ADIKAVI NANNAYA UNIVERSITY

UNIVERSITY COLLEGE OF SCIENCE & TECHNOLOGY

RAJAMAHENDRAVARAM - 533296

DEPARTMENT OF BIOTECHNOLOGY

M.Sc BIOTECHNOLOGY SYLLABUS

(W.e.f 2019-2020 A.B)

PROGRAM STRUCTURE
(2019-20 Admitted batch onwards)

S.No	Course Code	Title	Total Marks	Internal Exam Marks	Sem-End Exam Marks	Teaching Hours/ week	Credits
SEMESTER I							
1		Cell Biology	100	25	75	4	4
2		Biomolecules	100	25	75	4	4
3		Microbiology	100	25	75	4	4
4		Analytical Techniques	100	25	75	4	4
LAB COURSE							
5		Cell Biology lab	50	12	38	3	2
6		Biomolecules lab	50	12	38	3	2
7		Microbiology lab	50	12	38	3	2
8		Analytical Techniques lab	50	12	38	3	2
SEMESTER II							
9		Molecular Biology	100	25	75	4	4
10		Enzymology	100	25	75	4	4
11		Immunology	100	25	75	4	4
12		Bioinformatics and Biostatistics	100	25	75	4	4
LAB COURSE							
13		Molecular Biology lab	50	12	38	3	2
14		Enzymology lab	50	12	38	3	2
15		Immunology lab	50	12	38	3	2
16		Bioinformatics and Biostatistics lab	50	12	38	3	2
SEMESTER III							
17		Cell culture Technology and Tissue Engineering	100	25	75	4	4
18		Plant Biotechnology	100	25	75	4	4
19		Animal and Aquaculture biotechnology	100	25	75	4	4
20		Medical and Environmental Biotechnology	100	25	75	4	4

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LAB COURSE							
21		Cell culture technology and Tissue Engineering lab	50	12	38	3	2
22		Plant Biotechnology lab	50	12	38	3	2
23		Animal and Aquaculture Biotechnology lab	50	12	38	3	2
24		Medical and Environmental Biotechnology lab	50	12	38	3	2
SEMESTER IV							
25		Industrial Biotechnology	100	25	75	4	4
26		Genetic Engineering and Gene Transfer Techniques	100	25	75	4	4
27		Proteomics and Genomics	100	25	75	4	4
28		Bioethics, IPR and Research Methodology	100	25	75	4	4
LAB COURSE							
29		Industrial Biotechnology lab	50	12	38	3	2
30		Genetic Engineering and Gene Transfer Techniques lab	50	12	38	3	2
31		Proteomics and Genomics lab	50	12	38	3	2
32		Bioethics, IPR and Research Methodology lab	50	12	38	3	2
33		Comprehensive Viva-voce	100				4

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PROGRAM OUTCOME

On Successful completion of the programme, the student will be able to:

- Acquire knowledge on various aspects of plant, animal, microbial, health and environmental biotechnology with more emphasis on hands-on experience in the laboratory setting
- Gain insight about biotechnological applications such as primitive fermentation processes developed in the nineteenth century to the principles of genetically modified microorganisms in the current time
- Understand the transgenic technology which enabled development of disease resistant lines for achieving higher yields and this knowledge prepares students in direction of improving agricultural crops
- Get domain knowledge in medical biotechnology aspects for producing therapeutic drugs such as human insulin by Recombinant DNA (R-DNA) technology, gene therapy, molecular diagnosis by ELISA and PCR for early detection of pathogens
- Understand the embryonic stem cell technology for treating genetic diseases and also about monoclonal antibodies that are being used to treat many ailments such as cancer at present
- Deal with environmental biotechnology aspects such as in managing the environmental pollution, through biotechnological applications including bioremediation, and energy production from waste etc.
- Prepare for the future challenges by developing biotechnological tools for the protection of human race from emerging bacterial and viral infections

CAREER OPTIONS:

Upon completion of the program, the students will:

- Find career options in both private and government sector as scientists and research personnel and in any research and development laboratories
- Grab opportunities in biopharmaceutical companies like Biocon, Serum Institute of India, Biocon, Panacea Biotech, Dr. Reddy's Laboratories
- Excell as Microbiologists in the top companies like Pfizer, Bharat Biotech International and as biotech specialists in health care industry
- Find jobs in life science companies like Reliance Life sciences, Ranbaxy Laboratories

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Mapping of Courses having focus on Employability / Skill Development / Course Possess Entrepreneurship

S.No	Title	Does the Course Provides Employability	Does the Course Provides Skill Development	Does the Course Provides Entrepreneurship
1	Cell Biology	√	.....	.....
2	Biomolecules	√	.....	.....
3	Microbiology	√	.....	.....
4	Analytical Techniques	√	.....	.....
5	Molecular Biology	√	.....	.....
6	Enzymology	.....	.....	√
7	Immunology	√	.....	.....
8	Bioinformatics and Biostatistics	.....	.....	√
9	Cell culture Technology and Tissue Engineering	.....	√	.....
10	Plant Biotechnology	.....	√	.....
11	Animal and Aquaculture biotechnology	.....	.....	√
12	Medical and Environmental Biotechnology	.....	.....	√
13	Industrial Biotechnology	.....	√	.....
14	Genetic Engineering and Gene Transfer Techniques	.....	√	.....
15	Proteomics and Genomics	√	.....	.....
16	Bioethics, IPR and Research Methodology	√	.....	.....
	LAB COURSE			
1	Cell Biology lab	√	√	.....
2	Biomolecules lab	√	√	.....
3	Microbiology lab	√	√	.....
4	Analytical Techniques lab	√	√	.....
5	Molecular Biology lab	√	√	.....
6	Enzymology lab	√	√	.....
7	Immunology lab	√	√	.....
8	Bioinformatics and Biostatistics lab	√	√	.....
9	Cell culture technology and Tissue Engineering lab	√	√	.....
10	Plant Biotechnology lab	√	√	.....
11	Animal and Aquaculture Biotechnology lab	√	√	.....
12	Medical and Environmental Biotechnology lab	√	√	.....
13	Industrial Biotechnology lab	√	√	.....
14	Genetic Engineering and Gene Transfer Techniques lab	√	√	.....
15	Proteomics and Genomics lab	√	√	.....
16	Bioethics, IPR and Research Methodology lab	√	√	.....
17	Comprehensive Viva-voce	√	√	.....

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SEMESTER – I
COURSE-I
CELL BIOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome:
By the end of the course, the students will be able to:

- Acquire basic knowledge on structures and functions of prokaryotic and eukaryotic cells to the students
- Have focuse on the detailed study of structure, composition, functional role of cell organelles and their components in the physiological processes, cell cycle and cell division
- Understand the structural organization and the role of cellular components in the living organisms
- Understand metabolic activities of the cell for genetic engineering of cells inorder to develop new transgenic cells

Students upon completion of this course will find opportunities as cell biologists and scientists in cell culture laboratories

Unit I:
Structure of a typical cell, Differences between prokaryotic and eukaryotic cells; Structural organization and functions of nucleus, endoplasmic reticulum, golgi complex, lysosomes, vacuole, microbodies, ribosomes.

