MANONMANIAM SUNDARANAR UNIVERSITY
TIRUNELVELI – 627 012
M.Sc Biotechnology (University Department)
Restructured Syllabi as per the UGC Model Curriculum
Effective from the Academic year 2019 – 2020
The Course Structure and Scheme of Examination
Eligibility:

A candidate possessing B.Sc. degree with minimum 50 % marks in Biotechnology/ Chemistry/ Microbiology/Botany/Zoology/B.Pharm/B.Sc.Agriculture/Life Sciences as main subject and have passed the entrance examination shall be held eligible for admission to M.Sc. course in biotechnology.

No passing minimum for internal mark

SEMESTER I

Course	Subject Code	Subject	Hrs /W	Credit	Marks				
					Maximum			Passing Minimum	
					Int.	Ext.	Total	Ext.	Total
Core I		Cell and Molecular Biology	4	4	25	75	100	38	50
Core II		Biochemistry	4	4	25	75	100	38	50
Core III		Advanced Microbiology	4	4	25	75	100	38	50
Core IV		Molecular Genetics (e-PG Pathshala)	4	4	25	75	100	38	50
Core Practical		Practical 1- Cell Molecular Biology , Biochemistry, Advanced Microbiology and Molecular Genetics	4	2	25	75	100	38	50
Elective I		Electives: select one	3	3	25	75	100	38	50
		1. Marine Biotechnology							
		2. Food Technology							
		3. Environmental Technology							
Total			22	21			600		

SEMESTER II

Course	Subject Code	Subject	Hrs /W	Credit	Marks				
					Maximum			Passing Minimum	
					Int.	Ext.	Total	Ext.	Total
Core I		Genome Biology	4	4	25	75	100	38	50
Core II		Recombinant DNA Technology	4	4	25	75	100	38	50
Core III		Immunology and Immunotechnology	4	4	25	75	100	38	50
Core IV		Fermentation Technology	4	4	25	75	100	38	50
Core Practical		Practical 2 - Molecular biology, Genetic Engineering,	4	2	25	75	100	38	50

		Immunology and Fermentation Technology							
Elective II		Electives: select one	3	3	25	75	100	38	50
		1.Nano biotechnology							
		2.Pharmaceutical technology							
		3.Cancer biology							
		4.Algal and fungal technology							
EDC		Extra Departmental Course *** (NPTEL Online Course)	3	3	25	75	100	38	50
Total			25	24			600		

SEMESTER III

Course	Subject Code	Subject	Hrs /W	Credit	Marks				
					Maximum			Passing Minimum	
					Int.	Ext.	Total	Ext.	Total
Core I		Animal and Plant Biotechnology	4	4	25	75	100	38	50
Core II		Applied Biotechnology	4	4	25	75	100	38	50
Core III		Bio separation	4	4	25	75	100	38	50
Core IV		Bio informatics	4	4	25	75	100	38	50
Core Practical		Practical 3 - Animal and Plant Biotechnology, Applied Biotechnology, Bio separation and Bio informatics	4	2	25	75	100	38	50
Elective III		Electives: select one	3	3	25	75	100	38	50
		1. Clinical Trials and management							
		2. Stem cell and regenerative biology							
		3. Molecular virology							
		4. Biosensors							
EDC		Extra Departmental Course*** (NPTEL Online Course)	3	3	25	75	100	38	50
Total			25	24			600		

SEMESTER IV

Course	Subject Code	Subject	Hrs /W	Credit	Marks				
					Maximum			Passing Minimum	
					Int.	Ext.	Total	Ext.	Total
Core I		Research Methodology and Biostatistics	4	4	25	75	100	38	50

Core II		Molecular Therapeutics (e-PG Pathshala)	4	4	25	75	100	38	50
PROJECT		PROJECT (Related to Biotechnology)	17	13	25	75	100	38	50
Total			25	21			600		

***Extra Departmental Course** (EDC)

II SEMESTER

Modified	Mode
Bioinformatics: Algorithms and application	NPTEL Course

III SEMESTER

Modified	Mode
Genetic Engineering: Theory and applications	NPTEL course

ABSTRACT

CORE COURSE	14X 4= 56
PRACTICAL	3X 2= 06
ELECTIVES	3 X 2= 06
EDC	2 X 3= 06
WORK	1X 16= 16
TOTAL	**90**

SEMESTER I

1.1 CELL AND MOLECULAR BIOLOGY

L	P	T	C
4	0	4	4

Unit 1 10 Hrs

Diversity of cell size and shape. Cell theory. Isolation and growth of cells. Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, electrical properties of membranes

Unit 2 10 Hrs

Structural organization and function of intracellular organelles (Cell wall, nucleus, mitochondria, Golgi bodies, lysosomes, endoplasmic reticulum, peroxisomes, plastids, vacuoles, chloroplast, structure & function of cytoskeleton and its role in motility).

Unit 3 10 Hrs

Cell division and cell cycle - Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle. Structure of Nuclesome and Organization of chromatin. Role of Condesin in chromatin packing. Techniques in cell biology: Fluorescent microscopy, Immunostaining, FACS analysis, live videograpy.

Unit 4 10 Hrs

Density arrest. Genes associated with Density arrest: RB, p53, ATM, Chk2, Cdc25A, Wee1 and Cyc D and E. Disease associated with failure of density arrest. DNA replication licensing factor, Gemini, Cdc45, Intra-S checkpoint, ATR, ATRIP, Chk1, Cdc25C, Wee1, Cdc2/CycE. Irregular duplication of genome, centrosome and associated diseases.

Unit 5 10 Hrs

Role of Topoisomerases and Catenation process. Spindle checkpoint, protein in spindle detection. Bubr1, Role of microtubule, kinesin, dynin, Aurora A and Aurora B. Cohesin and separsae. Cytokinesis. Cell synchronization: G0/G1, S and mitotic cell synchronization. Factors influence the cell cycle: Chemical, physical and biological. Aging of cell: Quiescence, Senescence, Apoptosis, Immortalization of cell.

References:

1. *Molecular Biology of Cell,* Alberts, B *et al*
2. *Molecular Cell Biology,* Lodish *et al*
5. *Cell in Development and Inheritance,* EB Wilson, MacMilan New York
6. *The Coiled Spring,* Ethan Bier, Cold Spring Harbor Press
8. *Molecular Biology of sterioid and Nuclear Hormone Receptors,* LP Freedman, Birkhuser

1.2 BIOCHEMISTRY

L	P	T	C
4	0	4	4

Unit 1 10 Hrs

Structure of atoms, molecules, chemical bonds, Van der Waals and electrostatic forces, hydrogen bonding, hydrophobic interaction. Principles of biophysical chemistry - pH, buffer, reaction kinetics, thermodynamics.

Unit 2 10 Hrs

Composition, structure and function of Carbohydrates, Metabolism (Bioenergetics, oxidative phosphorylation, coupled reaction, group transfer, biological energy transducers) and regulation of carbohydrates.

Unit 3 10 Hrs

Composition, structure and function of Proteins, Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Stability of proteins, Metabolism and regulation of Proteins. Composition, structure and function of Lipids, Metabolism and regulation of lipids

Unit 4 10 Hrs

Composition, structure and function of Nucleic acids, Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA - Chargoff rule- DNA composition, Watson & Crick model of DNA- Structure of RNA. Stability of nucleic acids, Metabolism and regulation of nucleotides.

Unit 5 10 Hrs

Principles of catalysis, enzymes and enzyme kinetics, enzyme regulation, mechanism of enzyme catalysis, isozymes. Enzyme classification and nomenclature. enzyme specificity, effect of pH temperature and other environmental factors on enzyme activity and stability, units of enzyme activity, co-enzymes and co-factors. Immobilised enzymes. Composition, structure and function of Vitamins, Metabolism and regulation of Vitamins.

References

1. Essential of Molecular Biology, David Friefilder, Jones and Barllett Publications Proteins-Structure and Molecular Properties, TE Creighton, WH Freeman and company
2. Genes VII, B. Lewin, Oxford University Press
3. Encyclopaedia of Molecular Biology, J. Kendrew, Blackwell Scientific Publications, Oxford
4. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons
5. Biophysical Chemistry, Cantor, WH Freeman 9. Protein Structure, by Max Perutz.
6. Biochemistry, D Voet and JG Voet, J Wiley and Sons
7. Physical Biochemistry, D Freifilder, W.H. Freeman & Company
8. A Biologists Guide to Principles and Techniques of Practical Biochemistry, K Wilson & KH Goulding, ELBS Editon, 1986 '

1.3. Advanced Microbiology

L	P	T	C
4	0	4	4

Preamble

To understand the basics of Microbial world, their diversity, metabolism, disease associated with them and their control.

Unit 1 Origin of Microbiology

History and Scope of Microbiology. Microbiology in Perspective: to the 'golden age' and beyond. Prokaryotic Diversity - the Eukaryotes of Microbiology - Acellular pathogens. Microbial metabolism.

