological networks.

UNIT IV **6 h**

Genomic DNA library construction, Total RNA preparation and cDNA library construction, 5' RACE and 3' RACE. DNA sequencing: Sanger's sequencing and Next Generation sequencing technologies. Bacterial expression: vector design and problems associated with expression of eukaryotic protein in *E.coli*. Affinity purification of recombinant proteins. Baculovirus mediated protein expression system.

UNIT V **10 h**

Mammalian expression vectors, Transient transfection and stable transfection, Viral vectors for mammalian cells, Gene therapy, Generation of knock-out and knock-in mouse, Vectors for higher plants, Agrobacterium mediated transformation, Removal of marker genes, Applications of plant biotechnology: Insect resistance, herbicide resistance and delaying of fruit ripening, Terminator seed technology.

UNIT VI **5 h**

Application of DNA technologies in Forensic sciences, siRNA and miRNA mediated knock down. Genome engineering technologies: Zinc finger nucleases, TALENS and CRISPR-Cas9 technology.

References:

1. Gene Cloning & DNA Analysis, 2016, Seventh edition, Wiley-Blackwell. Author: T. A. Brown.
2. Principles of Gene Manipulation and Genomics, 2006, Seventh edition, Wiley-Blackwell. Authors:Primrose SB &Twyman R.
3. Molecular Cloning: A Laboratory Manual, 2012, Fourth edition, Cold Spring Harbor Laboratory Press. Author: Michael R. Green.

Course Outcome: *By the end of the course, the students will acquire the knowledge and thorough understanding on different types of vectors and various methods of recombinant DNA technology.*

BIOT 514 MARINE BIOTECHNOLOGY CREDITS: 3

Course Objectives: *The course aim to understand the knowledge on Marine organisms, Marine hydro colloids, applications of Genetic engineering, extraction of Marine Bioactive Compounds and extremophile.*

Pre-requisite: Master level course in Molecular Biology and Animal Biotechnology

UNIT I 12 h

Biotechnology in Marine Sciences. Aquaculture: culture of shrimp, crab, edible mollusc, oysters and pearl oysters, Culture of milkfish, mullets and eel. Culture of sea weeds .Culture of live feed organisms-brine shrimp, rotifers.Marine micro algae- aquaculture, antioxidants-carotenoids, astaxanthin

UNIT II 8 h

Marine hydrocolloids-agar,agarose, carageenan, alginates, chitosans and chitin. Marine enzymes - Applications of enzyme for fish processing. Marine Lipids- application of lipases for modification of fats and oils. Marine flavourants. Bioconversion of organic materials and fish ensilage.

UNIT III 9 h

Aquaculture biotechnology- hormonal manipulation of sex,chromosomal manipulation of sex fish, cryopreservation of fish gametes and embryo. Diseases of cultured shrimp, fish. Diagnostics and their application to aquaculture.

UNIT IV 8 h

Production of transgenic fishes.-growth hormone, antifreeze protein, disease resistant fish, application of hormones in induced breeding in aquaculture. Antifreeze protein and its applications.

UNIT V 8 h

Pharmaceuticals from marine realms, type of drugs from marine organisms and their medical applications. Biofouling and their control. Marine bioremediation-Biosurfactants and Control of oil spills. Extremophiles

Text Books:

1. Aquaculture: Principles and Practices - T.V.R. Pillay -1990
2. Steven M. Colegate and Russel J. Molyneux. 2008. Bioactive Natural Products (II Ed.). CRC Press.
3. Aquaculture: The farming and husbandry of Freshwater & Marine organisms by J.Bardach, Ryther J. Mclarhey.W. 1972.

References:

1. Advances in Fisheries Technology and biotechnology for increased profitability - Ed. Michael N. Voigt, J. Richard Botta. Technomic Publishing Co. Inc.(1990)
2. Biotechnology in the Marine Science- Proceedings of the first Annual MIT Sea Grant Lecture and Seminar - Colwell R.R. 1982.
3. New Developments in Marine BiotechnologyEd. LeGal and H.O.Halvorson Plenum press 1998.

Course Outcome: *The students acquires the knowledge on Marine organisms, Marine hydro colloids, applications of Genetic engineering , extraction of Marine Bioactive Compounds and extremophile.*

BIOT 512 PLANT BIOTECHNOLOGY CREDITS: 3

Course Objectives: *The* objective *of "Plant Biotechnology" course is to provide fundamental knowledge on modern* plant molecular biology and *processes, including plant genome organization, protein targeting into organelles, tissue-specific gene expression, transposons, transformation cassettes, gene transfer tools and genetic engineering.*

Pre-requisite: Master level course in Molecular biology

UNIT I **10 h**

Genome organization and protein targeting: General organization of nuclear, mitochondrial and chloroplast genome. Targeting of proteins synthesized in cytoplasm to chloroplast, mitochondria and within the endomembrane system of plants.

UNIT II **10 h**

Structure and expression of gene: Tissue specific genes, structure and organization of nuclear genes concerning storage proteins, phytochrome, microbial infection and other stresses. Maize transposable elements, organization and function of transposons.

