KARPAGAM ACADEMY OF HIGHER EDUCATION

DEPARTMENT OF BIOTECHNOLOGY

FACULTY OF ARTS, SCIENCE AND HUMANITIES

PG PROGRAM (CBCS) – M.Sc. Biotechnology

(2018–2019 Batch and onwards)

Course code	Name of the course	Objectives and Outcomes		Instruction hours / Week			Credit (s)	Marks		
		PEO´s	PO´s & PSO´s	L	T	P		CIA	ESE	Total
SEMESTER - I										
18BTP101	Biochemistry and Microbiology	I, II	a, b, c, d	4	0	0	4	40	60	100
18BTP102	Cell Biology and Molecular Genetics	I, II	a, d	4	0	0	4	40	60	100
18BTP103	Ecology, Evolutionary and Developmental Biology	I, II	a, b, c, d	4	0	0	4	40	60	100
18BTP104	Bioinstrumentation and Biostatistics	II, III	d, e, f	3	1	0	4	40	60	100
18BTP105A 18BTP105B 18BTP105C	Biodiversity, Biosafety And IPR Nano-Biotechnology Bio-energy Technology	II, IV	d, g, h	4	0	0	4	40	60	100
18BTP111	Biochemistry and Microbiology - Practical – I	II, III	d, e, f	0	0	4	2	40	60	100
18BTP112	Cell Biology and Molecular Genetics - Practical – II	II, III	d, e, f	0	0	4	2	40	60	100
Journal Paper Analysis & Presentation				2	0	0	-	-	-	-
Semester total				**21**	**1**	**8**	**24**	**280**	**420**	**700**
SEMESTER - II										
18BTP201	Recombinant DNA technology	II, III, IV	d, g, h	4	0	0	4	40	60	100
18BTP202	Fermentation and Bioprocess Technology	II, III, IV	d, g, h	4	0	0	4	40	60	100
18BTP203	Enzyme Technology	IV	g	3	1	0	4	40	60	100
18BTP204	Immunotechnology	II, III, IV	d, e, f, g	4	0	0	4	40	60	100
18BTP205A 18BTP205B 18BTP205C	Pharmaceutical Biotechnology Agricultural Biotechnology Industrial Toxicology	IV	g	4	0	0	4	40	60	100
18BTP211	Recombinant DNA, Fermentation and Bioprocess Technology - Practical – III	IV	g	0	0	4	2	40	60	100
18BTP212	Immuno and Enzyme Technology -Practical – IV	IV	g	0	0	4	2	40	60	100
Journal Paper Analysis & Presentation				2	0	0		-	-	-
Semester total				**21**	**1**	**8**	**24**	**280**	**420**	**700**

Course code	Name of the course	Objectives and Outcomes		Instruction hours / Week			Credit (s)	Marks		
		PEO's	PO's	L	T	P		CIA	ESE	Total
SEMESTER - III										
18BTP301	Plant and Animal Biotechnology	II, III, IV	d, g, h	4	0	0	4	40	60	100
18BTP302	Genomics, Proteomics and Bioinformatics	II, III, IV	d, g, h	4	0	0	4	40	60	100
18BTP303	Food Biotechnology	IV	g	4	0	0	4	40	60	100
18BTP304	Environmental Biotechnology	II, III, IV	d, e, f, g	3	1	0	4	40	60	100
18BTP305A 18BTP305B 18BTP305C	Applied Biotechnology System Biology Tissue Engineering and Regenerative Medicine	IV	g	4	0	0	4	40	60	100
18BTP311	Plant and Animal Biotechnology-Practical – V	II, III, IV	d, g, h, f	0	0	4	2	40	60	100
18BTP312	Genomics, Proteomics and Bioinformatics - Practical – VI	II, III, IV	d, g, h, f	0	0	4	2	40	60	100
Journal Paper Analysis & Presentation					0	0	-	-	-	-
Semester total				**21**			**24**	**280**	**420**	**700**
SEMESTER – IV										
18BTP491	Project and *Viva Voce*	III, IV	f, g, h, i	-	-	-	15	80	120	200
Semester total				**-**	**-**	**-**	**15**	**80**	**120**	**200**
				42	**3**	**45**	**87**	**920**	**1380**	**2300**

Elective courses*

Elective – 1 (18BTP105)		Elective – 2 (18BTP205)		Elective – 3 (18BTP305)	
Course code	**Name of the course (Theory)**	**Course Code**	**Name of the course (Theory)**	**Course Code**	**Name of the course (Theory)**
18BTP105A	Biodiversity, Biosafety And IPR	18BTP205A	Pharmaceutical Biotechnology	18BTP305A	Applied Biotechnology
18BTP105B	Nano-Biotechnology	18BTP205B	Agricultural Biotechnology	18BTP305B	System Biology
18BTP105C	Bio-energy Technology	18BTP205C	Industrial Toxicology	18BTP305C	Tissue Engineering

*Electives are Transborder / cross disciplinary / Discipline centric elective nature.