Unit II:
Structural organization and chemical composition of cell membrane, symmetry of the membrane; membrane fluidity; membrane structure models, membrane transport - active transport; active transport of Na^+ K^+ (Sodium potassium ATPase) Ca^{2+} (Ca^{2+}-ATPase); active transport of sugars coupled to phosphorylation; Passive transport - anion exchange proteins; Donnan membrane equilibrium, group translocation (γ-Glutamyl cycle).

Unit III:
Mitochondria - Structural organization, composition and functions; mitochondrial respiratory chain; mechanism of oxidative of phosphorylation; Chloroplast - Structural organization, composition, components and functions of chloroplast.

Unit IV:
Cell cycle – phases and events of cell cycle; Cell division - Mechanism of mitosis and meiosis; Regulation of cell cycle - Molecular events including cell cycle check points and CDK – cyclin complexes, tyrosine kinases; Programmed cell death - apoptosis.

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Suggested Reading:

1. EDP de Robertis and EMF de Robertis (2017). "Cell and Molecular Biology", 8th edition
2. Lodish Baltimore L (1999). "Cell and Molecular Biology". 4th edition, W.H.Freeman & Co Ltd
3. GM Cooper and Hausman (2013). "The Cell, A molecular Approach", 6th edition (Ed), Sinauer Associates Inc, India
4. B.Alberts etal. (2014). "Molecular Biology of the Cell". 6th Edition. Garland publications incorporation, USA
5. J. Darnell, (1990). "Molecular Cell Biology", 2nd Edition. Scientific American Books.USA
6. P.K.Gupta (2005). "Cell and Molecular Biology", 5th Edition, Rastogi Publ. India

SEMESTER – I
COURSE-II
BIOMOLECULES

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: The course aims to provide the students:

- A fundamental knowledge on macromolecules such as proteins, carbohydrates, lipids and nucleic acids in the living system
- An overview on the structure, classification, physicochemical properties and biological role of macromolecules
- Knowledge of classification, structure and functions of nucleic acids and their biological role
- A deep understanding about lipids, their derivatives, importance
- Acquaintance on basic of biomolecules, their importance in the cellular functions and their role in nature and understand every aspect of biological systems at the molecular level

Students after this course completion will find opportunities as biochemists in medical labs and in pharma industries

Unit I:

Chemical foundations and chemical bonding of biology;Amino acids – classification, structure and physicochemical properties, Peptide bond – structure; Proteins – classification, structural organization, physicochemical properties;Isolation, purification, sequence determination and characterization of proteins; biological functions of proteins; Denaturation & renaturation of proteins.

Unit II:

Carbohydrates–classification, structure and physicochemical properties, biological importance; Monosaccharides, Oligosaccharides and Polysaccharides; carbohydrate derivatives and glycoconjugates.

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Unit III:

Lipids – classification, biological importance;fatty acids– classification, structure physicochemical properties; Structureand biological roles of triglycerides, phospholipids, sphingolipids, cholesterol, lipid derivatives and lipid conjugates.

Unit IV:

Nucleic acids – classification, structure - nucleotides, purine and pyrimidine bases physicochemical properties of nucleic acids, biological role ; DNA and RNA – structure and types; nucleosome and chromatin formation; DNA – histone interactions; DNA denaturation and renaturation kinetics –Tm, Cot curve and C-value paradox.

Suggested Reading:

1. Nelson.D.L, Cox. M. M. (2017). "Lehninger's Principle of Biochemistry". 7th Edition. W H Freeman, , USA

2. Murray. R.K, Granner.D.K, Mayes. P. A, Rodwell. V. W. (2012). "Harper's Biochemistry" , 28th Edition, McGraw Hill publications.

3. Donald Voet. (2017). "Fundamentals of Biochemistry, Life at the Molecular Level". 5th Edition, Wiley publications, USA

4. West, E.S., Todd (1966). Textbook of Biochemistry Mason &Vanbruggen, 4th Edition, Macmillian&Co., New York

5. LubertStryer. (2019). "Biochemistry", 9th edition WH Freeman publications.

SEMESTER – I
COURSE-III
MICROBIOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: The course aims to help the students to:

- Understand basic aspects of microorganisms and their culture techniques, microbial nutrition, growth characteristics, reproduction cycles
- Learn about important groups of microorganisms including actinomycetes and different viruses including their life cycles, growth patterns and their control
- Gain deep insight about various microbial diseases including their sourse, symptoms, diagnosis and prevention.
- Acquaint with microbiological activities and advanced research aspects in the field of microbiology

Students can find jobs as microbiologists and as scientists in vaccine production industries such as in serum insttitue of India, Bharat Biotech etc.

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Unit I:
History and Scope of Microbiology; Classification and taxonomy – morphological, physiological and metabolic, ecological, genetic analysis and molecular characterizations; Characteristics and importance of Archaebacteria, Actinomycetes, Eubacteria, Pseudomonads, cyanobacteria, mycoplasma; Bacterial cell - Structural components and their functions; Gram positive and Gram negative bacteria.

Unit II:
Modes of nutrition – phototrophy, chemotrophy, methylotrophy, organotrophy, mixotrophy, saprophytic, symbiotic and parasitic modes of nutrition; Sterilization techniques – Physical, chemical and radiation; Culture media – types, batch and continuous cultures, chemostat; Microbial Growth curve and kinetics, Direct and Indirect methods of microbial growth; Effect of pH and temperature on microbial growth; Preservation of cultures (glycerol stocks, freeze drying).

Unit III:
Virus - morphology, characteristics and life cycle (ØX174, t4, HIV, Rota virus); Methods of culturing of viruses; Biology of subviral agents – Viroids, Prions, Satellite viruses; Antiviral agents- chemical and biological agents; Inactivation of viruses – photodynamic inactivation; Yeasts – morphology, characteristics and reproduction; Molds –morphology, characteristics and reproduction.

Unit IV:
Microbial diseases – Source, Symptoms, Diagnosis and Prevention – bacterial infections (Cholera, Typhoid, Hepatitis B, tuberculosis), viral infections (Polio, Rabies, small pox, HIV), fungal infections (systemic mycoses, candidiasis), protozoan diseases- Malaria, Trypanosomiasis).

Suggested Reading:

1. Willey, Sherwood and Woolverton (2007). "Prescot's Microbiology" 7th Edition, McGraw-Hill Science Engineering
2. Gerard J. Tortora, Berdell, R. Funke, ChristineL. Case (2014). "Microbiology: An Introduction". 12th Edition, Benjamin Cummings, Pearson Publishers
3. Pelczar MJ, Chan ECS, and Krieg NR (1986). "Microbiology". 5th Edition, McGrew-Hill, New York
4. R.C.Dubey and D.K. Maheswari (2012). "ATextbook of Microbiology", Revised Edition, S.Chand Publishers, New Delhi
5. F M.Frebisher (1974). "Fundamentals of Microbiology" 9th edition, Thomson Learning

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SEMESTER – I
COURSE-IV
ANALYTICAL TECHNIQUES

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end of this course, the students will have the knowledge of:

- Basic aspects of instrumentation and applications of various biophysical teachniques used for analysis of biomolecules
- Different techniques such as microscopy, spectroscopy, X-ray diffraction, flow cytometry, centrifugation, electrophoresis, chromatography, radioisotopes and electrochemistry
- Practical experience in handling the instruments associated with various analytical techniques
- Biophysical and biochemical properties of the cells and molecules revealed through advanced instrumentation technology

After completing this course, students can find opportunities in R&D labs and pharma industry

Unit I:
Microscopy- Principles and applications of light, phase contrast, fluorescence, scanning and transmission electron microscopy; Properties of electromagnetic radiations; Principles, instrumentation and applications of UV, visible, infrared, NMR spectroscopy; Spectrofluorimetry and mass spectrometry, X-ray diffraction; Flow cytometer.