Unit 2 Methods in Microbiology

Sterilization, Pure culture techniques, Principles of microbial nutrition, Culture media, Growth, mathematical expression of growth, growth curve, measurement of growth and growth yields, Growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen, Culture collection and maintenance of cultures.

Unit 3 Structural Organization & Prokaryotic Diversity

Prokaryotic cells- Structure and Function - Cell walls of eubacteria and related molecules, Outer membrane of Gram negative bacteria, Cell wall and cell membrane synthesis, flagella and motility, cell inclusions like endospores, gas vesicles. Bacteria: New approaches to bacterial taxonomy including ribotyping, ribosomal RNA sequencing. Cyanobacteria, Acetic acid bacteria, Budding and appendaged bacteria, Spirilla, Spirochaetes, Gliding and sheathed bacteria. Lactic acid and propionic acid bacteria, Endospore forming rods and cocci, Pseudomonads, Mycobacteria, Rickettsias, Chlamydias and Mycoplasmas. Archae: Halophiles, Methanogens and Thermoplasmas. Viruses: General properties.

Unit 4 Microbial Genetics

Bacterial and viral genetic system: Transformation, Conjugation, Transduction, Recombination, Plasmids and Transposons, T_4 and Lambda Phage and its life cycIe, Virus - host interactions Genetic system of Yeast and Neurospora.

Unit 5 Epidemiology & Control

Emerging and reemerging infectious diseases - infective syndromes - hospital associated infections - Antimicrobial sensitivity testing - prophylactic immunization.

References

1. General Microbiology, Stanier, R. Y., Ingram, J.L.K., Wheelis, M.L and Painter, P.R, The Macmillan Press Ltd.,
2. Biology of Microorganisms, Brock, Madigan, M.T., Martinko, J.M. and Parker, J. Prentice-Hall.
3. Textbook of Microbiology- 4th edition, D.R.Arora and Brij Bala Arora.
4. Microbiology- Pelczar M.J. Jr., Chan, E.C.S. and Kreig, N.R., Tata McGraw Hill.

5. Chemical Microbiology, An introduction to Microbial Physiology - AH Rose, Butterworth, London.

1.4. MOLECULAR GENETICS(e-PG Pathshala)

L	P	T	C
4	0	4	4

UNIT: I

Changing Concepts of Genes: Part 1, Changing Concepts of Genes: Part 2, Structural organization of genome: Genome structure and organization, Structural organization of genome: Sequence organization of genome, Comparative Genomes, Structural organization of genome: Bioinformatics.

UNIT: II

Mobile DNA elements in Prokaryotes, Structural organization of genome: Mobile DNA elements in Eukaryotes, Structural organization of genome: Genome dynamics: Part 1, Structural organization of genome: Genome dynamics: Part 2, Molecular basis of maintenance of genetic information, Molecular basis of transmission of genetic information.

UNIT: III

Model Organisms in Genetics: *E. coli, Saccharomyces, Arabidopsisthaliana*, Model Organisms in Genetics: *Drosophila melanogaster, Caenorhabditiselegans*, Model Organisms in Genetics: *Musmusculus, Zebrafish*, Transgenic Animals: Part1. Methods of Production, Transgenic Animals: Applications, Gene knock out and Gene knock down (Model Organisms).

UNIT: IV

Methods for gene identification: Restriction mapping (RFLP based pedigree analysis), Methods for gene identification: In-situHybridization, Methods for gene identification: Southern Blot Hybridization, Methods for gene identification: Cloning, Methods for gene identification: Polymerase chain reaction.

UNIT: V

Large scale analysis of genome: Structural Genomics, Large scale analysis of genome: functional Genomics, Large scale analysis of genome: Metogenomics, Large scale analysis of genome: Human Genome Part I, Large scale analysis of genome: Human Genome Part II, System Biology, Epigenetics.

Practical 1

Cell and Molecular biology, Biochemistry, Advance Microbiology and Molecular Genetics

L	P	T	C
0	4	0	2

1. Stages of Mitosis.
2. Stages of Meiosis.
3. Preparation of Buffers and stock solutions of media/reagents. Preparation of Normality, ppm, molar and percentage solutions.
4. Histochemical techniques
5. Colorimetric determination of pK
6. Estimation of proteins.
7. Estimation of carbohydrates.
8. Estimation of lipids.
9. Isolation and quantitation of DNA and RNA.
10. Preparation of liquid and solid media for growth of Microorganisms
11. Cultural characteristics of Microorganisms
12. Isolation and maintenance of organisms by plating, streaking and serial dilution methods. Slants and stab cultures
13. Bacterial identification
14. Biochemical tests for identification of Bacteria
15. Isolation of microorganisms from soil and water
16. Microscopic examination of bacteria, yeast and moulds
17. Counting of bacteria using Haemocytometer
18. Assay of antibiotics and demonstration of antibiotic resistance
19. Analysis of water for potability and demonstration of MPN
20. Karyotyping of human chromosomes (Human karyotype figure on paper should be cut in to different sets of chromosomes and students are asked to arrange them in an order and comment on the idiogram)
21. Pedigree analysis
22. Identification of genetic syndromes given on charts.
23. Problems based on Mendelian inheritance (at least one problem for each for the laws of segregation and law of independent assortment).

Elective Subjects

1. Marine Biotechnology

L	P	T	C
3	0	3	0

Unit 1 8 Hrs

World oceans and seas,ocean currents, physical and chemical properties of sea water, abiotic and biotic factors of the sea, ecological divisions of the sea, history of marine biology, bioecochemical cycles, food chain and food web.

Unit 2 8 Hrs

Phytoplanktons, zooplanktons, nektons, benthos, marine mammals, marine algae mangroves, coral reefs, deep sea animals and adaptation, intertidal zone, fauna and flora.

Unit 3 8 Hrs

Marine pollution, biology indicators (marine micro algae) biodegradation & bioremediation, marine fouling and corrosion.

Unit 4 8 Hrs

Medicinal compound from marine flora and fauna, marine toxin, antiviral and antimicrobial agents.

Unit 5 8 Hrs

Important of coastal aquaculturem, marine fishery resources, common fishing crafts and gears, aquafarm design and construction.

References:

1. Recent advances in marine biotechnology volume 3 – M. Fingerman , R . Nagabhushanam Mary – Frances Thomson.

.2. FOOD TECHNOLOGY

L	P	T	C
3	0	3	2

Unit 1 8 Hrs

Food Biotechnology, Definition, Scope, Application. Food Fermentation- Batch and continuous process, Fermentor design, solid substrates fermentation, instrumentation and control, criteria used in media formulation, downstream processing, alcoholic beverages, cheese making, bread making, fermented soya based foods, meat fermentations and vinegar.

Unit 2 8 Hrs

Isolation and identification of microorganisms methods for the microbiological examination of foods, Indicator organisms, Direct examination, cultural techniques, Enumeration methods, plate counts, most probable number counts, Alternative methods, dye reduction tests, electrical methods, ATP determination; Rapid methods for the detection of specific organisms and toxins.

Unit 3 8 Hrs

Prevention of contamination and spoilage, Principles of preservation, classification of food preservation. Physical, high temperature, low temperature, irradiation and microwave heating, concentration, drying and dehydration. Chemical methods, Preservatives. Biological Fermentation, Hurdle technology. Non destructive method of preservation, High pressure processing, pulse electric field, pulse light field, ultrasound, MAP, CAP and Vaccum packaging.

Unit 4 8 Hrs

Toxicology - Definition, Principles of Toxicology, Routes of toxicant exposure and absorption, biotransformation, storage and exertion of toxicants. Measurement of toxicity, biological techniques, physical and chemical methods binding assays. Dose, response relationships, animal toxicity test, risk assessment, standard setting.

Unit 5 8 Hrs

Genetically modified foods - Definition, examples of GM foods and its production, advantages and disadvantages, ethical and legal concerns, safety aspects of foods produced by biotechnology and genetic engineering.