UNIT III **7 h**

Development of plant transformation cassettes: Structure and function of Ti plasmid of *Agrobacterium*, Mechanism of T-DNA transfer to plants. Ti plasmid vectors for plant transformation. Promoter and marker genes in plant transformation. Criticisms regarding the use of different promoters and markers.

UNIT IV **8 h**

Gene transfer and tissue culture techniques: Physical, chemical and biological methods for plant gene transfer. Shoot-tip culture, Rapid clonal propagation, Somoclonal variation and synthetic or artificial seeds, cytoplasmic male sterility.

UNIT V **10 h**

Transgenic plants for virus resistance, herbicide tolerance, delay of fruit ripening, resistance to insect, fungi and bacteria. Production of antibodies, viral antigens and peptide hormones in plants.

Text Books:

1. Lea, PJ, Leegood, RC, Eds. Plant Biochemistry and Molecular Biology, John-Wiley and Sons, Chichester and New York, 1999.
2. Hughes M., A. Harlow. Plant Molecular Genetics. Addison Wesley Longman, England 1996.
3. Kirsi-Marja, Wolfgang Barz. Eds., Plant Biotechnology and Transgenic Plants. Marcel Dekker, 2002.
4. Jones R, Ougham H, Thomas H, Waaland S. The Molecular Life of Plants. First Edition. Wiley-Blackwell publications, 2012.

References:

1. Stewart, CN Jr. Plant Biotechnology and Genetics: Principles, Techniques and Applications. First edition, Wiley-Interscience, 2008.
2. Trigiano RN, Gray DJ., Eds. Plant Development and Biotechnology. CRC press, 2004.
3. Pierce, Benjamin A. Genetics/Conceptual approach. 4th ed. New York, W.H. Freeman & Company, 2012.
4. Journal Review and Research articles.

Course Outcome: *The students understand the application of genetic engineering in plants, transgenic plants as well as tissue culture.*

BIOT 523 MEDICAL BIOTECHNOLOGY CREDITS: 3

Course Objectives: *Students will acquire knowledge on drug discovery & development, molecular diagnostics, newer therapeutics, vaccines and vaccine technology.*

Pre-requisite: Master level course in Microbiology and Immunology

UNIT I Drug discovery and Development 10 h

Introduction, worldwide market in medical biotechnology, revolution in diagnosis, changing approaches of therapy, FDA – Organization chart and regulatory measures for drug discovery: Investigational new drug. Drug discovery: Overview, rational drug design, combinatorial chemistry in drug development, computer assisted drug design, role of bioinformatics in genome – based therapy, antisense DNA technology for drug designing.

UNIT II Molecular Diagnostics 5 h

Biosensors in clinical diagnosis, Use of nucleic acid probes and antibodies in clinical diagnosis and tissue typing. Nanotechnology in diagnosis.

UNIT III Modern Therapeutics 10 h

Stem cells in therapy, Gene Therapy: basic approaches to gene therapy, vectors used in gene therapy, applications of gene therapy in cancer, genetic disorders and AIDS. Therapeutic proteins, interleukins, interferons – principle, production and applications. Biotechnological approaches to obtain blood products: Tissue plasminogen activator and erythropoietin. Nutraceuticals- Food derived bioactive peptides.production of single cell protein. Chiral technology - Principle and applications

UNIT IV Vaccines and Vaccine Technologies 10 h

History of vaccines, Conventional vaccines: Bacterial and Viral vaccine.Vaccine based on routes of administration. Minicells as vaccines, impact of genetic engineering on vaccine production. New Vaccine Technologies - Rationally designed vaccines, DNA vaccination, Mucosal vaccination, New approaches for vaccine delivery, Engineering virus vectors for vaccination, Vaccines for targeted delivery systems. Disease specific vaccines: Tuberculosis vaccine, Malaria vaccine, HIV/AIDS vaccine.New Emerging diseases and vaccine needs –Ebola, Zika

UNIT V Clinical trials and Licensing 10 h

Clinical trials: Phase I, Phase II, Phase III and Phase IV trail norms, ICMR guidelines for design and conducting clinical trials, licensing procedure in India, intellectual Property Rights and patents in biotechnology.

Text Books:

1. Pongracz J, Keen M. Medical Biotechnology. First Edition, Churchill Livingstone, Elsevier Publication, UK, 2009.
2. Trivedi PC. Medical Biotechnology, First Edition, Aavishkar Publisher Distrib. Jaipur, India, 2008.
3. Albert Sasson. Medical Biotechnology: Achievements, Prospects and Perceptions. United Nations University Press, 2005.
4. Kun LY. Microbial Biotechnology – Principles and applications. World Science publications, 2004
5. Glick BR & Patten CL. Molecular Biotechnology: Principles and applications of Recombinant DNA, Fifth Edition, ASM press, 2017.