Unit II:
Chromatography - Principles and applications of gel-filtration, ion-exchange and affinity chromatography, TLC, GLC and HPLC. Centrifugation - Basic principles of sedimentation. Types of centrifuges. Applications of preparative and analytical ultra-centrifuges.Principle and applications of lyophilization.

Unit III:
Electrophoresis - General Principle of electrophoretic techniques, Poly Acryl amide Gel Electrophoresis, Isoelectric focusing, Isotachophoresis, 2-D Electrophoresis, Capillary electrophoresis, Agarose gel electrophoresis of DNA and RNA. Blotting techniques.

Unit IV:
Stable and radioactive isotopes. Detection and measurement of radioactivity. Applications of radioisotopes in biological sciences, Autoradiography, Non-isotopic tracer techniques. Principles and range of electrochemical techniques. Principles and applications of Ion-selective and gas sensing electrodes, Operation of pH electrodes and Oxygen electrodes.

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Suggested Reading:

1. Keith Wilson and John Walker (2010). "Principles and Techniques of Biochemistry and Molecular Biology". 7th edition, Cambridge Univeristy press
2. Upadyay, Upadyay and Nath (2016). "Biophysical chemistry principles and techniques" Himalaya publishing.
3. B.L Williams and Keith Wilson (1979). "A Biologists guide to Principles and techniques of practical Biochemistry". 2nd Edition, London
4. Rodney Boyer (2001). "Modern experimental Biochemistry 3rd Edition, Pearson Education., USA

I SEMESTER PRACTICALS

Cell Biology Lab

1.Microscopic observation of cell tissues
2.Observation of stages of mitosis and meiosis
3.Mitosis in onion root tip cells by Squash method
4.Arrest and observation of chromosomes after colchicine treatment in onion roots
5.Blood smear preparation and identification of cells
6.Total RBC count
7.Separation of cell organelles

Biomolecules Lab

1.Qualitative analysis of proteins
2.Quantitative analysis of proteins
3.Qualitative analysis of carbohydrates
4.Quantitative analysis of carbohydrates
5.Qualitative analysis of lipids.
6.Quantitative analysis of nucleic acids.

Microbiology Lab

1.Introduction to sterilization techniques.
2.Preparation of liquid and solid media for growth of microorganisms.
3.Isolation of Bacteria from soil –serial dilution technique.
4.Simple Staining, acid fast staining, spore staining, Grams staining.
5.Biochemical tests for bacteria.
6.Pure culture techniques-streakplate, spread plate and pour plate.
7.Bacterial growth curve.

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Analytical Techniques Lab

1.Microscopic examination.
2.Spectroscopic determination of nucleic acids and proteins.
3.Separation of biomolecules by Paper chromatography and Thin Layer Chromatography
4.Subcellular fractionation by differential centrifugation.
5.Polyacrylamide gel electrophoresis of proteins.
6.Qualitative determination of nucleic acids by agarose gel electrophoresis.
7.Preparation of buffers and pH determination by pH meter.

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SEMESTER – II
COURSE-I
MOLECULAR BIOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: Upon completion of the course, students should be able to:

- Understand the central dogma of life and learn different DNA replication and repair mechanisms
- Post transcriptional, RNA processing, its importance, translation process, post translational modifications and mechanism of protein synthesis
- How to develop diagnostic applications to identify gene defects and gene related problems
- The importance of enzymes in gene expression, genetic code concept and significant differences between prokaryotic and eukaryotic systems interms of protein synthesis mechanism
- Molecular diagnosis of viral diseases and understand cloning, DNA complications and genome editing etc.

Students after completing this course will work as molecular biologists, research scientists in molecular diagnostic labs and industries

Unit I:

Models of DNA Replication Origin and direction of replication, Semi discontinuous replication, DNA polymerases of prokaryotes and their mechanism of action, Primase, Ligase, Single strand DNA binding protein, Helicase, Topoisomerases, Replication strategies for replicating circular DNA:φ mode replication,σ mode or rolling circle replication and D-loop replication; Inhibitors of replication.

Unit II:

DNA Repair mechanisms, Photoreactivation, Excision Repair mechanism,Postreplication repair mechanisms-recombination repair, mismatch repair system, SOS response, transcription-repair coupling. Recombination-models of general recombination; Holliday model, asymmetric strand transfer model, double strand break repair model, site-specific recombination; Transposition of DNA; Transposable elements, Prokaryotic transposons, Eukaryotic transposons, Retroposons.

Unit III:

Prokaryotic RNA polymerase, Conserved sequences of prokaryotic promoters, Initiationof transcription, Chain elongation, Chain termination, Eukaryotic RNA polymerases, Conserved sequences of eukaryotic promoters, Transcriptional factors and basal eukaryotic transcription complex, Enhancers, Transcriptional termination in eukaryotes, Post transcriptional processing ofpre-mRNA-additionofCaptothe5'end,Polyadenylation tothe3'end, mechanism of

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intron removal and exon splicing, Processing of r-RNA, Self-splicing of introns, Processing of tRNA, Inhibitors of RNA synthesis.

Unit IV:

General features of genetic code, Structural components of prokaryotic and eukaryotic ribosomes, Mechanism of protein synthesis in prokaryotes and eukaryotes –aminoacylation of tRNA, protein synthesis-initiation, elongation and chain termination, Protein synthesis inhibitors, Post translational modifications of proteins.

Suggested Reading:

1. Lehninger (2017). "Principles of Biochemistry", David L.Nelson, Michael M.Cox 7th Edition, W.H. Freeman & Co
2. Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, and James D Watson (2002). "Molecular Biology of the Cell" 4th Edition, Garland Science, New York
3. Donald Voet, Judith G.Voet (2010). "Biochemistry", 4th Edition, John Wiley & Sons
4. Watson (2017). "Molecular Biology of the gene", 7th edition, Pearson Education, USA
5. Harvey Lodish, David Baltimore, Molecular Cell Biology, 4th Edition, W.H. Freeman Publisher. 2000
6. D Friefelder (2014). Molecular Biology, 2nd Edition, Narosa Publishing House

SEMESTER – II
COURSE-II
ENZYMOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end of the course, the students will acquire and understand:

- The basic knowledge on biochemical catalysts, the crucial molecules involved in homeostasis among the cellular processes and functions in the biological system to the students
- The structure, nomenclature, classification and characteristic properties of enzymes, their activity, mechanism of action with substrates and their regulation.
- Kinetics of enzymes and helps the students to further explore novel enzymes in nature.
- Isolation, characterization and purification of enzymes from a biological source, which paves a platform for students to work in several research laboratories, medical field and food industries.