References

1. Owen Pward, Fermentation Biotechnology Principles, processes and products, Prentice H New Jersey, 1989.
2. Frazier and West Hoff , Food Microbiology, Tata McGraw Hill publishing company Ltd, New Delhi, 1995.
3. Dubey, R.C , Text book biotechnology S.Chand and Co Ltd,New Delhi, 2001.
4. Gary Walsh and Denis R. Headen, Protein Biotechnology John Willey & Sons England.
5. Stanbur, P.F and Allan, W. (1984): Principles of fermentation technology, Pergamon Press oxford
6. Lee, B.H . (1996), Fundamentals of food biotechnology, VCH publishers, Inc. New york.
7. Herzaka, A. and R.G. (1981), Food industry wastes, disposal and recovery, Applied Science Publishers, London
8. Lawrence K.W. and Wang, MUS (1992), Handbook of Industrial waste treatment, Marcel Dekker, Inc. New York
9. WHO (1990): Strategies for assessing the safety of foods by biotechnology, Report of joint FAO/WHO consultation –Geneva

3. ENVIRONMENTAL BIOTECHNOLOGY

L	P	T	C
4	0	4	4

Course Objective:

To get familiarize with biotechnological interventions related to environment

Unit 1: Fundamentals of Microbial Diversity and Environmental Pollutants

General characters, important uses and harmful effects of a) Protozoa b) algae, c) fungi, d) bacteria and e) viruses. Water, Soil and Air: their sources and effects. Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal Accumulation. Environmental problems- ozone depletion, greenhouse effect, water, air and soil pollution, land degradation

Unit 2: Environmental Microbiology and Reactions

Bioremediation, advantages and disadvantages; In-situ and ex-situ bioremediation. Slurry bioremediation; Bioremediation of contaminated ground water and phytoremediation of metals in soil; microbiology of degradation of xenobiotics, Role of environmental biotechnology in the management of environmental problems

Unit 3: Biotransformation and Biodegradation

Common prejudices against the use of enzymes- Advantages & Disadvantages of Biocatalysts - Isolated Enzymes versus whole cell systems- Mechanistic Aspects and Enzyme Sources, Xenobiotic compounds: Aliphatic, Aromatics, Polyaromatic hydrocarbons, Polycyclic aromatic compounds, Pesticides, Surfactants and microbial treatment of oil pollution

Unit 4: Bioremediation of Soil, Water and Air Environment

Environment of Soil Microorganisms, Soil Organic Matter and Characteristics, Soil Microorganisms Association with Plants, pesticides and Microorganisms; Biotechnologies for Ex-Situ Remediation of Soil, Waste water characteristics - Sewage and waste water treatments systems; Primary, secondary and tertiary treatments- Biological waste water treatment - Atmospheric Environment for Microorganisms, Microbial Degradation of Contaminants in Gas Phase, Biological Filtration Processes for Decontamination of Air Stream

Unit 5: Advances and Case Studies

Biopesticides, Biofertilizers, Biofuels, Biosensors, Bioindicators, Biodegradable plastics, Factors Affecting the Bioremediation Processes, Effects of co-substrates on microorganisms, Phytoremediation, Sequestering Carbon Dioxide, Biomonitoring, Biomembrane Reactors, Important Case Studies in Environmental Biotechnology: Oil spill, Textile wastewater treatment,

Textbook(s):

1. McCarty PL - Environmental biotechnology: principles and applications - Tata McGraw- Hill Education – 2012
2. Mitchell R, Gu J D - Environmental microbiology - John Wiley & Sons – 2010 (2nd Edition)
3. Díaz E - Microbial biodegradation: genomics and molecular biology - Horizon Scientific Press - 2008.
4. Scragg AH - Environmental biotechnology - Essex: Longman - 1999.

SEMESTER II

Genome Biology

Objectives: To provide knowledge on the functional aspect of genome and their application in healthcare system.

Outcome: The students will develop the ability to understand the modern area of biotechnology and will increase job opportunity

Unit 1 Next Generation Sequencing

Sanger sequencing, pyrosequencing,iontorrent, illunia, Nanopore etc. and NGS sequence analysis: denovo and reference based assembly of genome

Unit 2 Human Genome Resources

Predication and annotation of a gene, Blast, Blast2GO, FASTA, FASTQ, VCF, GFF3, NCBI, 1000 genome project, SNP, confirmation of mutation.

Unit 3 Transcriptome

Denovo and reference based assembly, mRNA, ORF, splicing, Poly A, signals, protein predication and confirmation, non-coding RNAs and their significance and structure and predication, differential gene expression and analysis, heatmap

Unit 4 Proteomics

Protein-protein interaction, Protein-ligand interaction,MS-MS, MALDI-TOF. Immuno-precipitation, co-immuno-precipitation, pull-down assay, sizing column. Protein structure, Domains and motifs, Protein crystallography, Their applications in drug discovery

Unit 5 Metabolomics

NMR, Mass-spec, crystallization, single crystal X-ray diffraction, organ specific metabolites, disease markers

References

1. Greg Gibson, Spencer V Muse. "A Primer of Genome Science" 3rd edition, Oxford University Press.
2. *Molecular Biology of Cell,* Alberts, B *et al*.,
3. Robert F Weaver. "Molecular Biology " 5th edition
4. Kaufmann, Michael, Klinger, Claudia, Savelsbergh, Andreas. "Functional Genomics: Methods and Protocols" 2017, Springer Protocols
5. David Mount. "Bioinformatics: Sequence and Genome Analysis" 2nd edition, cold spring harbor laboratory.
6. Fan, Teresa Whei-Mei, Lane, Andrew N, Higashi, Richard M. "The Handbook of Metabolomics", 2012, Springer Protocols
7. Raftery, Daniel. "Mass Spectrometry in Metabolomics: Methods and Protocols", 2014, Springer Protocols
8. Hector C Keun. "NMR-based Metabolomics", 2018, Royal Society of Chemistry
9. Donald Voet, Judith Voet. "Biochemistry" 4th edition, 2010, Wiley.

Recombinant DNA TECHNOLOGY

Preamble

1. To understand the concept of recombinant DNA technology for gene manipulation
2. To understand the gene manipulation methods and their applications
3. To explain the general principles of generating transgenic organisms

Unit-I:

Restriction endonucleases and their importance in gene cloning. Enzymes used in recombinant-DNA technology: DNA polymerases, ligasesand DNA modifying enzymes (methylases, alkaline-phosphatases,topoisomerases). Cloning vectors: Plasmids, Phagemids, Cosmids, Viral vectors, shuttlevectors and Binary Vectors.Expression vectors: Bacterial, Yeast, Animal and Plant

Unit-II:

Gene cloning strategies, analysis and expression of cloned genes. Construction of Genomic libraries: genome mapping and chromosomewalking and DNA foot printing, BAC and YAC. C-DNA synthesis: Isolation of eukaryotic mRNA and mechanism of C-DNAsynthesis, c-DNA libraries and *in vitro* packaging. Genome sequencing: Different strategies. DNA sequencing methods- Maxam-Gilbert and Sanger's method, automatedsequencing, multiplex sequencing. DNA arrays- principle, spotted DNA array; oligonucleotide chips

Unit-III:

Blotting techniques: Southern, Western and Northern blotting techniques. Molecular markers: RFLP, RAPD, AFLP, SSR and their applications.DNA finger printing technology and its application in forensic medicine. PCR Technology-Designing and synthesis of oligonucleotide primers-PCRamplification of specific DNA sequences, current innovations, cloning PCRproducts, mutagenesis by PCR, thermostable DNA polymerases andapplications of PCR technology in Biology and medicine.

Unit-IV:

Introduction of Recombinant DNA molecules into appropriate hosts-competentcells preparation. Genetic selection – alpha complementation, insertional inactivation.Screening of libraries using labeled probes. Transposable elements, types and mechanism of transposition

Unit-V:

Site directed mutagenesis and RNA interference**.** Knock-in and knock- out technology. Genome engineering technology- CRISPR-Cas system, TALENs & zinc finger,Nucleases.Next generation sequencing- principle, types and applications. Applications of genetic engineering in agriculture & animal husbandry. Applications of genetic engineering in industry and medicine.

REFERENCE

1. Principles of Gene Manipulation and Genomics- Sandy B. Primrose, Richard Twyman 7th Edition; Blackwell Publishing
2. Gene Cloning and DNA Analysis: An Introduction- T. A. Brown - John Wiley & Sons
3. An Introduction to Genetic Engineering- Desmond S.T. Nicholl – Cambridge University Press
4. Molecular Biotechnology: Principles and Applications of Recombinant DNABernard
R. Glick, Jack J. Pasternak, Cheryl L. Patten- ASM Press
5. Molecular Cloning: A Laboratory Manual (Cold Spring Harbor) - M. R. Green, J. Sambrook.

Immunology and Immunotechnology

Preamble

To have a clear understanding about the immune system, its regulation and diseases associated with it and have an in-depth knowledge of various immunological techniques.

Unit 1 Introduction to Immunology

Overview of the Immune system - Innate immunity - Adaptive immunity - comparative immunity - Immune dysfunction and its consequences - Cells and Organs of the immune system.

Unit 2 Antigens and Antibodies

Nature and biology of Antigens and Super antigens - Haptens - Structure and function of Antibodies - classes and biological activities of Immunoglobulins - Monoclonal antibodies -Antigen - Antibody interactions- Major Histocompatibility Complex- Complement system and its pathways.

Unit 3 Regulation of Immune Response

Antigen processing and presentation, generation of humoral and cell mediated immune responses. Activation of B and T Lymphocytes. Cytokines and their role in immune regulation - T-cell regulation - their assay methods - MHC restriction - Immunological tolerance. Cell - mediated cytotoxicity - Mechanism of T cell and NK cell mediated lysis - Antibody dependent cell mediated cytotoxicity - macrophage mediated cytotoxicity - Hypersensitivity - Autoimmunity - Transplantation - Immunity to infectious agents (intercellular parasites, helminthes & viruses). Tumor Immunology - AIDS and other Immunodeficiencies.