References:

1. Marks AR &Neiil US. Textbook of Molecular Medicine - Science in Medicine, Jones and Bartlett Learning, New Delhi; 2010.
2. Glazer AN, Nikaido H. Microbial Biotechnology – Fundamentals of Applied Microbiology WH Freeman, New York 1994.
3. Vyas. Methods in Biotechnology and Bioengineering, CBS publications, 2003.
4. Marshak et al., Stem cell Biology. CSHL publications, 2002.

Course Outcome: *The students understand the concept of drug discovery & development, molecular diagnostics, newer therapeutics, vaccines and vaccine technology.*

BIOT 482 MICROBIAL BIOTECHNOLOGY CREDITS: 3

Course Objectives: *Students are exposed to & sensitized on the importance of microbes & their various biotechno-logical applications including antibiotics, biopolymers, bioplastics, food, feed, colorants, biopulping, biobleaching, biocontrol, biopesticides, biofertilizers, bioreme-diation, bioconversion, biofuels, waste water treatment, degradation of xenobiotics, etc.*

Pre-requisite: Master level course in Microbiology and Genetic Engineering

UNIT I **7 h**

General concepts of microbial biotechnology. Microorganisms as factories for the production of novel compounds. Genetic engineering of microbes to improve production of antibiotics, amino acids, lipids, enzymes, steroids and secondary metabolites. Biopolymers and bioplastics

UNIT II **8 h**

Definition, Concepts- history, biotechnological potentials of microalgae – food, feed Colourant, fuel and pharmaceutically valuable compounds. Cultivation methods of algae with reference to *Dunaliella.* Production of microbial biofertilizers cyanobacteria, *Rhizobium, Azotobacter, Azospirillum*, *Phosphobacteria*and VAM.

UNIT III **10 h**

Biological pest control, scheme for selection of microbial antagonist for biological control of insects, bacterial, fungal and viral diseases. Mode of action of biological control involved in different biocontrol agents. Genetics of antimicrobial metabolite production in biocontrol bacteria. Risks associated with GMOs, Potential impacts on the environment and human health.

UNIT IV **10 h**

Bioconversion of cellulosic and non-cellulosic wastes. Agrobyproducts, Biopulping, Biobleaching. Bioremediation of wood, lubricants, rubber and plastics. Biofuels.

UNIT V **10 h**

Waste utilization: Waste water treatment - Aerobic and Anaerobic processes, Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries. Sewage disposal, compost making, methane generation. Microbiology of degradation of xenobiotics in environment: Ecological considerations, decay behavior, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides and dyes.

Text Books:

1. Bernad R. Glick and Jack J. Pasternak. Molecular Biotechnology Principles and Applications of Recombinant DNA. WCB, 2002
2. Dasilva EJ, Dommergues YR, Nyns EJ, Ratledge C. Microbial Technology in the Developing world, Oxford Scientific Publications, 1987.
3. Glazer, A.N. and Nikaido, H. (2008). Microbial Biotechnology. Cambridge University Press. 576 pp.

References:

1. Braun, V. and Gotz, F. (2002). Microbial Fundamentals of Biotechnology. Wiley-Vch.
2. Baltz, R.H., Demain, A.L. and Davies, .E. (2010). Manual of Industrial Microbiology and Biotechnology, Third Edition. American Society for Microbiology. 788 pp.
3. Crueger, W., Crueger, A. and Aneja, K.R. (2017). Cruegers Biotechnology: A Textbook of Industrial Microbiology. 3rd edition. Medtech. 408pp.

4. Harzevili, F.D. and Chen, H. (2017). Microbial Biotechnology: Progress and Trends. 379 pp. CRC Press. Taylor and Francis Group.
5. Walker, J.M. and Raply, R. (2009). Molecular Biology and Biotechnology 5th Edition. Royal Society of Chemistry, Cambridge, UK.
6. Clark, D. P. and Pazdernik, N.J. (2009). Biotechnology Applying the Genetic Revolution. – Elsevier Academic Press.
7. Singh, J.S. and Singh, D.P. (2019). New and Future Developments in Microbial Biotechnology and Bioengineering. Elsevier.

Course Outcome: T*he students will understand the detailed application of micro organisms and Mushroom cultivation as additional income generation activity, bioconversion of agroresidues to useful products, isolation & screening of antibiotic producing microbes may help in finding new drugs in clinical labs, use of green technologies such as biopulping, biobleaching and biofuels.*

BIOT 424 **IMMUNOTECHNOLOGY** **CREDITS: 3**

Course Objectives: *The students will acquires knowledge on immunochemical methods and protocols, methods involved in antibody production and antibody engineering*

Pre-requisite: Master level course in Immunology

UNIT I **8 h**

Introduction Scope of Immunotechnology, Kinetics of immune response, memory; Preparation and purification of Antigens, Extraction of antigens from pathogens, parasites and other biological materials. Antigen fractionation and purification. Preparation of synthetic antigens, Recombinant antigens.

UNIT II **6 h**

Principles of Immunization, different kinds of Immunization procedures; Techniques for analysis of Immune response. Production, purification and characterization of antibodies. Purification of Immunoglobulins, Characterization of Immunoglobulins.