Successful completion of this course will provide the students to work as biochemists in industry, enzyme experts in pharma, Application specialists, Experts in Enzyme technology, Food industry etc.

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Unit I:

Enzymes - Classification, nomenclature, properties, assay, Units of enzyme activity; Factors affecting enzyme activity; Enzyme – substrate complex formation by Fisher and Koshland models, Active site mapping, Modern concepts of evolution of enzyme catalysis.

Unit II:

Enzyme kinetics - Michaelis – Menten equation, Lineweaver - Burk, Eadie – Hofstee and Hanes plots, Significance of Vmax, Km, Kcat, specificity constant (Kcat/Km); Kinetics of multisubstrate reaction - Rate expression for non-sequential (ping-pong) and sequential (ordered and random) mechanisms, Enzyme inhibitions – competitive, non-competitive, uncompetitive inhibition, irreversible inhibition, Determination of KI values.

Unit III:

Enzyme catalysis – General acid – base, electrostatic, covalent, metal – ion catalysis, Proximity and orientation, Mechanism of reaction catalyzed by chymotrypsin, carboxypeptidase, lysozyme, ribonuclease; Mechanism of catalysis with coenzymes – pyridoxal phosphate, flavin nucleotides, thiamine pyrophosphate, biotin.

Unit IV:

Enzyme regulation – Allosteric enzymes (ATCase), Symmetric and sequential models of allosteric enzymes and their significance; Feedback inhibition and feed forward stimulation, Isoenzymes – Lactate Dehydrogenase, Multienzyme complex systems – Pyruvate dehydrogenase complex; Methods for isolation and purification of enzymes.

Suggested Reading:

1. Palmer T., Bonner P (2007). "Enzymes" 2nd Edition, Woodhead Publishing
2. Alan Fersht, (1984). "Enzyme structure and mechanism". 2nd Edition, W. H. Freeman & Co Ltd, New York
3. Khan M.Y., Khan Farha, (2015). "Principles of enzymology technology:, Eastern Economy Edition, PHI Learning Pvt Ltd, Bangalore
4. Colowick and Kaplan, (2013). "Methods in enzymology" 1st Edition, Academic Press, USA
5. Segel IH (1993). "Enzyme kinetics": 1st Edition, Wiley Interscience, India

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SEMESTER – II
COURSE-III
IMMUNOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: After completing the course, the students will be able to:

- The fundamental knowledge on the components of immune system and the mechanisms of their action involved in immune response against pathogenic infections.
- Understand various immunotechniques associated with antigen – antibody interactions, hybridoma technology and vaccine development, which gives scope on therapeutic and diagnostic areas.
- Apply them in the manufacture of monoclonal antibodies, genetically engineered vaccines and decipher drugs for autoimmune and immunodeficiency disorders
- Understand various therapeutic aspects, and help them develop pharmaceutical drugs inorder to avert disorders and diseases

Students after completion of the course can get placed as Faculty, Research fellows and Project Fellows/Associates in various National / State level research institutes of Immunology and molecular biosciences

Unit I:

Types of immunity – Innate and adaptive; Antigens – properties, Haptens, Adjuvants; Immunoglobulins – structure, types and biological activities; Theories of antibody diversity; Organs of the immune system - Thymus, bone-marrow, spleen, lymph node.

Unit II:

Cells of Immune system - T and B lymphocytes – Origin, activation, differentiation, characteristics and functions; Humoral and cell-mediated immune responses - Immunological memory and immune tolerance; Antigen presenting cells - Processing and presentation of antigens, Major Histocompatibility Complex and its role in immune response.

Unit III:

Antigen-antibody interactions - Precipitation reactions – single immunodiffusion, double immunodiffusion, immunoelectrophoresis; Agglutination reactions - Heme agglutination; complement fixation - components and activation; Immunofluorescence, RIA, ELISA, Immunoblotting, Hybridoma technology - production of monoclonal antibodies and their applications; Vaccines- production of conventional and recombinant vaccines.

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Unit IV:

Hypersensitivity: immediate (type I, type II, type III and type V) and delayed hypersensitivity (type IV); Immunodeficiency diseases – SCID and AIDS; Autoimmunity - organ specific (Hashimoto's thyroiditis) and systemic (Rheumatoid arthritis) diseases; Tissue transplantation – types, graft rejection and graft acceptance, immunosuppressive agents.

Suggested Reading:

1. Delves PJ, Martin, SJ, Burton DR and Ivan M. Roitt (2013). "Essential immunology" 13th Edition, Wiley Blackwell
2. John W.Kinball (1986). "Introduction to Immunology". Revised Edition, Macmillan, USA
3. D.M. Weir and Stewart (1997). "Immunology". 8th Edition, Churchill Livingstone Publisher
4. Punt J, Stanford S, Jones P and Owen JA (2018). "Kuby Immunology". 8th Edition, WH Freeman, UK

SEMESTER – II
COURSE-IV
BIOINFORMATICS & BIOSTATISTICS

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: The course aims to help students understand:

- The basic bioinformatics tools and explains the importance and introduces them to the applications of computational methods in Biology.
- How to retrieve information from different biological databases by bioinformatic approaches.
- The biostatistical concepts, statistical tools to work with biological data and understand about the data by using tests of significance Chi-square test and ANOVA.
- And get trained in bioinformatics and biostatistics which paves a platform for research studies on field data.

Students find jobs as Bio-statisticians, Data scientists in Bioinformatics industry, ICMR instittues as Project Scientists and may also get an opportunity in computational drug designing fields and pharmaceutical industries

Unit-I

Scope of computers in current biological research. Basic operations, architecture of computer. Introduction of digital computers. Organization, low level and high level languages, binary number system. The soft side of the computer – Different operating systems – Windows, Linux. Introduction of programming in C. Introduction to Internet and its applications.

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Unit-II

Introduction to Bioinformatics, Genomics and Proteomics. Bioinformatics – Online tools and offline tools. Biological databases; An overview of types of biological databases – NCBI, EMBL, Gen bank, Swiss prot, and PDB. Database searching using BLAST and FASTA. Human Genome Project.

Unit-III

Sequence alignment-Introduction and significance of sequence alignments. Pair wise and Multiple sequence alignment. Gene and Genome annotation – Tools used. Physical map of genomes. Protein secondary structure prediction. Protein 3D structure prediction. Protein docking. Introduction to homology modeling, Computer Aided Drug Design (CADD) in Drug discovery. Molecular phylogeny - Concept methods of tree construction.

Unit-IV

Brief description and tabulation of data and its graphical representation. Measures of central tendency - mean, median, mode. Measures of dispersion- range, variance, standard deviation. Simple linear regression and correlation. Types of errors and level of significance. Tests of significance – t- test, Chi-square test, ANOVA.