Unit 4 Cancer and the immune system

Cancer - Malignant transformation of cells - Oncogenes and cancer induction - Tumors of the immune system - Tumor Antigens - Tumor evasion and Cancer Immunotherapy.

Unit 5 Immunotechnology

Hybridoma Technology and Monoclonal antibodies. ELISA, Western blotting, Insitu hybridization RIA, FACs, Immunoprecipitation, Immunodiagnosis, Flowcytometry, Vaccines - Routes of Immunization. Analysis of DNA regulatory sequences and Microarrays.

References:

1. Kuby Immunology, *5*th Edition, W. H. Freeman and Company, New York.
2. Immunology - A short Course, 4th Edition Eli Benjamin, Richard Coico, Geoffrey Sunshine. (Wiley-Liss).
3. Clinical Immunology- Principles and Practice- 5th edition, Robert R.Rich.
4. Fundamentals of Immunology, William Pau1.
5. Essential Immunology, I. Roitt, 1994, Blackwell Science, Singapore.
6. Klaus, D. Elgert, 1996, Immunology - Understanding of immune system, Wiley - Liss, New York.
7. A.Bul and K. Abbas, 1994, Cellular and Molecular immunology.

FERMENTATION TECHNOLOGY

Objectives: To impact knowledge about biological and biochemical technology, with a focus on biological products, the design and operation of industrial practices.

Outcomes: Upon completion of the course, the learners will acquire skills to:

1. Evaluate factors enhancing biomass and product formation during mass cultivation process.
2. Analyse kinetics of cell and product formation in batch, continuous and fed-batch cultures

Unit I

History of fermentation industry - Fermentation process: - Strain, culture collection, criteria used in media formulation, Inoculum preparation, Scale up of the inoculum - Sterilization, Batch and Continuous sterilization of medium, Aseptic operation.

Unit II

Types of Fermentation Processes: Batch, Fed-batch and continuous bio reactions, stability of microbial reactors, analysis of mixed microbial populations, specialized bioreactors (pulsed, fluidized, photo bioreactors etc.

Unit III

Fermentation control systems - manual and automatic control in fermentation processes. Architecture of Fermentation systems, temperature measurement and control, flow measurement and control, pressure measurement and control, measurement of pH and dissolved oxygen and related sensors, Computer applications in fermentation technology.

UNIT IV

Downstream Processing: Introduction, Removal of microbial cells and solid Matter, foam separation, precipitation, filtration, centrifugation, cell disruptions, liquid-liquid extraction, chromatography, Membrane process, Drying and Crystallization. Effluent treatment: B.O.D. and C.O.D. treatment and disposal of effluents.

Unit V

Microbes-Industrial Applications: Industrial bioprocess Industrial Production: Anaerobic (ethanol, lactic acid) aerobic process (citric acid, Streptomycin and single cell protein), Acids (citric), solvents (glycerol), Antibiotics (penicillin, streptomycin) Single cell Protein, Use of microbes in mineral beneficiation and oil recovery.

References

1) Agriculture and Medicine, Vol 1, 2, 3 and 4 (2004). Edited by M. M. Young, Reed Elsevier India Private Ltd, India
2) Biochemical Engineering, Aiba, S., Humphrey, A.E and Millis, N.F., Academic Press 1973. Bailey, J.E. and Ollis, D.F., Biochemical Engineering Fundamentals, McGraw-Hill 1986.
3) Bioprocess Engineering, Principles Doran, P.M, Academic Press 2012.
4) Bioprocess Engineering: Basic Concepts Shuler, M.L. and Kargi, F., , Prentice-Hall 1992.
5) Bioprocess Engineering: Basic concepts, Shuler ML and Kargi F., Prentice Hall, Engelwood Cliffs, 2002.
6) Bioprocess Technology, Kalaichelvan and Arulpandi, MJP. Publishers, 2008.
7) Biotechnology: The Biological Principles (1990) Edited by M D Trevan, S Boffey, K H Goulding, and P Stanbury, Tata McGraw-Hill Publishing company Ltd, New Delhi, India.

8) Comprehensive Biotechnology. The Principles, Applications and Regulations of Biotechnology in Industry,
9) Doran. Bioprocess Engineering Principle. Elsevier. 2007.
10) Principles of Fermentation Technology, Stanbury, RF and Whitaker A., Pergamon press, 2007.

Practical 2
Genome biology, Recombinant DNA technology, Immunology & Immunotechnology and Fermentation Technology

L	P	T	C
0	4	0	2

1. Plasmid and genomic DNA isolation
2. Electrophoresis of DNA
3. Restriction and digestion
4. Preparation of competent cells.
5. Gene cloning-Ligation, transformation and Screening of transformants.
6. Southern, Northern hybridization
7. Determination of Melting temperature (Tm) of nucleic acid
8. Effect of pH on nucleic acids
9. PCR primer designing and PCR
10. Developing RFLP and RAPD maps
11. PAGE
12. Western blotting.
13. Hapten Conjugation and quantization
14. Immunohistochemistry.
15. In-situ hybridization.
16. BrdU labeling retention assay.
17. TUNEL assay.
18. Blood film preparation and identification of cells
19. Immunization, Collection of Serum, ELISA
20. Single Radial Immuno diffusion
21. Double immuno diffusion and Immuno-electrophoresis,
22. Rocket immuno electrophoresis
23. Demonstration of primary and secondary lymphoid organs including Lymph nodes
24. Blood Collection and Route of immunization
25. Purification of IgG from serum
26. Immobilization of cells and enzymes
27. Wine and alcohol production
28. Growth of bacteria-Estimation of biomass, calculation of specific growth rate.
29. Growth of yeast- Estimation of biomass, calculation of specific growth rate.

30. Cell disruption
31. Production of enzyme-using batch Fermentor.
32. Production of citric acid by solid state fermentation.

Elective subjects

1. NANOBIOTECHNOLOGY

Objectives: To provide knowledge on nano-materials and their properties and application in the area of biology.

Outcome: The students will have the ability to understand the nano-materials and their biological applications.

Unit 1 Nano biotechnology 8Hrs

Definition and scope, recent development and applications, Nanoparticles, Nanowires and thin films, Types of nanomaterials and their classifications, Applications of nanotechnology viz. anti cancer activity, artificial mitochondria, Nanobiosensors, bio imaging, separation of cells and cell organelles, drug delivery, gene therapy etc.

Unit 2 Nanotechniques 8Hrs

Techniques to construct nanostructures, scanning probe instruments, Techniques to predict nanostructures, TEM, SEM, AFM, FRET, Confocal Microscopy, Uv visible spectroscopy, X- Ray diffraction, TIRF imaging, IR and Raman Spectroscopy, EDC.

Unit 3 Biological Nanoparticles Production 8Hrs

Biologiical synthesis of nanoparticles – use of bacteria, fungi, actinomycetes and plants – mechanism of synthesis. S-layers, Chemistry and structure, Magnetosomes- Bacteriorhodopsins, Liposomes, Cubosomes and Hexosomes, biopolymers, chitosan, drug targeting and Iron oxide nanoparticles for functional MRI.

Unit 4 Biosensors, Definition and Classification 8 Hrs

Nanofibers and their application in tissue engineering, Nanomaterials and drug delivery, cancer diagnosis and therapy, biologically inspired nanocomposites, nanotechnology and Tissue engineering, Scaffolds, nanotechnology in Agriculture (Fertilizers and pesticides) and waste management: current status of nanobiotechnology

Unit 5 Application of Nanotechnology 8 Hrs

Nanomaterials in consumer markets, Is nanotechnology bad or good?, Implications of nanotechnology: Health and safety implications from nanoparticles: Environmental issues, Toxicology of Nano particles: Need for regulation, Potential benefits and risks for developing countries, Criticism of Nanotechnology

References

1. Nanobiotechology: Concepts, Applications and perspectives, Christ of M.Neimeyer, Chad.A.Mirkin (eds.,) Wiley VCH Weinheim (2004).

2. Bionanotechnology: concepts, Lessons from Nature, by David.S.Goodsell, Wiley-Liss (2004).

3. R.S. Greco, F.B.Prinz and R.L.Smith, Nanoscale Technology in Biological Systems, CRC press, 2005.

4. Protein Nanotechnology Protocols, Instrumentation and Application, Tuan Vo-Dinh, Series ; Methods in Molecular Biology (2005).

5. Nanocomposite Science & Technology Ajayan, Schadler& Braun.

6. Challa S.S.R.Kumar (Ed). 2006. Biologicals and pharmaceutical nanomaterials, Wiley-VCH Verlag Gmbh & Co, KgaA.

2. PHARMACEUTICAL TECHNOLOGY

L	P	T	C
3	0	3	2

Unit 1 8 Hrs

Introduction of pharmacology, sources of drugs, route of administration, mechanism of action of drugs. Pharmacogenetics and pharmacokinetics: absorption, distribution, metabolism and excretion of drugs.