UNIT III **10 h**

Hybridoma and monoclonal antibody (MAb) techniques, Production of murine hybridoma, Production of MAbs in cultures and animal (Ascites), Purification of MCAbs. Characterization of MAbs/ and Labelling of antibodies Antibody engineering; Phage display libraries; Antibodies as *in vitro* and *in vivo* probes.

UNIT IV **11 h**

Cellular immunological methods, CD nomenclature, Markers of immune cells, Separation and purification of immunocompetant cells. Flow cytometry and FACS, Functional tests for immunocompetant cells, Cytokine expression assays; Cell cloning and reporter assays and Histocompatibility testing.

UNIT V **10 h**

Immunological assays; Agglutination tests, Complement fixation tests, *In vivo* tests, Neutralization tests, Radioimmunoassays, Enzyme immunoassays, ELISPOT assayImmunoblotting, Immunohistochemistry and immunohistopathology and Immunofluorescenece techniques.

Text books:

1. Hannigan BM, Moore CBT, Quinn DG. Immunology, Second edition, Viva books Publishers, New Delhi, 2010.
2. Chakrawarty AK. Immunology and Immunotechnology. Second edition, Oxford University press. India, 2008.
3. Kindt TJ, Goldsby RA, Osborne BA. Kuby Immunology, Sixth Ed, W.H. Freeman and company, New York, 2007.
4. Pandian MR, Senthil Kumar B. Immunology and Immunotechnology, First Edition, Panima Publishers, New Delhi, 2007.

References:

1. Benny K. C. Lo Editor. Antibody Engineering: Methods and Protocols (Methods in Molecular Biology) Humana Press, 2003.
2. Rose et al., Manual of Clinical laboratory Immunology, 6th Ed ASM Publications, 2002.

Course Outcome: *The student will understand the concepts and immunochemical protocols, methods involved in antibody production and antibody engineering*

BIOT 423 APPLIED MICROBIOLOGY CREDITS: 3

Course Objectives: *The student will understand the elaborated application of micro organism in fermentation, industrial process using microbes for production of alcohol, lactic acids, organic acids, antibiotics and therapeutic and diagnostic proteins*

Pre-requisite: Master level course in Microbiology and Molecular Biology

UNIT I **10 h**

History and development-Growth phase, Isolation, Preservation Screening of microbes used in Industry: Strain improvement by mutation, selection and enrichment. Bioreactors-types. Air lift, cavitator, acetator, fluid Bed reactors.

UNIT II **10 h**

Production of beverage and industrial alcohols, wine, beer. Production of organic acids -lactic acid, acetone-butanol, citric acid and acetic acid. Production of microbial biomass –SCP.

UNIT III **10 h**

Industrial Production of antibiotics- Penicillin, erythromycin and streptomycin; Bacterial production of enzymes-protease,cellulase, amylase, glucose isomerase, etc, Immobilization of enzymes and development of biosensors.

UNIT IV **8 h**

Role of Microorganisms in cheese production –cheddar cheese, blue cheese, Swiss cheese, camembert cheese, yogurt, buttermilk , sour cream, koumiss,kefir manufacturing. Leather processing.

UNIT V **7 h**

Production of therapeutic and diagnostic proteins –Interferon, somatotropin,cytokines, insulin, growth factors and steroids. Microbial leaching of ores.

Text Books:

1. Gerald (Ed.) Reed. Prescott and Dunn's Industrial Microbiology, Fourth Edition, CBS Publishers and Distributors, 2004.
2. Glick BR and Pasternak JJ. Molecular Biotechnology - Principles & applications of Recombinant DNA. ASM Press, 2009
3. Alani, DI. Murray MY. Perspectives in Biotechnology and applied Microbiology. Elsevier Publication. 1986.
4. Ketchun PA. Applied Microbiology, Microbiology- Concepts and applications. Cassida Jr. Tata McGraw hill Publications, 1994.

References:

1. Glick BR and Pasternak JJ. Molecular Biotechnology - Principles & applications of Recombinant DNA. ASM Press, 2006.
2. Staneberry et al. Fermentation Technology, 1998.

Course Outcome: *The students acquired the knowledge over various use of microbes in industries and the its production.*

BIOT 524 PROTEOMICS AND GENOMICS CREDITS: 3

Course Objectives: *The student will understand the important aspects of proteomics and genomics which are the backbone of biotechnology.*

Pre-requisite: Bachelor's level course in Life Sciences/ Chemical Sciences

UNIT I 10 h

Whole genome analysis: Prokaryotes and Eukaryotes, Foundations of genomics. Mapping of genome – linkage mapping, High resolution physical mapping – Marker associated and clone assisted genome mapping: Genome library construction – YAC, BAC and PAC libraries of genome.

UNIT II 9h

Genome sequencing – Hierarchical and shot gun sequencing methods – variation in sequencing methods – Pyroseqencing – Automation in genome sequencing – Sequence analysis – Databanks – Data mining.

UNIT III 9h

Annotation of genome – experimental and computational approaches – Functional genomics – Experimental and computational approaches – Gene knockouts, yeast two hybrid system – gene expression profiling – microarrays – cDNA and Oligo arrays – DNA chips – Application of DNA arrays – SNPs.