Suggested Reading:

1. Stephen Misener & S.A. Krawez. (2000). "Bioinformatics Methods and Protocols", 1st Edition, Humana Press,
2. R. Durbin, S. Eddy, A. Krogh & G. Mitchson. (2002) Biological sequence analysis. 7th Edition, University Press, Cambridge
3. C.P. Freidman & J.C. Wyatt, (1997) Computers and machine: Evaluation methods in Medical information. Springer Verlag, New York.
4. M.J. Bishop & Rawling, (1997) DNA and Protein structure analysis: A Practical approach. Oxford University Press.
5. Mount DW (2004). "Bioinformatics – "Sequence and Genome Analysis" 2nd Edition, Cold Spring Harbor Laboratory Press, U.S
6. Arthur M.Lesk (2013). "Introduction to Bioinformatics". 4th Fourth Edition, Oxford University Press, Oxford.
7. Mahajan and Srimathi (2018). "Methods in biostatistics". 9th Edition. Jaypee brothers Medical Publishers,
8. PSS Sundar Rao & J Richard. (2012). "An introduction to biostatistics and Research methods" 5th Edition, PHI Learning, New Delhi

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SEMESTER- II PRACTICALS

Molecular Biology Lab

1.Isolationof DNAfrombacterial,plantandanimalcells.
2.IsolationofRNA fromyeastcells.
3.Estimationof DNA and RNA by UV absorption method and determination of purity of nucleicacids.
4.Agarosegel forRNA,DNA,blotthegel
5.Determination of sugar and phosphate ratios in DNA and RNA samples.
6.Determination of melting Temperature(Tm)of DNA.

Enzymology Lab

1.Assay of Amylase from saliva
2.Assay of Acid phosphatase from potato
3.Effect of substrate concentration on enzyme activity
4.Time course effect on enzyme activity
5.Effect of pH on enzyme activity
6.Effect of temperature on enzyme activity
7.Isoenzymes of LDH – electrophoretic separation and specific staining technique-demonstration

Immunology Lab

1.Determination of A, B, O and Rh blood groups in human beings
2.Diagnostic test for typhoid fever
3.VDRL Test
4.Bleeding time and clotting time
5.Total WBC count
6.Radial Immunodiffusion
7.Rocket immunoelectrophoresis- demonstration
8.Enzyme Linked Immuno Sorbent Assay (ELISA)- demonstration

Bioinformatics and Biostatistics Lab

1.Searching Data from NCBI Database.
2.Working on EMBL.
3.Searching structural data from PDB.
4.Genome Map viewer from NCBI.
5.Database search using BLAST.
6.Sequence alignments.
7.Measures of dispersion- Standard deviation
8.Correlation coefficient calculation
9.Tests of significance - one way ANOVA.

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SEMESTER – III
COURSE-I
CELL CULTURE TECHNOLOGY AND TISSUE ENGINEERING

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: Upon successful completion of the course, the students will be able to:

- Work with both plant and animal cultures including understanding of behaviour of cells under invitro conditions such as somaclonal variations and their applications in plant breeding experiments
- Acquire an understanding of application of different tissue culture techniques such as micropropagation, organogenesis and regeneration of plant cells and importance of tissue culture to the students.
- Understand theoretical and practical aspects of plant and animal cell cultures and to prepare students capable to maintain animal cells and tissues for different biological applications

Students after completion of this course work as associate scientists in cell culture technology companies like Syngene and Danaher etc. In addition, they can work in State, Central research organizations as Research personnel

Unit-I

Plant tissue culture technology: culture media – composition and preparation. Factors governing *in-vitro* behaviour, Somatic embryogenesis, organogenesis and plant regeneration. Culture types. Micro propagation, Haploids, somaclonal variations. Isolation of protoplasts, protoplast fusion and culture.

Unit-II

Animal cell and tissue culture. Primary culture, balanced salt solutions and simple growth medium. Cell lines, primary and established cell line cultures. Basic techniques of mammalian cell culture *in vitro*. Production and use of artificial tissues and organs – Skin, liver and pancreas. Apoptosis-Mechanism and significance.

Unit-III

The biology of stem cells – types of stem cells – embryonic stem cells- isolation and propagation, fetal tissue stem cells, adult stem cells; stem cell differentiation. chimeras; generation of knock-out mice and knock-in technology.

Unit-IV

Hematopoietic stem cells and bone marrow transplantation: Cells for hematopoietic reconstitution – Cord blood stem cells; bone marrow transplantation - advantages and disadvantages. Clinical applications of stem cell therapy; neurodegenerative diseases – Parkinson's disease, Alzheimer's disease.

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Suggested Reading:

1. Bhojwani S.S (2003). "Plant tissue culture – theory and practice". Revised Edition Elsevier publications, Netherlands
2. Dixion R.A (1985). "Plant cell culture – A practical approach". Oxford University Press
3. R.I.Freshney. (1995). "Culture of Animal cells". Wiley – online
4. John R.W.Masters (2000). "Animal Cell Culture – A Practical approach". 3rd Edition, Oxford University Press, Oxford
5. Street, HE (1977) Plant tissue and cell culture, 2nd Edition, Oxford, Blackwell Scientific
6. Audet, Julie, Stanford and William (2009). "Stem cells in regenerative medicine" (Springer), Humana press

SEMESTER – III
COURSE-II
PLANT BIOTECHNOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: The course aims to provide to the students the required knowledge:

- For developing transgenic plants using different gene transfer techniques and understand about gene cloning in plant biotechnology.
- To become familiar with molecular markers and their applications in crop improvement programs. In addition, they will also become familiar with development of disease resistant, insect resistant and herbicide resistant cultivars in plants.
- To introduce quality traits in plants. They will also understand about large scale production of algae, bio- fertilizers and biopesticides and applications in agriculture

Students after completion of this course can work as Scientists, Scientific Officers in State and Central agricultural institutes like CTRI, NBPGR and as JRF and Project Scientists in ICRISAT in funded projects by DBT and DST, and also in private seed companies like DOW, Dupont, Bayer, Mahyco seeds, Corteva etc.

Unit-I

Plant Genetic engineering: Gene cloning, Gene transfer techniques in plants - Mechanism of gene transfer by TI and RI plasmids as vectors. Reporter genes, transient gene assays and identification of transgenic plants. Molecular markers and their significance. RFLP, AFLP, SSR, SNP and QTL in plants. RAPD for molecular mapping and crop improvement. Genome Editing - CRISPR

Unit-II

Agricultural Biotechnology: Engineering of herbicide tolerance in plants, production of disease resistant plants by gene transfer; Development of insect resistant plants. Biotechnological strategies for engineering abiotic stress tolerance - Drought and Salinity

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Unit-III

Altering protein and oil quality traits in seeds. Chloroplast transformation – advantages in tobacco and potato plants for expression of bacterial, viral and eukaryotic genes. Edible vaccines and plant antibodies. The genetic manipulation of crop yield by enhancement of photosynthesis.

Unit-IV

Algal Biotechnology: Laboratory culture of micro algae. Large scale biomass production. Marine micro algae/sea weeds and their products. Edible sea weeds and their cultivation. Biofertilizers – Blue green algal fertilizers – Azolla, Anabaena, symbiotic association. Sea weed fertilizers. Mycorrhizal biofertilizers, bacterial fertilizers. Biopesticides in agricultural production.