Unit 2 8 Hrs

Drugs acting on central nervous system:- Analgesics, Antipyretics, Anti-inflammatory, Antidepressants and CNS stimulants. Drug acting on cardio vascular system:- Anti-Hypertensive drugs and Anti-Hyper lipidemic drugs. Drug acting on Urinary system:- Diuretics and Anti-diuretics.Drug acting on respiratory system:-Anti-Asthmatic drug

Unit 3 8 Hrs

Compressed tablets, Wet granulation, Dry granulation or slugging, Direct compression, Tablet presses, Formulation, coating, Capsules sustained dosage forms, Parental solutions, Oral liquids Injections, Ointments, Standard of Hygiene and Good Manufacturing Practice.

Unit 4 8 Hrs

Transdermal delivery system, liposomes and Nanoparticles.

Unit 5 8 Hrs

Various categories of therapeutics like vitamins, antibiotics, hormones and biological

REFERENCES:

1. Medical pharmacology, K.D.Tripathi
2. Katzung, B.G.Basis and clinical pharmacology, prentice hall of international
3. Pharmacology and therapeutics-Satoskar
4. Pharmaceutical dosage forms: tablets volume-3 by liberman and lachman.
5. Theory and practice of industrial pharmacy by lachman.
6. Novel drug delivery system – Y. W. Cheinc Publications, Oxford, 1988.

3. CANCER BIOLOGY

Objectives: To provide cell biological, genetic and molecular biological details of cancer.
Outcome: The students will have the ability to understand the molecular reason for the disease cancer, treatment possibilities and further research directions on the cancer biology.

Unit 1 Origin of Life
Types of cells, Genetic material and their stability. Isolation, culturing and maintenance of cells. Growth factors and signal transduction.

Unit 2 Genomic Integrity
Importance of maintenance of genomic integrity. Carcinogenesis and mutagenesis. Proteins associated with genomic integrity. Cell cycle checkpoint: Density arrest, Intra- S, G2/M and Spindle check points.

Unit 3 Tumor Suppressors
p53, Rb, ATM, P53 BP, p10 and apoptosis. Oncogenes: cMyc, and vMyc, Aurora A, AKT,PI3K, TRK. The cancer stem cell theory. Metastasis. Tumor viruses. Cell immortalization.

Unit 4
Phenotype of Cancerous Cell, Hyperplasia, dysplasia, neoplasia, metaplasia.Aneuploidy, abnormal centrosome, loss of cell cycle arrest upon loss of genomic integrity.Philadelphia chromosome.

Unit 5 Genes Associated with Cancers
Stomach, colon, breast, lung, cervical, and oral cancers. Techniques of cancer biology: Biochemical and imaging technique., early detection of cancer: Therapeutic aspects of cancer.

References
1. Reya, T; Morrison, SJ; Clarke, MF; Weissman, IL (2001 Nov 1). "Stem cells, cancer, and cancer stem cells.". Nature 414 (6859): 105-11.
2. Heppner, GH; Miller, BE (1983). "Tumor heterogeneity: biological implications and therapeutic consequences.". Cancer metastasis reviews 2 (1): 5–23.
3. Dunmock N.J and Primrose S.B., “Introduction to Modern Virology”, Blackwell Scientific Publications, Oxford, 1988.

ALGAL AND FUNGAL TECHNOLOGY

OBJECTIVES:

1. To understand the concept and life cycle of algae and fungi.
2. To gain an insight on the various advancement in algal and fungal technology.

Unit I: Algae – Overview (10 hours)

A general account and classification of Algae – distribution - range of thallus organization – pigmentation- flagellation- reserve food – Reproduction(vegetative-asexual-sexual); Lifecycle patterns -salient features of algal divisions (Harold C Bold) – phylogeny - Fossil algae.

Unit II: Algae -Type Study (10 hours)

Structure and reproduction with reference to the following algal forms – *Anabaena, Chlorella, Volvox,Chara, Ectocarpus, Sargassum, Polysiphonia and Gracilaria.* (excluding the developmental stages).

Unit III: General characters of fungi (10 hours)

Habit, nutrition types, cell structure, mycelium – its modifications- Reproduction: vegetative, asexual,sexual, para-sexual; fruiting bodies of sexual and asexual, Life cycle patterns. Salient features of fungal classes (Alexopolus, 1962).

Unit IV: Fungal forms (10 hours)

Structure and reproduction with reference to the following fungal forms (no developmental stage) *Aspergillus*, *Saccharomyces*, *Neurospora*.

Unit V: Applications (10 hours)

Algal biotechnology- Mass cultivation of algae- production of agar agar, alginic acid. Importance of blue green algae. Importance of fungi- production of food and industrial products. Yeast cell transformation.

REFERENCE

1. Vashista, B.R. 2000. Fungi, Chand & Co. New Delhi
2. Harold C. Bold, 1982. Morphology of plants. Weiley- Eastern Ltd.
3. Trivedi.P.C.2001- Algal biotechnology.
4. Bilgrami, K.S. and Saha, L.C. 2012. A Textbook of Algae. CBS Publishers & Distributors Pvt. Ltd.,New Delhi.
5. Dubey, R.C. 2009. A Textbook of Biotechnology. S. Chand & Company Ltd. New Delhi.

SEMESTER III

PLANT & ANIMAL BIOTECHNOLOGY

Objectives: To provide knowledge on the techniques to manipulate genome of plants & animals, tissue culture facilities and Animal Stem Cells and Tissue Engineering facilities.

.

Outcome: The students will have the ability to understand and apply different techniques of plant genome editing and tissue culture, Animal Stem Cells and Tissue Engineering facilities.

Unit 1: Introduction to Plant Tissue Culture

Historical account, Totipotency. Preparation of nutrient media for callus culture. Processing of Various explants (mature seed, leaf base, node) for culture initiation. Callus cultures through organogenesis and somatic embryogenesis. Protoplast isolation and fusion. Transfer and establishment of whole plants in soil.

Unit 2: Gremplasm conservation & transformation

Germplasm Conservation :cryopreservation-methodology and steps, Plant conversion from synthetic seeds. Micropropagation of medicinal plants. Secondary metabolites from plant cells. Isolation and purification ofTi-plasmid DNA. Agrobacterium mediated transformation of plants. Transient ß-glucuronidase (GUS) gene expression assays in transformed intact explants and callus tissues by histochemical method.

Unit 3: Animal Cell Culture

types of culture media, composition, preparation and metabolic functions. Role of CO2, Serum, supplements, growth factors (EGF, PDGF, NGF, Gap-43). Biology of cultured cells culture environment, cell adhesion, cell proliferation and differentiation. Characterization of cultured cells, viability, Gene Transfer, cytotoxicity, growth parameters, cell death and Apoptosis

Unit 4 : Animal Stem Cells and Tissue Engineering

Embryonic and adult stem cells, properties, with reference to stem cells culture. Tissue engineering of skin, bone and neuronal tissues, biomaterials used in tissue engineering, three dimensional culture and transplantation of engineered cells. Tissue engineering -. Gene knock out and mice models. Methods of animal cloning

Unit 5: Transgenics

Transgenic plant with modified quality (Improved starch, oil, seed protein quality). Plant derived vaccines; Plants with improved nutrient value (Golden Rice). Pharmaceutical products produced by mammalian cells – plasminogen activator, erythropoietin, blood clotting factors, glycoprotein hormones, interleukins, interferons, Cell culture based vaccines.

References

1. Robert N. Trigiano. Dennis J. Gray, 1996, Plant Tissue Culture Concept and Laboratory Excersises. CRC Press, London.
2. P.S.Srivasta, 1998. Plant Tissue Culture and Molecular Biology, Narosa Publishing House, New Delhi.
3. John H. Dods and Lorrin W.Roberts, 1995, Experiments in Plant Tissue Culture, Cambridge University Press, USA.
4. J. Hammond, P. McGarvey and V. Yusibov (Eds): Plant Biotechnology. Springer Verlag, 2000

5. T-J. Fu, G. Singh, and W.R. Curtis (Eds.): Plant Cell and Tissue Culturefor the Production of Food Ingredients. Kluwer Academic/Plenum Press. 1999.
6. H.S. Chawla: Biotechnology in Crop Improvement. International Book distributing Company. 1998.
7 . Ballinic C.A., Philips J.P and Moo Young M. Animal Biotechnology. Pergamon Press, New York. 1989.
8. Watson J.D.et al. Molecular Biology of Gene (6th Ed.) Publisher Benjamin Cummings.2007.
9. Berger S. L. and A.R. Kimmel.Methods in enzymology guide to molecular cloning techniques (Vol 152). Academic Press Inc. San Diego.1996.
10. Glick, B.R. and Pasternak J.J. Molecular Biotechnology.ASM Press, Washington DC.2003.

APPLIED BIOTECHNOLOGY

Objectives: To provide knowledge on the extent of application of biotechnology in different avenues of sciences.