UNIT IV 8h

Genomics versus Proteomics – Tools for proteomics – 2D Electrophoresis – Protein digestion techniques and mass spectrometry – MALDI TOF/QTOF – Analysis of proteins.

UNIT V 9h

Proteome analysis – Algorithms for proteomics – Protein expression profiling – protein arrays – Protein-Protein interactions – Protein microarrays. Advantages and disadvantages of DNA and protein microarrays.

Text Books:

1. Twyman, RM, Primrose SB.Principle of Genome analysis and Genomics. 3rd Edition, Wiley-Blackwell publications, Australia 2007.
2. Westermeier, Reiner. Proteomics in Practices. 3rd edition, Weinheim, Wiley, 2002.
3. Simpson RJ. Purifying Proteins for Proteomics / A Laboratory Manual, First edition. Cold Spring Harbor Laboratory Press, 2004.
4. Brown TA. Introduction to Genetics: A Molecular Approach. First Edition, Garland Science, Taylor & Francis group. 2012.

References:

1. Veenstra, TW and Tates III, JR, 2006. Proteomics for biological discovery, Wiley Publications, 2006.
2. Durbin R, Eddy SR, Krogh A, Mitchison G. Biological Sequence Analysis, Probabilistic Models of Proteins and Nucleic Acids, Cambridge University Press, 2000.

Course Outcome: *The students acquire the knowledge on genomics and proteomics analysis method and its application in various field researches. An insight into whole genome proteomics would enable them to modify technologies provided in the course.*

BIOT 562 **GENETIC ENGINEERING LAB** **CREDIT 1**

30 h

1. PCR amplification of mammalian gene and purification of PCR product.
2. Estimation of PCR product concentration and purity by UV spectrophotometer.
3. Restriction digestion of the DNA and purification.
4. Ligation and transformation.
5. Screening of transformants by colony PCR.
6. Isolation of recombinant plasmid from positive transformants.
7. Confirmation of the cloning by double digestion of recombinant plasmid.
8. Transfection of the recombinant plasmid in HEK293 cells.
9. Estimating the transfection efficiency by fluorescence microscope.
10. Analysis of the protein expression by western blotting.

Suggested Reading:

1. Gene Cloning & DNA Analysis, 2016, Seventh edition, Wiley-Blackwell. Author: T. A. Brown.
2. Molecular Cloning: A Laboratory Manual, 2012, Fourth edition, Cold Spring Harbor Laboratory Press. Author: Michael R. Green

BIOT 564 MARINE BIOTECHNOLOGY LAB CREDIT: 1

30 h

1. Estimation of water quality parameters in Sea Water (Dissolved Oxygen,Salinity Ammonia and Nitrates)
2. Identification and partial characterization of fish bacterial pathogen
3. PCR detection of White Spot Virus or MonodonBaculoVirus in shrimps
4. Production and characterization of Marine protease
5. Production and characterization of Marine lipase
6. Production and characterization of Marine carotenoids
7. Enrichment of live feed organisms –Artemia
8. Field visit to shrimp hatchery, farms,diagnostic laboratory and salt pans

Suggested Reading:

1. Methods in Marine Biotechnology 2001 –CMST, ManonmaniumSundranar University publications.
2. Manual on Fish Genetics and Aquaculture biotechnology T.J.Pandian 2005,Science Pub
3. Practical Handbook of Estuarine and Marine Pollution M.J.Kennish 1996 CRC marine Science

BIOT 566 **MEDICAL BIOTECHNOLOGY LAB** **CREDIT: 1**

30 h

1. Identification and characterization of selected medically important pathogens – *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcuspneumoniae* and *Acinetobacter baumannii*
2. Culturing of single cell protein (SCP) (Spirullina)
3. Ammonium sulfate precipitation of parasite (cystic sacrosis) antigen
4. Quality control of antibodies – HPLC
5. Introduction and use of various genome databases.
6. Similarity searches using tools like BLAST and interpretation of results
7. Multiple Sequence alignment using ClustalW
8. Phylogenetic analysis of protein and nucleotide (16S) sequences
9. Role of bioinformatics in drug development computer assisted drug designing and computer based ligand and Receptor interaction
10. Genetic and biochemical analysis of novel molecules

Suggested Reading:

1. Bernard R. Glick, Terry L. Delovitch, Cheryl L. Patten. Medical Biotechnology, ASM Press. 2014

BIOT 480 MICROBIAL BIOTECHNOLOGY LAB CREDIT: 1

30 h

1. Production of *Taq*polymerase using recombinant *E. coli*
2. Mushroom cultivation
3. Different methods of antimicrobial susceptibility testing
4. Isolation of antagonistic bacteria for growth suppression of pathogens
5. Isolation and characterization of Nitrogen fixers
6. Microbial bioconversion of agricultural wastes using fungi and/or bacteria
7. Microbial degradation agricultural pollutants, fungicides and insecticides
8. Cultivation and mass multiplication of *Azolla*
9. Microbial degradation of hydrocarbons.