Suggested Reading:

1. A. Slater, N.W. Scott and M.R. Fowler (2008). "Plant Biotechnology, the genetic manipulation of plants", 2nd Edition, Oxford University press, Oxford
2. Swaminathan, M.S (2000). "Biotechnology in Agriculture" Mc. Milllan India Ltd, New Delhi
3. Copping LG and P.Rodgers (1986). "Biotechnology and its applications to Agriculture", British Crop Projection, Intl Specialized Book Service
4. Kung, S.and C.J.Arntzen (1989). "Plant Biotechnology", 1st Edition, (Butterworths)
5. Bansal PB (2007). "Biotechnology and its applications in Agricultral Science, Gene-Tech Books Publisher

SEMESTER – III
COURSE-III
ANIMAL AND AQUACULTURE BIOTECHNOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end of the course, it aims to enlighten the students:

- About the areas such as invitro fertilization in humans and cattle, artificial insemination, embryo transfer techniques etc.
- On advanced research areas like stem cells and cloning and become familiar with production of transgenic animals - mice and fish and be familiar with various legal and ethical aspects of animal cloning
- To gain deep understaning about biotechnology application in aquaculture including fresh, brakish and marine habitats and understand about bioactive compounds and pearl culture technology
- About transgenic fish production, induced breeding techniques, learns about different fish viral bacterial diseases and their management in the aquaculture practices

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Students after completion of this course work as Project Assistant, JRF, SRF and RA in central institutes like NDRI, NIAB and also as hatchery managers and technicians in aquaculture industry, however they can also start aqua and water quality testing labs on their own.

Unit-I

Types and causes of male and female infertility, sperm collection, Cryopreservation, artificial insemination, Oocyte recovery, superovulation, oocyte maturation *in-vitro*, *In-vitro*fertilization in humans and cattle. Embryo culture, embryo transfer in farm animals. Immunocontraception - hormonal methods. Biotechnological approaches for the management of pests, mosquitoes and nematodes.

Unit-II

Production of transgenic animals - mice and fish. Molecular pharming and animal cloning. Somatic cell nuclear transfer in humans – Legal and ethical aspects. Potential applications of transgenic animals – Animal models for diseases and disorders.

Unit-III

The role of biotechnology in aquaculture. Economically important aquatic resources from fresh water, brackish water and marine habitats – the finfish, shellfish, algae, corals and holothurians. Aquaculture - Fresh water fish culture practices and types. Brackish water shrimp culture practices. Bioactive compounds from corals. Pearl culture technology – principles and applications.

Unit-IV

Hypophysation and induced breeding techniques in finfish. Eyestalk ablation. Techniques involved in transgenic fish production. Genome manipulation in fish - Gynogenesis, Androgenesis and Polyploidy. Hormonal manipulation of sex in fishes. Diagnosis of shrimp & fish diseases caused by bacterial, fungal and viral pathogens using molecular methods. Vaccines - DNA vaccines application in aquaculture.

Suggested Reading:

1. PK Gupta (2010). "Elements of Biotechnology. 2nd Edition, Rastogi & Co, New Delhi
2. Keshav Trehan (2002). "Biotechnology", New Age International (P) Limited, New Delhi
3. Balasubrahmanian et al(2005). "Concepts in Biotechnology". Revised edition, University press, Hyderabad
4. TVR Pillay Kutty MN. (2005). "Aquaculture: Principles and practices of aquaculture", 2nd Edition, Blackwell publishing
5. Santhanam. R. and Ramanathar, N and Jagatheesan G, (1990). "Coastal aquaculture" C.B.S. Publishers, New Delhi
6. Srivatsava CBL and Srivastava S (2006). "A Text of Fishery science and Indian fisheries" Mahal, India
7. Lakra. W S et al., (2008). "Fisheries Biotechnology" 1st Edition, Narendra Publishing house, New Delhi
8. Jhingran, V.G. (1991). "Fish and Fisheries of India". 3rd Edition, Hindustan Publishing Co., Delhi

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SEMESTER – III
COURSE-IV
MEDICAL AND ENVIRONMENTAL BIOTECHNOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end of the course, the students will gain:

- Skills and knowledge on the health care products like insulin, growth hormone by using recombinant DNA Technology and vaccines for various viral infectionsB
- Knowledge in disease diagnosis, genetic diseases, gene therapy and approaches for development of vaccines to deadly diseases
- The knowledge in Environmental Pollution, Bioremediation, and energy production from waste
- Substantial knowledge to students to pursue their career in the field of medicine as research personnel including scientists

Students after completion of this course can work as biotechnologists in food, agriculture, bioremediation and human health sector

Unit-I

Health care products. Products from recombinant DNA Technology - insulin, growth hormone, factor VIII, tissue plasminogen activator, interferons, lymphokines and Hepatitis- B vaccines.

Unit-II

Disease diagnosis: DNA probes, Enzyme probes - glucose oxidase, lactate oxidase, onoamine oxidase. PCR amplification and diagnosis - Applications in forensic medicine. Genetic diseases and gene therapy. Current strategies for development of vaccines against HIV, Malaria, Tuberculosis.

Unit–III

Environmental pollution – types, sources and control. Reduction of environmental impact of industrial effluents, chemical herbicides and fertilizers. Removal of oil spills. Environmental monitoring and biomonitoring. Bioremediation - solid and liquid waste treatment. Biomass and energy production from waste. Bioleaching – Microbial recovery of metals and acid mine drainage. Water pollution and its control. Microbiological approach of waste water treatment.

Unit-IV

Environment and energy: Renewable sources of energy – Biogas, waste materials, energy crops, cellulose. Production of energy and fuel using microorganism – Biofuels and Biodiesel. Global environmental problems: Ozone depletion, UV-B, Green house effect. Biodiversity - benefits to mankind - Conservation; Ecology and sustainable development.

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Suggested Reading:

1. BD.Singh (2014). "Biotechnology". 4th Edition, Kalyani publishers, New Delhi
2. PD Sharma, (2011). "Ecology and Environment", 3rd Edition, Rastogi publications
3. Odum, EP (2004). "Fundamentals of Ecology", 5th Edition, (Mc Graw Hill)
4. U. Satyanarayana (2020). "Biotechnology" (Books & Allied (P) Ltd).

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SEMESTER-III PRACTICALS

Cell Culture Technology and Tissue Engineering Lab

1.Preparation of media for plant tissue culture (MS and B5).
2.Establishment of callus cultures from carrot cambial tissue.
3.Establishment of cell cultures and plating.
4.Embryo culture of maize/ Crotalaria.
5.Organogenesis and regeneration of plants from tobacco explants.
6.Anther culture and production of haploids.
7.Micropropagation using suitable system: Potato / Solanum

Plant Biotechnology Lab

1.Isolation of genomic DNA from dicot and monocot plants.
2.Qualitative and quantitative analysis of plant genomic DNA
3.Amplification and cloning of a plant gene
4.Mapping of a plant gene. Analysis of a plant gene sequence using Clone Map Software
5.Western analyses of expressed plant protein.
6.*Agrobacterium* mediated plant transformation/Preparation of compotent cells
7.*Agrobacterium* Co-cultivation method
8.Strip test/dipstick test for GMO detection

Animal and Aquaculture Biotechnology Lab

1.Preparation of animal cell culture media and membrane filtration.
2.Preparation of single cell suspension from spleen and thymus.
3.MTT assay for cell viability and growth.
4.Demonstration of sections of human ovary, testis and aborted human embryos.
5.Identification of some commercially important aquatic species.
6.Estimation of water quality parameters: Dissolved Oxygen, Alkalinity, Hardness
7.Identification and partial characterization of fish and shrimp pathogens.
8.Fish Pituitary hypophysation- Demonstration
9.PCR diagnosis of WSSV-Demonstration

Medical and Environmental Biotechnology Lab

1.Estimation of dissolved oxygen
2.Estimation of salinity in water samples.
3.Estimation of Chemical Oxygen Demand (COD).
4.Estimation of Biochemical Oxygen Demand (BOD).
5.Determination of suspended solids in industrial effluents.
6.Removal of colour of the industrial effluents by biological methods.
7.Reduction of pollution load in effluents by biological methods (laboratory models).
8.PCR - demonstration.