Outcome: The students will have the ability to understand the uses and application of the biotechnology on various sectors of the economy. It also helps them to broaden the scope of ideas related to biotechnology and other walks of science.

Unit 1: Marine Biotechnology
History of marine biology, bioecochemical cycles, food chain and food web. Marine Pollution biology indicators (marine micro algae) biodegradation & bioremediation, marine fouling and corrosion Importance of coastal aquaculture, marine fishery resources, Medicinal compound from marine flora and fauna, marine toxin, antiviral and antimicrobial agents.

Unit 2: Medical Biotechnology
Cancer Biology - treatment of cancer-chemo therapy, radio therapy, immunotherapy and gene therapy. Gene therapy, barriers to gene delivery, overview of inherited and acquired diseases for gene therapy; Retro and adeno virus mediated gene transfer; Liposome mediated gene delivery. Cellular therapy; use of stem cells.

Unit 3: Pharmaceutical Technology
Pharmacogenetics and pharmacokinetics: absorption, distribution, metabolism and excretion of drugs. New therapeutic strategies and delivery systems: Transdermal delivery system, liposomes, peptide and protein delivery, glycoprotein administration, gene therapy and RNA interference.

Unit 4 : Nanobiotechnology
Concept of Nano-biotechnology & Historical background. Overview application and method of microbial nano-particle production with reference to Bacteriorhodopsin. DNA-Protein Nanostructures : Oligonucleotide-Enzyme conjugates. DNA conjugates of binding proteins. Non-covalent DNA-Streptavidin conjugates. DNA-Protein conjugates in microarray technology

Unit 5: Environmental Biotechnology
Environmental management and Impact Assessment. Overview on Environmental Pollution, Microbiology of degradation of Xenobiotics: Degradation of hydrocarbons, substituted hydrocarbons, oil pollution and surfactants. Bioremediation of contaminated soils, Biotechnology intervention in waste water treatment. solid wastes management: composting, vermiculture, mushroom cultivation and biogas production.

References

1. Recent advances in marine biotechnology volume 3 - M. Fingerman, R . Nagabhushanam Mary - Frances Thomson.
2. Bradach, J.E., H.H. Ryther and W.D. MC Larney, Aquaculture, farming and husbandry and fresh and marine organisms, Wiley lnterscience, New York. 1972.
3. Stickney, R.R., 2000. Encyclopedia of Aquaculture. John Wiley Sons Inc. pp. 1063.
4. Judit Pongracz and Mary Keen, Medical Biotechnology 1st Edition, Elsevier Publications,2008.
5. S. N. Jogdand Medical Biotechnology 2nd Edition Himalaya Publishers 2008.
6. Jawetz, Melnuk and Adelgerg, Medical Microbiology, Appleton & Lange Pub 1971.
7. Medical pharmacology, K.D.Tripathi.
8. Katzung, B.G.Basis and clinical pharmacology, Prentice Hall of International
9. Pharmacology and Therapeutics-Satoskar
10. Novel drug delivery system - Y. W. Chein.
11. Nanobiotechnology: Concepts, Applications and Perspectives, Christof M. Niemeyer (Editor), Chad A. 12.Mirkin (Editor) , Wiley Publishers, April 2004.
12. Nanotechnology, William Illsey Atkinson, JAICO Publishing House, Second Impression-2008.
13. Wastewater Engineering - Treatment, Disposal and Reuse. Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi.
14. Environmental Biotechnology, M. H. Fulekar, CRC Press, 2010

BIOSEPARATION

Objectives: To provide knowledge on the importance and techniques on downstream processing.

Outcome: The students will have the ability to understand the basics of downstream processing and different techniques utilized for the processing.

Unit 1: Introduction to downstream processing

Requirement of Downstream Processing Basic concepts of separation Technology, Overview of a bioprocess including upstream and downstream processing, Importance of downstream processing in biotechnology, characteristics of biological molecules, New Separation process in modern biotechnology; Separation characteristics of proteins and enzymes – size, stability & other biological properties; Selection of purification methodologies, Characteristics of fermentation broth & its pretreatment.

Unit 2: Biomass removal

Biomass Removal and Disruption Biomass removal and disruption: Cell disruption by Mechanical and non mechanical methods, Chemical lysis, Enzymatic lysis, physical methods, Sonication, Types of Homogenizers, Centrifugation; Sedimentation; Flocculation.

Unit 3 Product isolation

Product Isolation Liquid - liquid extractions, Precipitation (salt, pH, organic solvent, high molecular weight polymer). Separation of particulate by filtration, Rotary Vacuum Filtration, Centrifugation & Ultracentrifugation (Batch, continuous, basket), settling, sedimentation, decanting; Electrophoresis.

Membrane based purification of bio product using Microfiltration, Ultrafiltration, Reverse osmosis (UF and RO); Dialysis; Electrodialysis; Diafiltration; Pervaporation; Perstraction,

Unit 4: Separation by Adsorption

Separation by Adsorption and Chromatography Types of adsorption; adsorbents types, their preparation and properties, Chromatography: general theory, partition coefficients, zone spreading, resolution and plate height concept and other chromatographic terms and parameters; chromatographic method selection; selection of matrix; separation based on size, charge, hydrophobicity and affinity: Gel filtration, Ion exchange chromatography, Affinity chromatography, IMAC chromatography; Covalent chromatography; Reverse phase chromatography (RPC) and hydrophobic interaction chromatography (HIC), HPLC, role of HPLC in protein characterization; Chromatofocussing; Polishing of Bioproducts by Crystallization of small and large molecules, drying and Formulations.

Unit 5: Case Studies

Case Studies Baker's yeast, Ethanol, Power alcohol, Citric acid, Intracellular proteins, Penicillin, Streptomycin, Insulin, Casein, interferon, Large scale separation and purification of E.coli, yeast, Recombinant products.

Texts/References:

1. E L V Harris and S. Angal, Protein Purification Methods, Ed. IRL Press at Oxford University Press, 1989. 2. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley- Interscience Publication, 1988.
3. J. E. Bailey and D. F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, Mc-Graw Hill, Inc., 1986.
4. Seperation, Recovery and Purification in Biotechnology, Aenjo J.A. and J.Hong
5. Priniciples of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)
6. Comprehensive Biotechnology" Vol.2 Ed.: M. Moo-Young (1985) 7. Biotreatment, Downstream Processing and Modeling" (Advances in Biochemical MASTER OF TECHNOLOGY IN Biotechnology CURRICULUM & SYLLABUS 2
7 Engineering /Biotechnology, Vol 56) by T. Schepler et al, Springer Verlag
8. Chromatographic and Membrane Processes in Biotechnology" by C.A. Costa and J.S. Cabral, Kluwer, Academic Publisher
9. Downstream Processing" by J.P. Hamel, J.B. Hunter and S.K. Sikdar, American Chemical Society
10. Protein Purification" by M.R. Ladisch, R.C. Wilson, C.C. Painton and S.E. Builder, American Chemical society ,Verlag
11. Protein purification: Principle and practice, third edition, Robert k. Scopes, Springer, editor: Charles R. Cantor
12. Physical Biochemistry: David Friefelder, 5th Ed, PHI 13. Guide to protein purification: Methods in enzymology, volume 182

BIOINFORMATICS

PREAMBLE:

This course introduces students the basics of computers and networks and elaborates about biological databases, sequence and structure analysis and molecular phylogenetics. At the end of the course, students can understand and perform sequence and structural analysis using various tools and software in bioinformatics.

Unit 1: INTRODUCTION

Computer Hardware, Computer networks, Types of networks, Internet, Internet Protocols, Search engines, Operating systems, Scope and applications of bioinformatics, Bioinformatics resources: NCBI, EBI, RCSB, ExPASy.

Unit 2: BIOLOGICAL DATABASES

Introduction to databases -Biological databases- Classification of biological databases- Primary and Secondary databases, Sequence and structure databases, Specialized databases- Various file formats for bio-molecular sequences: GenBank, FASTA, GCG, MSF- Data submission and Information Retrieval from biological databases.

Unit3: SEQUENCE ANALYSIS

Definition of terms: Homology, Similarity and Identity, Sequence alignment- Local and global alignment, Pair wise sequence alignment, multiple sequence alignment, Dot Plots, Dynamic programming, Substitution matrices- PAM and BLOSSUM, Database similarity searching -FASTA and BLAST, Protein signatures.

Unit4: PHYLOGENETIC ANALYSIS

Molecular Evolution and Molecular Phylogenetics, Phylogenetic tree, Forms of Tree Representation, Rooted and un-rooted trees, Phylogenetic Tree Construction Methods: Distance based methods- NJ, UPGMA, Character based methods –Maximum Parsimony, Phylogenetic programs

Unit5: STRUCTURAL BIOINFORMATICS

Basics of Protein structure, Protein structure visualization and comparison, Secondary structure prediction- Chau-Fasman, GOR, Protein tertiary structure prediction- Homology modeling, Threading and Fold recognition.