Suggested Reading:

1. Verma, S., Das, S. and Singh, A. (2014). Laboratory Manual for Biotechnology Students. S. Chand. 1000pp
2. Das, S. and Dash, H.R. (2015). Microbial Biotechnology – A Laboratory Manual for Bacterial Systems. Springer
3. Gupta, V.K., Tuohy, M.G., Ayyachamy, M., Turner, K.M. and O'Donovan, A. (2013). Laboratory Protocols in Fungal Biology. Current Methods in Fungal Biology. Springer.
4. Aneja, K.R. (2014). Laboratory Manual of Microbiology and Biotechnology. Medtech. 424 pp.
5. Harisha, S. (2007). Biotechnology procedures and experiments handbook. Infinity Science Press LLC. New Delhi.

BIOT 474 **IMMUNOTECHNOLOGY LAB** **CREDIT: 1**

30 h

1. Preparation of antigens from pathogens and parasites
2. Slide and Tube agglutination reaction
3. Immunofluorescence technique
4. Separation of mononuclear cells by Ficoll-Hypaque
5. SDS-PAGE and Immunoblotting
6. Rapid detection of HBV/ HCV candidate antigens and Diagnostic PCR
7. Demonstration of Phagocytosis of latex beads
8. Separation of CD cells using Flow cytometry
9. Isolation and Identification of lymphocytes and their subsets
10. Immunodiagnostics using commercial kits

Suggested Reading:

1. Immunochemical Protocols, Editors: Burns, Robert (Ed.) Humana Press Springer Inc., 2005
2. Current Protocols in Immunology Editors: John E. Coligan et al., Volume 124, A Wiley Grand publications, 2014.

BIOT 473 APPLIED MICROBIOLOGY LAB CREDIT: 1

30 h

1. Estimation of Microbial biomass
2. Red and White wine fermentation/Alcohol production from molasses using yeast
3. Production of amylase using bacillus under submerged conditions
4. Production of protease using Protease vulgaris under submerged conditions
5. Production of protease using rice bran / Cottage cheese production
6. Production of penicillin-G
7. Mass culture of LAB in fermentor
8. Industrial visit to brewery and distillery

Suggested Reading:

1. Microbial Biotechnology: Fundamentals of Applied Microbiology (2007). Alexander N. Glazer and Hiroshi Nikaido. 2nd edition. Cambridge University Press

BIOT 574 **PROTEOMICS AND GENOMICS LAB** **CREDIT: 1**

30 h

1. One and two dimensional separation of protein
2. Scanning and image analysis of 2D gels and spectral analysis of proteins.
3. Computer assisted demonstration of microarray technology: DNA and protein.
4. Liposome preparation
5. Identification of cystic fibrosis gene from Human genome and fatty acyl desaturase gene in *Arabidopsis* genome.
6. Characterization of the protein coded by gene sequence above (in Expt 4) using NCBI software online.
7. Primer designing methods: degenerate and specific oligonucleotide primers.
8. Protein-protein interaction: immune-neutralization (Antigen-antibody precipitation).

Suggested Reading:

1. Bioinformatics, Proteomics and Genomics, Charles Malkoff. Callistro Reference, 2017.

BIOT525 PHARMACEUTICAL BIOTECHNOLOGY CREDITS: 3

Course Objectives: *The course will give a broad overview of basic pharmacology and extensive overview of research and development carried out in industrial setup towards drug discovery and development*

Pre-requisite: Bachelor's level course in Life Sciences/Biochemistry

UNIT I **9 h**

Introduction to Pharmacology- History, nature and source of drugs, Classification of drugs, Dosage forms (liquid & solid dosage forms, Topical applications and aerosols), routes of drug administration-types, advantages and disadvantages, site of action of drugs, Combined effect of drugs, Factors modifying drug action, tolerance and dependence, Mechanism of action of drugs, drug interactions, Adverse Drug Reactions.

UNIT II **10 h**

Principles of Basic and Clinical pharmacokinetics- Models of pharmacokinetics, Transmembrane transport of drugs. Drug absorption pathway; Bioavailability of drugs-definition, factors influencing bioavailability; Fate of Drug - Drug metabolizing enzymes (hepatic drug enzymes and cytochrome P450), Excretion of drug-types, models of elimination and mechanism. Biological half-life of Drugs, Bioassays and Therapeutic Drug Monitoring, Drug accumulation in continuous medication. Application of drug plasma concentration monitoring

UNIT III **10 h**

Hit to Lead Optimisation by Preclinical Studies & Clinical Trials- Approaches to screen lead molecules-Irrational Approach, Rational approach, Anti sense Approach, High Throughput Screening, Sources of lead molecules, including natural products, synthetic libraries, and in silico structure-based molecules, Prodrugs, Chiral Drugs, Vaccines, Antibodies, Cytokines, Hormones, gene therapy. Preclinical Toxicology- acute,subacuteand chronic toxicity. Animal tests (OECD and CPCSEA guidelines), Prodrugs, Formulation and Drug Delivery Systems. Clinical Trials-Ethical consideration, Regulatory requirements for Clinical Trials, Phases of Clinical Trials.