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SEMESTER – IV
COURSE-I
INDUSTRIAL BIOTECHNOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: The course aims to provide to the students:

- An understanding of commercial manufacturing of organic solvents, recombinant proteins, antibiotics, vitamins, amino acids, enzymes etc.
- The applications of biological and engineering principles to problems involving microbial, mammalian and biological or biochemical systems.
- The current knowledge in biological and biochemical technology.
- The work of the attendees in pharmaceutical and non-pharmaceutical industries especially in the production section of the units of various drugs
- The work in quality control and quality assurance departments of various pharmaceutical industries and Biotech R&D departments

Students after completion of this course will have opportunities as quality control and quality assurance department of vaccine and pharma industries

Unit-I

Heterologous Expression: Expression vectors and hosts Generally Regarded As Safe (GRAS) organisms. Large Scale Production of active recombinant proteins of prokaryotes, Eukaryotic and mammalian. Principles of microbial growth, Principle and Types of Fermentation, Design and Types of Bioreactors

Unit-II

Downstream processing: Harvesting microbial cells – Membrane filtration system, high speed semi continuous centrifugation – disrupting microbial cells. Gram scale purification of recombinant proteins – Chromatography systems and analytical methods for large scale purification. Stabilization of the proteins, Crystallization of proteins

Unit-III

Processing technology: Microbial metabolites - Organic solvents (Alcohol, Acetone, Butanol), Organic acids (Citric acid, lactic acid), Wines and beers, Antibiotics (penicillin, streptomycin, semi synthetic penicillins), Vitamins (Vitamin B12 and Riboflavin), Amino acids (glutamic acid). Production of single cell proteins.

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Unit-IV

Enzyme technology: Production and purification of enzymes for the industrial use. Application of enzymes in pharmaceutical, food processing and other industries. Whole cell immobilization - Techniques of Enzyme immobilization and applications. Design and operation of immobilized enzyme systems and bioreactors. Biosensors - principle and types.

Suggested Reading:

1. Rehem H.-J, and Reed G, (1993). "Biotechnology: Biotechnology Fundamentals, Volume 1, 2nd Edition.Wiley Online
2. Casida LE Jr. (2019). "Industrial Microbiology", 2nd Edition, New Age International publishers
3. Presscot and Dunn (1982). "Industrial Microbiology". 4th edition, Palgrave Macmillan
4. Messing RA (1975). "Immobilized enzymes" Academic Press, New York
5. Bailey and Ollis (2017). "Biochemical engineering fundamentals" 2nd Edition, Mc Graw Hill, India
6. BD Singh (2021). "Biotechnology", Latest Edition, Kalyani publishers, New Delhi
7. Wulf Crueger (2017). "Cruegers Biotechnology: A Textbook of Industrial Microbiology" , 3rd Edition, Medtech publisher
8. G. Reed, (2004). "Prescott & Dunn's Industrial Microbiology" 4th edition CBS Publishers, India

SEMESTER – IV
COURSE-II
GENETIC ENGINEERING AND GENE TRANSFER TECHNIGQUES

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: By the end of the course, the students will gain the knowledge on:

- The basic aspects of genetic engineering and gene transfer techniques including transformation and transfection and, applications of genetic engineering in agriculture, animal husbandry and medicine.
- The importance of molecular biology techniques such as PCR and its applications in diasease diagnosis such detection of other viral infections.
- Gene annotation and gene identification. Students expertise with course will find career as research scientists in pharma and agriculture sectors.

Students after completing this course will find opportunities in medicine, research, industry and agriculture sectors and transforming microbes such as bacteria and yeast, metabolic engineering jobs, and pharma industry, R-DNA technology based companies

Unit-I

Isolation of DNA and RNA. Restriction mapping, DNA sequencing by chemical and enzymatic methods. Nucleic acid blotting – southern and northern blotting. DNA cloning. Enzymes used in genetic engineering: Restriction endonucleases - types, nomenclature and

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properties. DNA polymerase-I, polynucleotide kinase, DNA ligase, terminal nucleotide transferase, Reverse transcriptase, alkaline phosphatase, S1 nuclease.

Unit-II

Salient features of cloning vectors, types of cloning vectors - plasmids, cosmids, phages (lamda and M13 phages), animal (SV40, Baculo) and plant (CMV) viruses, Artificial chromosomes - YACs and MACs. Ligation of foreign DNA to vectors - cohesive and blunt end methods - homopolymer tailing and adaptors. Preparation of gene libraries and c-DNA libraries .

Unit – III

Techniques of gene transfer - transformation , transfection, micro injection, electroporation, lipofection and biolistics. Selection of r-DNA clones and their expression. Nucleic acid probes, colony and fluorescent in-situ hybridization.

Unit – IV

Polymerase Chain Reaction and its applications. DNA micro array technology. Applications of genetic engineering in agriculture, animal husbandry, medicine and in industry. Genomics – genome sequencing by shot gun and hierarchical method. Genome annotation – identification of genes, promoters and exon – intron boundries

Suggested Reading:

1. Watson et. al., (1983). "Recombinant DNA technology". 2nd Edition, Scientific American Books, New York
2. Benjamin Lewin (2003). "Genes-VIII". (Oxford), Pearson, 2003, USA
3. Old and Primrose (2001). "Principles of Gene Manipulation" 6th Edition. Wiley–Blackwell
4. David A Micklos and Greg Freyer (2003). "DNA Science: A first course". 2nd Edition, Cold Spring Harbor Laboratory Press
5. Ernst–Ludwig and Winnacker (1987). "From genes to clones". Wiley VCH,
6. Jeremy W daleand Malcolm von Scrantz (2011). "From genes to genomes: Concepts and applications of DNA technology" 3rd Edition, Willey blackwell publications
7. Glick B, Paternak JJ and Cheryll (2010). "Molecular Biotechnology, principles and applications of recombinant DNA", 4th Edition, ASM Press, Washington, DC
8. Sandhya Mitra (2017). "Genetic Engineering: Principles and practice". 2nd Edition, McGraw Hill Education
9. T.A. Brown (2017), "Genomes". 4th Edition, Garland Science

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SEMESTER – IV
COURSE-III
PROTEOMICS AND GENOMICS

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: The course will provide deep understanding about:

- The basic aspects of genomics and proteomics including learned techniques of peptide sequencing, protein analysis and applications of proteomics in biology
- The protein modelling and drug discovery aspects useful for drug designing in pharma industries
- Different biological databases that store experimental data and about various bioinformatic tools
- Genome sequencing techniques and its applications in studying gene structure and function
- The skills required in applied bioinformatics, comparative genomics, evolutionary, human genomics and functional genomics
- Work in core facilities and commercial biological and medical laboratories

Students after completion of this course work as computational experts and/or biologists in drug development industry and also as computational biologist position in Institute of Bioinformatics (IOB) and stem cell research

Unit-I

Introduction to proteomics- Protein structure, function and expression. Proteome analysis: high- throughput proteome analysis with 2D- IEF. Current concepts of peptide sequencing with MS-MS methods, MALDI-TOF; Phage display, Protein chips Rational drug design, lethal mutants, Significance and applications of proteomics in biology.