TEXT BOOK:

1. JinXiong– Essential Bioinformatics – Cambridge University Press – 2006 (1st Edition).

REFERENCES:

1. Lesk, A. M – Introduction to Bioinformatics – Oxford University Press – 2003 (1st Edition).
2. Baldi, P., Brunak, S – Bioinformatics, The Machine Learning Approach – MIT press – 2008 (2nd Edition).

PRACTICAL 3

Animal & Plant Biotechnology, Applied Biotechnology, Bioseparation and Bioinformatics

L	P	T	C
0	4	0	2

1. Preparation of media for animal tissue culture
2. Preparation of metaphase chromosomes from cultured cells
3. Isolation of DNA and demonstration of apoptosis of DNA laddering
4. Gene expression in *E.coli* and analysis of gene product
5. Handling of lab animals (Mice, Zebrafish, Earthworm, *C.elegans*)
6. Study of embryonic induction during development in chick
7. Initiation of mammalian cell culture and maintenance.
8. Growth studies by viable cell count analysis
9. Effect of growth factors on cell proliferation
10. Preparation of media for plant tissue culture
11. Induction of Callus tissue
12. Agrobacterium mediated transformation (Carrot, Tobacco)
13. Hairy root culture
14. Mechanical isolation of protoplast.
15. Enzymatic isolation of protoplast and culture
16. Pairwise alignment
17. Multiple alignment
18. Phylogenic tree construction
19. Protein structure viewing – RASMOL, AUTODOCK, SWISS PDB VIEWER

Elective Subjects

Clinical Trials and Management

Preamble

This course provides a basic understanding of drug development processes and various phases of clinical trials. This course will also help in gaining an understanding of good clinical practice and various regulatory bodies and their regulationsin conducting clinical trials. A detailed description of managing clinical data and international clinical trials are also included in this course.

Unit 1: DEVELOPING NEW DRUGS, BIOLOGICS, AND DEVICES

The Drug Development Process - Pre-Clinical Studies –Various phases of Clinical Trials- Application to Market New Drugs and Biologics - Developing New Devices - Post marketing Surveillance of Drugs, Biologics, and Devices

Unit 2: GOOD CLINICAL PRACTICE AND THE REGULATIONS

Guidelines - - Principal Investigator Responsibilities - Sponsor Responsibilities - Sponsor-Investigators - FDA Guidance Documents - Informed Consent and the Regulations - Institutional Review Boards - Monitoring, Audits, and Inspections

Unit 3: PROTOCOL, FEASIBILITY AND ACTIVITY STUDIES

Common Components of a Protocol - Study Organization - Objectives/Endpoints - Study Design - Statistical Aspects - Subject Data and Record Retention – Monitoring - Study Start-up Phase - Study Maintenance Phase - Study Completion and Close-Out Phase.

Unit 4: MANAGING CLINICAL TRIAL DATA

Guidelines and Regulations Regarding Clinical Trial Data - Study Site Responsibilities Regarding Clinical Trial Data - Source Document Verification of Clinical Trial Data - Confidentiality of Clinical Trial Data - Endpoint Adjudication

Unit 5: GLOBAL HEALTH AND INTERNATIONAL TRIALS

International Clinical Trials - Ethnic and Racial Differences - Ethical Issues and Cultural Sensitivities - Importance of International Trials - HIV/AIDS – Malaria – Tuberculosis – Polio - International Regulations - Future Efforts

Text Book:

1. Liu, M.B. and Davis, K., Clinical trials manual from the Duke Clinical Research Institute: lessons from a horse named Jim., John Wiley & Sons, Ltd., 2nd Edition, 2010.
2. Gallin, J.I. and Ognibene, F.P. Johnson.L. Principles and Practice of Clinical Research, Academic Press., 4th Edition, 2017

STEM CELLS AND REGENERATIVE BIOLOGY

Objectives: To provide knowledge on the stem cells and their application in healthcare system.
Outcome: The students will develop the ability to understand the difference between stem cells and other cell types along with the available techniques to study the stem cells.

Unit 1
Introduction to Stem cells
Stem cell, embryonic stem cells, embryonic germ cell, Bone marrow stem cells, Adult stem cell, Differentiation. Introduction to concepts in stem cell biology (renewal, potency, etc.). Stem cell characterizations: isolation & characterizations, markers & their identification, growth factor requirements and their maintenance in culture. Pluripotency and Reprogramming.

Unit 2
Stem Cell Development
Hematopoietic Stem Cell. Induced pluripotent stem (Ips) cell technology. Epigenetic memory in iPS cells. Epigenetic controls of stem cells. Early embryonic development. Lymphoid cell differentiation and maturation. Cell cycle regulators in stem cells. Molecular mechanisms of self-renewal, pluri/multipotency and lineage differentiation. Molecular basis of pluripotency and stem cell niche.

Unit 3
The Human Umbilical Cord
A source of stem cells. Isolation of mesenchymal stem cell (MSCs) from the umbilical cord. *In vitro*Differentiation potential of Umbilical cord mesenchymal stem cell. In vivo applications of UCSC. Cord blood stem cells transplantation: Advantages and disadvantages. Cord blood banking.

Unit 4
Embryonic Cell Utilization
Generation and Manipulation of Mouse Embryonic Stem Cells. Generation and Manipulation of Human Embryonic Stem Cells. Animal Models of Regeneration (Hydra, Planaria, Earthworm, Zebra fish, etc).

Unit 5
Cancer Stem Cell
The origin of cancer stem cells, the impact of cancer stem cell concept on cancer therapy. Epigenetics and Reprogramming in Stem Cell Biology. Stem Cell Gene Therapy. Stem cell therapy for neurodegenerative diseases. Stem cell therapy for cardiac regeneration. Clinical cell transplantation for leukemia. Ethical issues associated with stem cell biology.

References
1.Regenerative Medicine and Cell Therapy (HosseinBaharvand, Nasser Aghdami. 2012).
2. Principles of Regenerative Medicine 2nd Edition (Anthony Atala, Robert Lanza, James A. Thomson &Robert Nerem. 2010).
3. Stem Cells (Anna Wobus& Kenneth Boheler. 2008).
4. Essentials of Stem Cell Biology 2nd Edition (Robert Lanza, 2009).
5. KursadTurksen, Adult and Embryonic Stem Cells, Humana Press.
6. Carlson, B. M. (2007). Principles of Regenerative Biology. Elsevier Inc.. pp. 400. ISBN 978-0-12-369439-3.
7. Reddien, P. W.; Alvarado, A. S. (2004). "Fundamentals of planarian regenerations". Annual Review of Cell and Developmental Biology 20: 7250757.
8. Reya, T; Morrison, SJ; Clarke, MF; Weissman, IL (2001 Nov 1). "Stem cells, cancer and cancer stem cells." Nature 414 (6859): 105-11.
9. Heppner, GH; Miller, BE (1983). "Tumor heterogeneity: biological implications and

therapeutic consequences". Cancer metastasis reviews 2 (1): 5-23.

Molecular Virology

Preamble

To create a thorough knowledge about viruses, its structural architecture, therapeutic application and its study at molecular and genomic level.

Unit 1 Introduction to Virology

Viruses - History of Virology - classification of viruses - living host system - Cell culture methods - serological/immunological methods - Ultra structural studies - viruses in other organisms - sub viral agents.

Unit 2 Viral Architecture

Function and formation of virus particles - virus architecture - enveloped virus - complex virus structure - helical and icosahedral capsids. Virus receptors: recognition and binding. Protein - nucleic acid interactions and genome packaging. Tools used for virus structure research.

Unit 3 Genomic Studies and Replication

Structure and complexity of virus genome - virus genetics - virus mutants - genetic and non genetic interaction between viruses - positive and negative strand RNA viruses - reverse transcription and transposition. Virome - evolution and epidemiology. Virus replication - overview and replication cycle.

Unit 4 Pathogenesis

Mechanisms of Cellular Injury - Viruses and Immunodeficiency - Virus-Related Diseases - Bacteriophage and Human Disease - Cell Transformation by Viruses - Interferons - Evasion of Immune Responses by Viruses

Unit 5 Viruses as Therapeutics

Virus - Host Interactions - Prevention and Therapy of Virus Infection - RNA Interference - Viruses as Therapeutics - Chemotherapy of Virus Infections.

References

1. Principles of Molecular Virology- 5th edition, Alan Cann.
2. Fundamentals of Molecular Virology- 2nd edition, Nicholas H. Acheson.
3. Molecular Virology of Human Pathogenic viruses- Wang-Shick Ryu.
4. Molecular Virology: Molecular and Medical Aspects of Disease-Causing Viruses of Man and Animals - Yechiel Becker.
5. Principles of Virology: Molecular Biology, Pathogenesis, and Control- L. W. Enquist, S. Jane Flint and V. R. Racaniello.