UNIT IV **8 h**

Good Practices (GMP, GLP, GCP), Regulatory Authorities & Regulatory Applications-Overview, Policies and Procedures: The Process of Drug Discovery, Drug Development Process, Role of Regulatory Authorities, USFDA, WHO, European Union and DCGI Regulations, Drugs and Cosmetics Act, India. Schedule- Y, Schedule-M and Schedule-T, GMP Inspection, Structure of Pharmaceutical Industry, Manufacture of Small Molecules and Large Molecules, Finished Dosage Forms; IPR and patenting.

UNIT V **8 h**

Future Directions of Drug Development in the Pharma Industry- Biosimilars, Novel Drug delivery systems, Drug targeting- Target Identification, Methods used to identify potential drug targets, Target Validation, Drug Interaction with targets or receptors; In silico models in drug discovery and development, Molecular modeling in silico, Computer models to predict ADMET, The 'omics' era in drug development: Proteomics, Genomics, Metalobomics, Pharmacogenomics- The promise of personalized medicine.,

Text Books:

1. 1. R. S. Satoskar & Bhandarkar Pharmacology and Pharmacotherapeutics. Revised 23rd Edition, 2013 Bombay Popular Prakasam Publishers
2. Rang H & MM Dale. Pharmacology, Fifth Edition, Churchill-Livingstone, 2003.

References:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics 12th Edition, 2013, MacMillan Publishing Company.
2. Ho et al., Biotechnology and Biopharmaceuticals Transferring Proteins and Genes. 2003

Course Outcome: *On completion of this course, students would be able to understand basics of drug discovery and development which would enable them able to apply knowledge gained in respective fields of pharmaceutical industry.*

BIOT 526 NANOBIOTECHNOLOGY CREDITS: 3

Course Objectives: *To teach principles, synthesis methods, characterization and applications of biological nanomaterials.*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **10 h**

Introduction to Nanobiotechnology: Definition and concepts, biological, microbial and nano world. Nanomaterials: nanoparticles, nanowires, nanoclusters, nanotubes, nanocomposites, nanovesicles, nanospheres and nanocapsules. Biomolecules as nanomaterials: lipids as nanobridges, proteins as nanomolecules, polysaccharides and nucleic acids in nanotechnology.

UNIT II **10 h**

Biological synthesis of nanomaterials: Synthesis of nanomaterials using plants, extracellular synthesis of nanoparticles by bacteria, extracellular and intracellular synthesis of nanoparticles by fungi. Production of bacterial magnetosomes, hybrid nano-conjugates, DNA-oligomers and aptamers. Optimization of parameters for biological synthesis of nanoparticles. Advantages and limitations of biological synthesis of nanomaterials.

UNIT III **8 h**

Characterization of nanomaterials: Confirmation of synthesis and characterization by UV-Vis spectroscopy, X-ray diffraction (XRD), Transmission electron microscopy (TEM), Scanning electron microscopy (SEM), Selected-area electron diffraction (SAED), Energy dispersive x-ray analysis (EDAX) AFM, Infrared (IR) and Thermo gravimetric analysis (TGA) analysis.

UNIT IV **10 h**

Applications of nanomaterials in medicine, agriculture and environment: Medical applications- Nanomedicines, drug delivery, nanoparticles for pathogen detection, nanodevices, diagnosis and imaging. Nano-based antimicrobial agents and cosmetics. Agricultural applications- Nanofertilizers, Nanopesticides, Nanopigments, Food processing and Smart packing. Nanoparticles for compound and gene delivery. Environmental applications: Antimicrobial nanoparticles in textile industry, Nanopaints and Nanofilters. Nanocatalysts for degradation of pollutants.

UNIT V **7 h**

Impact, ethical issues, challenges, patent issues in nanotechnology. Health and environment risk assessments. Nanoeconomy and commercialization. Impact of nanotechnology on society.

Text Books:

1. D. E. Reisner, Joseph D. Bronzino. Bionanotechnology: Global Prospects. CRC Press (2008).
2. E. Papazoglou and A. Parthasarathy. Bionanotechnology. Morgan & Claypool publishers (2007).
3. E. Gazit. Plenty of room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press (2006).

References:

1. C. M. Niemeyer, C. A. Mirkin, -Nanobiotechnology: Concepts, Application and Perspectives, Wiley – VCH, (2004).
2. T. Predeep, - Nano: The Essentials, McGraw – Hill education, (2007).
3. D. S. Goodsell, - Bionanotechnology, John Wiley & Sons, (2004).

Course Outcome: *Students will acquire knowledge on the basic concepts of biological nanomaterials and their utility in health, agriculture and environment.*

BIOT 527 BIOSAFETY, BIOETHICS AND BIOENTREPRENEURSHIP CREDITS: 2

Course Objectives: *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. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications. DNA testingIn a rapidly developing life science industry, there is an urgent need for people to combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.*

Pre-requisite: Bachelor's level course in Life Sciences/ Chemical Sciences

UNIT I BIOSAFTEY 5 h

Biosafety and Biosecurity - Introduction and overview of biological safety in plants and animals. Environmental risk assessment and food and feed safety assessment including heavy metal contaminations; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; National & International Regulations: OECD, EPA, RCGM, GEAC, IBSC, FSSAI and BRAI.