Unit-II

Protein sequence Data base- Swiss-prot, Tr-EMBL, PIR, Uniprot. Structural Data bases- CATH, SCOP. Molecular Modeling-Homology modelling and docking studies (Using Molegro Virtual Docker) – RASMOL. Docking, Analysis, Constrains, Data analyser, sidechain flexibility and template docking, Drug discovery – target identification, target validation, lead identification, lead optimization, Phase I, II and III clinical trials, pharmacodynamics.

Unit-III

The human genome project. Data bases- INSD-International Nucleotide Sequence Database, Gen Bank, EMBL, DDBJ, special focus on NCBI, Sequence comparison techniques (BLAST etc). Comparative Genomics - Phylogeny, Synteny (comparison of grass genomes).

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Unit-IV

Functional Genomics - ESTs, SAGE, Shotgun libraries. Conventional sequencing (Sanger and Maxam & Gilbert methods), automated sequencing. Analysis of Single nucleotide polymorphism (SNP) using DNA chips.

Suggested Reading:

1. T. Palzkill (2002). "Proteomics", Kluwer Academic Publishers
2. Jenny Gu, P.E. Bourne (2009). "Structural bioinformatics". 2nd Edition, Wiley Blackwell publishers
3. C. Kannicht (2002). "Methods in Molecular Biology Vol 194": Posttranlational modifications of proteins: Tools for functional proteomics" Himana Press, New Jersey
4. DW Mount (2004). "Bioinformatics: Sequence and Genome analysis", 2nd Edition, Cold Spring Harbor press
5. AD Baxevanis and BFF Ouellette "Bioinformatics: A practical guide to the analysis of genes and proteins", John Wiley and Sons Inc.
6. Stephen P. Hunt and Risk Livesey, eds., (2000). "Functional Genomics: A practical approach" 1st Edition, Oxford University Press.
7. Arthur Lesk. "Introduction to Genomics". 3rd Edition, Oxford University Press,
8. A. Malcolm Campbell. (2003). "Discovering Genomics, Proteomics and Bioinformatics" Benjamin Cummings

SEMESTER – IV
PAPER-IV
BIOETHICS, IPR AND RESEARCH METHODOLOGY

Teaching hours for week	Credits	Internal marks	SEM end/ External marks	Max. marks
4	4	25	75	100

Course outcome: After completing the course the students will get introduced to:

- Professional conducting, good laboratory practices and gain better understanding about Bioethics, good manufacturing practices and laboratory accreditation.
- IPR, copyrights, acquisition of rights and patent application process, obtaining patents and development of patent law. They will also be much aware of Patent specifications – International Institutions
- Protocols in research methodology and need based research, Research project planning, design of the experiments, evaluation of results, statistical approach, validation of findings and research communications.
- How to pursue good quality research in public and private sector organizations.

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Students after completion of this course can work as Patent officers in State, Central Organizations and also haveIntellectual property lead jobs in companies like Vakilsearch etc. They can also find jobs like content writers in academic industry

Unit–I

Introduction – causes of unethical acts, ignorance of laws, policies and procedures, recognition, friendship, personal gains. Professional ethics – professional conduct Ethical decision making, ethical dilemmas Teaching ethical values to scientists, good laboratory practices, good manufacturing practices, laboratory accreditation.

Unit–II

Socio-economic and legal impacts of biotechnology, national and international guidelines, experimental protocols approval, levels of containment Use of genetically modified organisms, their release in the environment, moral and ethical issues in biotechnology, cloning, safety issues with GMO.

Unit–III

Fundamentals of IPR, Basic Principles, Copyright, Trademark, Design, Geographical indication, Acquisition of rights and remedies for infringement of these IPRs- Patent Law History, development of patent law, basic principles, criteria, novelty. Utility and non obviousness, subject matter in US, UK, drafting patent specifications – International Institutions and International instruments (WTO, WIPO, TRIPS, CBT, Paris Convention, Budapest treaty)

Unit–IV

Introduction – Basic research, applied research, need based research, Identification of the problem, defining the problem, Research project planning, Literature search – Information sources, library resources – online literature search. Design of the experimental programme – variables in the experiments, materials and methods, evolution of methods, application of methods, Progress of research – evaluation of results, statistical approach, comparison with existing methodologies, validation of findings, research communications, impact factor of journals

Suggested Reading:

1. PK Gupta (2010). "Elements of Biotechnology. 2nd Edition, Rastogi & Co, New Delhi
2. P.K. Gupta. (2000). "Environmental Biology" 1st Edition, Rastogi Publ., Meerut, India.
3. V. Sree Krishna (2007). "Bioethics and Biosafety in Biotechnology" 1st Edition, New Age International Publishers.

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IV SEMESTER PRACTICALS

Industrial Biotechnology Lab

1.Production of protease/amylase by batch fermentation.
2.Immobilization of whole cells for enzyme/antibiotic production by gel entrapment.
3.Screening of soil samples for isolation of bacteria, fungi and actinomycetes.
4.Microbial growth curve.
5.Production of alcohol by *S.cerevisiae* and its estimation.
6.Production of citric acid by *A. niger*.
7.Production of red wine from grapes.

Genetic Engineering and Gene Transfer Techniques

1.Isolation of DNA from blood
2.Isolation of RNA from yeast
3.Blotting Techniques
4.Gene transfer techniques
5.PCR applications

Proteomics & Genomics Lab:

1.Demonstrate familiarity with databases of information pertaining to genes, markers, maps
2.Diseases such as Online Mendelian Inheritance in Man (OMIM) and Medline;
3.Understanding the principles of designing oligonucleotide primers for PCR and utilization of relevant software;
4.PCR applications in assigning genotypes to RFLP / VNTR sequences;
5.Screening samples for identified mutations.
6.Immobilisation of an enzyme (amylase or invertase) and its assay.
7.Expression of an enzyme activity using a western Blotting technique.
8.Equation for substrate consumption in an immobilized cell reactor.
9.Affinity purification of Histidine Tagged proteins.
10.Expression of Eukaryotic protein in a prokaryotic system.

Bioethics, IPR And Research Methodology Lab:

1.Intellectual property and India: e filing of patents , Trademarks.
2.On line patent search.
3.Online patent register and application status.
4.Online public search for Patents, trademarks and design.
5.e filing services for designs, GI, status of patents, designs, trademarks,
6.IP Case studies.
7.WIPO online database search.

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