BIOSENSORS

Objectives of the Course : This course helps to understand the use of biomolecues as recognition elements for detection of a particular analyte and the use of biological elements such as proteins in place of silicon chips.

Outcome: The students will have the ability to understand the concepts of biosensor and how it can be used for the benefits of the biosphere

Unit 1: Introduction

What are Biosensors? Advantages and limitations, various components of biosensors. Desired characteristics of biosensors: reliability, simplicity, cost, and related parameters. operating conditions, calibration, positive and negative controls, safety requirements of a biosensor

Unit 2: Types of Biosensors

Biocatalysis based biosensors, bioaffinity based biosensors & microorganisms based biosensors, biologically active material and analyte. Types of membranes used in biosensor constructions.

Unit 3: Transducers In Biosensors

Various types of transducers; principles and applications - Calorimetric, optical, potentiometric / amperometric conductrometric/resistormetric, Piezoelectric, semiconductor, impedimetric, mechanical and molecular electronics based transducers. Chemiluminiscene - based biosensors.

Unit 4: Application And Uses Of Biosensors I

Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food

Unit 5: Application And Uses Of Biosensors II

Low cost- biosensor for industrial processes for online monitoring; biosensors for environmental monitoring.

REFERENCE:

1. Brian R Eggins - Biosensors an Introduction , First edition (1996), John Wiley & Sons Publishers.
2. Loic J. Blum, Pierre R Coulet - Biosensors Principles and Applications, First edition (1991), Marcel Dekker,Inc,.
3. Donald G. Buerk - Biosensors Theory and Applications, First Edition (1993), Technomic Publishing. Co, Inc,.
4. Aboul - Enein, H. V., Stefan, R. and Van Staden, (1999) Chemiluminiscence - based biosensors - An overview crit Rev. Anal. Chem. 29, 323-331.
5. Pearson, J.E. Gill, A., and Vadgama, P. (2000) Analytical aspects of biosensors Ann Clin Biochem 37, 119-145.

SEMESTER IV

4.1 RESEARCH METHODOLOGY AND BIOSTATISTICS

L	P	T	C
4	0	4	4

Unit 1: 10 Hrs

Computer Fundamentals-OS, Types of OS, Services and Components of OS, Computer Networks, LAN, MAN, WAN, Internet and WWW, E-mail, Introduction to Word processing package, Introduction to Spreadsheet package-Features and functions of spreadsheet, Introduction to Presentation and Photo editing Tools - Features and functions.

Unit 2: 10 Hrs

Research: Meaning – Purpose- Types of research- Steps in Research: Identification, selection and formulation of research problem. Formulation of hypothesis- types of hypothesis and testing of the hypothesis. Literature Survey: sources of information- Primary, Secondary, Tertiary sources – journals, reviews, books, monographs etc. bibliography. Web resources-E-Journal, Journal access, TOC alerts, Citation index, Impact factor, H-Index, E-Consortium, UGC infonet, E-Books, Internet discussion groups and communities, Scirus, Pubmed, Google Scholar, ChemIndustry, Wiki Databases, Science Direct, SciFinder, Scopus

Unit 3: 10 Hrs

Research proposal: Purpose and scope, Sponsor identification, format, Proposal development, structure of research proposal-style of write up. Research Report: Types of reports,Technical report, Popular report, Contents-Styles of reporting- Steps in drafting reports, Editing the final draft, Evaluating the final draft.

Unit 4: 10 Hrs

Scientific papers, Short communication, Research articles, Review articles, book reviews; justification for scientific contributions, bibliography, description of methods, conclusions, the need for illustration, style, Synopsis, Thesis writing. Presentations: Oral and Poster, publications of scientific works in journals, proceedings and chapters in book, Plagiarism.

Unit 5: 10 Hrs

Brief description and tabulation of data and its graphical representation, Measures of central tendency and dispersion: mean, median, mode, range, standard deviation, variance. Idea of two types of errors and level of significance, tests of significance (F & t test); chi-square tests. Simple linear regression and correlation, Computer - Oriented Statistical Techniques and various statistical software and its applications- SPSS, SAS. Frequency table of single discrete variable, Bubble sort, Computation of mean, variance and standard deviation; t-test, correlation coefficient

References:

1. Dawson, Catherine, 2002, Practical Research Methods, New Delhi, UBS Publishers'Distributors
2. Kothari, C.R.,1985, Research Methodology- Methods and Techniques, New Delhi,

Wiley Eastern Limited.
3. Kumar, Ranjit, 2005, Research Methodology-A Step-by-Step Guide for Beginners,(2nd.ed.),Singapore, Pearson Education.
4. Thesis and Assignment writing - Anderso J.berry H.D. & Poole M. Wiley Eastern Limited, New Delhi.
5. Davis, G.B. and C.A. Parkar 1997. Writing the doctoral dissertation. Barrons Educational series, 2nd edition, Pp 160. ISBN : 0812098005.
6. Duncary, P.2003. Authoring a Ph.D. thesis: how to plan, draft, wirite and finish a doctoral dissertation. Plagrave Macmillan, Pp256. ISBN 1403905843.
7. Krathwohl, D. R. (1993). How to prepare a research proposal. (3rd edition). Syracuse, NY: Syracuse University Press.
8. Fundamentals of Computers by Rajaraman, Prentice Hall India Pvt. Limited
9. Microsoft Office Word 2007: Complete Concepts and Techniques by Gary B. Shelly, Thomas J. Cashman, Misty E. Vermaat, Cengage Learning Inc.

MOLECULAR THERAPEUTICS (e-PG Pathshala)

UNIT-I

Ethics in Biomedical Research, Biosafety and biocontainment I , Biosafety and Biocontainment II, Animal models in metabolic and infectious diseases, Animal models in molecular therapeutics, Animal handling and experimentation, Research Inference and variousStatical procedures, Biostatistics in research Part I, Biostatistics in research Part II

UNIT-II

Basics of Molecular Therapeutics Part I, Basics of molecular therapeutics II, Basics of molecular therapeutics III, Fundamentals of Gene Therapy, Gene editing, Gene regulation and Gene Silencing,Nutri genomics the latest trends, Cellular and Molecular aspects of stem cells, Nuclear Reprogramming in Molecular Therapeutics, Vaccines and vaccinology I, Vaccines and Vaccinology II

UNIT-III

Identification of Drug Targets and screening of inhibitors/modulators, Molecular mechanisms of pathogenesis, Basics of biotherapy/bioimmunotherapy, Cellular therapy , Antibody therapeutics, Cytokine therapy

UNIT-IV

Biology of viral diseases, Biotherapy for viral diseases, Biotherapy of cancer , Biotherapy of bacterial diseases, Biology of fungal diseases, Biotherapy of fungal diseases, Biology of protozoan diseases, Biotherapy of protozoal diseases

UNIT-V

Cancer Stem Cell, Recombinant protein therapeutics, Opioid peptide biotherapeutics, Basics of Cancer Biology, Basics of mammalian Cell Culture Techniques, frontiers in human genome.

***Extra Departmental Course** (EDC)

BIOINFORMATICS: ALGORITHMS AND APPLICATIONS

NPTEL Online Course:

PROF. MICHAEL GROMIHA
Department of Biotechnology, IIT Madras

COURSE PLAN

Week 1 : Introduction, DNA sequence analysis, DNA Databases

Week 2 : Protein structure and function, protein sequence databases, sequence alignment

Week 3 : PAM matrix, Global and local alignment, BLAST: features and scores

Week 4 : Multiple sequence alignment, Conservation score, phylogenetic trees

Week 5 : Protein sequence analysis, hydrophobicity pro_les, non-redundant datasets

Week 6 : Protein secondary structures, Ramachandran plot, propensity, secondary structure prediction

Week 7 : Protein tertiary structure, Protein Data Bank, visualization tools, structural classi_cation, contact maps

Week 8 : Protein structural analysis, protein structure prediction

Week 9 : Protein stability, energetic contributions, database, stabilizing residues, stability upon mutations

Week 10 : Protein folding rates, proteins interactions, binding site residues

Week 11 : Computer aided drug design, docking, screening, QSAR

Week 12 : Development of algorithms, awk programming, machine learning techniques, applications using WEKA

GENETIC ENGINEERING: THEORY AND APPLICATION

NPTEL Online Course:

PROF: VISHAL TRIVEDI

COURSE: EDC

COURSE PLAN:

Week 1**:** Introduction and Basics of Biological System.

Week 2**:** Basics of Biological System

Week 3**:** Basics of Cloning (Part I)

Week 4**:** Basics of Cloning (Part II)

Week 5**:** Recombinant DNA Technology (Part I)

Week 6**:** Recombinant DNA Technology (Part II)

Week 7**:** Product Recovery and Characterization

Week 8**:** Biotechnology in Social Welfare

Week 9: Lab Demo related to the molecular biology protocols

Week 10: Lectures by industry people- Bio pharma industry, real life experience

Week 11: Latest cutting edge technology for Genome editing.

Week 12: Conclusion