UNIT II BIOETHICS 5 h

Overview of ethical issues in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy and transplantation. Bioethics in stem cell research, Human and animal experimentation, Animal rights/welfare.

UNIT III BIO-BUSINESS 7 h

Scope of bio-entrepreneurship, Competitive dynamics of pharma and biotech industries, Strategy and operation of bisector firms, Business implications and communication of innovations and entrepreneurship in biosectors- lab to market activities, IPR and Challenges in bio-marketing.

UNIT IV BIO-MANAGEMENT 7 h

Basic contracts and agreements for joint ventures and development, Business plan preparation including strategy and legal requirements, Business feasibility study, financial management, collaborations and partnerships.

UNIT V TECHNOLOGY MANAGEMENT 6 h

Information technology in Biobusiness; Assessment, development and upgradation of technology, Technology transfer, Quality control. Regulatory Compliances and procedures [CDSCO, ISO, NBA GMP, GLP], Public private agencies for bio-entrepreneurship (MSME, BIRAC and TTB-DST).

Text books and References:

1. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
2. Onetti, A., &Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.
3. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
4. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.
5. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.

6. Office 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/
7. World Trade Organisation. http://www.wto.org
8. World Intellectual Property Organisation. http://www.wipo.int
9. International Union for the Protection of New Varieties of Plants. http://www.upov.int
10. National Portal of India. http://www.archive.india.gov.in
11. National Biodiversity Authority. http://www.nbaindia.org
12. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
13. Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp
14. 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 Outcome: *Students should be able to understand the rationale for IPR and patents and their regulation. 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 modified organisms, national and international regulations; Understand ethical aspects related to biological, biomedical, health care and biotechnology research. They would also gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.*

BIOT 577 NANOBIOTECHNOLOGY LAB CREDIT: 1

30 h

1. Synthesis of nanoparticles using fungus/bacterium/plant extract.
2. Characterization of nanoparticles using UV-vis spectroscopy/X-ray diffraction (XRD), Transmission electron microscopy (TEM)/Scanning electron microscopy (SEM)/Selected-area electron diffraction (SAED)/Energy dispersive x-ray analysis (EDAX) .
3. Production of nanocomposites.
4. Analysis of intracellularly synthesized mycogenic nanoparticles in the mycelia by Inductively coupled plasma-optical emission spectroscopy (ICP-OES).
5. Analysis of surface-coating molecules in the biologically synthesized nanoparticles using Infrared (IR) and Thermogravimetric analysis (TGA).
6. Antimicrobial activity of nanaoparticles – Agar-diffusion assay, Viable cell count, Cell membrane integrity and Flowcytometry.
7. Cytotoxicity assessment of nanoparticles-Peripheral blood mononuclear (PBMC) culture.
8. Biogenic nanoparticles as catalysts for the degradation of pollutants.

Suggested Reading:

1. A Laboratory Course in Nanoscience and Nanotechnology (2014). Ed. Gerrard Eddy Jai Poinern. CRC Press, USA.
2. Nanobiotechnology Protocols (2005). Eds. Rosenthal, Sandra J, Wright, David. Springer's Humana Press, USA.
3. Nanobiotechnology: Concepts and Applications in Health, Agriculture, and Environment (2019). Eds. Rajesh Singh Tomar, Anurag Jyoti and Shuchi Kaushik. CRC Press, USA.

BIOT 578 PHARMACEUTICAL BIOTECHNOLOGY LAB CREDIT: 1

30 h

1. Qualitative analysis of plant based drugs

2. Isolation of drugs by HPTLC (flavonoids/alkaloids)

3. Quantitative analysis of a drug (aspirin/paracetamol) by spectrophotometer/HPLC

4. Quantitative assay of drug/metabolite by ELISA

5. *Insilico*docking analysis of drug analogs

6. *In vitro* bioactivity assay- antioxidant activity/antidiabetic activity

7. Different routes of drug administration in rodents(Demo)

8. Evaluation of anti-inflammatory/analgesic effect of a drug (Demo)

9. Processing of biological fluids/tissues for biochemical assays

10. Isolation and processing of biological tissues for histopathological analysis

Suggested Reading:

1. A Practical Guide to Pharmacological Biotechnology Authors: Patra, J.K., Das, S.K., Das, G., Thatoi, H. Springer Publications e Book ISBN 978-981-13-6355-9
2. Laboratory Handbook on Biochemistry S. Shanmugam, T. Satish Kumar, Paneer Sevam, PHI Learning Pvt Ltd. New Delhi 2010
3. Screening Methods in Pharmacology 1st EditionVolume II Editors: Robert Turner Peter Hebborn Elsevier Publications 1971 eBook ISBN: 9781483264233