Blue – Employability **Green – Entrepreneurship** **Red – Skill Development**

PROGRAMME OUTCOMES (POs)

a) Graduates will able to have knowledge on the basic and applied theories.

b) Providing a broad educational and analytical knowledge necessary to make the students for appearing in competitive examinations

c) Ability to design and conduct experiments as well as to interpret the results.

d) An expert to work on Biotechnological concepts and allied fields (immuno, medical, microbial, Food, agricultural, environmental, plant and animal) with modern tools and techniques towards product and process development for academic, industrial and research application.

e) Generating the graduates with an ability to identify, formulate and solve to deliver process/product with professional, societal and ethical responsibilities.

f) Graduates will be able to visualize and work on multidisciplinary laboratory problems.

g) Graduates will be able to update the current knowledge of interdisciplinary subjects related to biotechnology

PROGRAMME SPECIFIC OUTCOMEs (PSOs)

To enable the student to emerge as:

h) Biotechnologist to recognize the societal need and lifelong learning.

i) Proficient to demonstrate entrepreneurial and leadership skills with life-long learning.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO I: The post-graduates of Biotechnology will able to acquire in-depth knowledge of the basic and applied subjects of Biotechnology and allied fields.

PEO II: The post-graduates of Biotechnology are equipped to design, analyze, conduct and interpret the experiments and data for the development of process/product within the realistic constraints.

PEO III: The post-graduates of Biotechnology will able to acquire the knowledge and ability to use the concept of theories, practical skills and recent technological tools in solving any technological and professional issues independently in a global and societal context.

PEO IV: The graduates of Biotechnology will continue learning to update and to become an entrepreneur in a competitive world of technology and also contribute to all forms of life.

MAPPING OF PEOs AND POs

PEOs			Programme Outcome (s)						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)
PEO I	×	×		`					
PEO II			×	×					
PEO III					×	×			
PEO IV							×	×	×

Semester – I

18BTP101 BIOCHEMISTRY AND MICROBIOLOGY 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To understand the key concepts of biomolecules and its organization
- To attain strong theoretical knowledge on three-dimensional construction of biological macromolecules and the principles of molecular recognition
- To understand the functions and importance of various biomolecules
- To inculcate knowledge on fundamentals of microorganisms
- To learn the structural organization, morphology and reproduction of microbes
- To understand the application of microorganisms in different fields of life sciences

Course Outcomes

On completion of the course, students are able to

1. Understand Biochemistry as discipline and milestone discoveries in life sciences that led to establishment of Biochemistry as separate discipline
2. Understand fundamental properties of elements, their role in formation of biomolecules and in chemical reactions within living organisms
3. Draw or describe the structure of amino acids, proteins, enzymes, chemical messengers, carbohydrates, lipids, and nucleic acid
4. Acquire basic knowledge on different structure of microbes
5. Discuss the diseases caused by microorganisms
6. Demonstrate how to control the growth of microbes

UNIT – I Introduction:

Chemical basis of life; Bonding; Theories; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Biomolecules –Structure, classifications and properties of carbohydrates, amino acids, proteins, lipids, Ribonucleic acids and deoxy-ribonucleic acids, nucleoprotein complexes.

UNIT – II Metabolisms:

Carbohydrates, lipids (fatty acid oxidation and biosynthesis), amino acids biosynthesis, nucleotides (de novo synthesis and salvage pathways). Disorders of lipid, carbohydrate, nucleic acid, amino acid metabolism. Inborn errors of metabolism. Metabolomics.

UNIT – III Bioenergetics:

TCA Cycle, glycolysis, gluconeogenesis, Pentose phosphate shunt, Embden-Meyerhof pathway, urea cycle, interconnection of pathways, Metabolic regulation, Bioenergetics: Respiratory chain, ATP cycle, energy-rich compounds.

UNIT– IV Microbial Diversity and techniques:

Diversity- Bacteria, fungi, algae - distribution, reproduction, characteristics, nutrition. Techniques - staining, Microscopy - Principle, types, applications. Microbial growth - nutrients, media, isolation, maintenance, preservation, curve, measurements, factors, regulation.

UNIT – V Applications, Diseases and control measures:

Causative agent, pathology, diagnosis, control and treatment of Bacterial - TB, Cholera and Typhoid. Protozoan – Amoebiasis and Malaria. Viral - AIDS. Control of microorganisms – drugs, chemotherapy, antimicrobial agents.

REFERENCES

1. Jain, J. L. (2002). *Fundamentals of Biochemistry* (5th ed.). New Delhi: S. Chand & Co.

2. Zubay, G.L., Parson, W.W., & Vance D.E. (1995). *Principles of Biochemistry*. (1st ed.) Oxford: MC Brown Publishers.

3. Nelson, D.L., & Cox, M.M. (2013). Lehninger: *Principles of Biochemistry* (6th ed.). New York: W.H. Freeman and Company.

4. Murray, R.K., Bender, D.A., Botham, K.M.,& Kennelly, P.J., (2012). *Harper's illustrated Biochemistry* (29th ed.). London : McGraw-Hill Medical.

5. Voet, G., & Voet, A. (2004). *Fundamentals of Biochemistry* (3 rd ed.). New York: John Wiley and Sons, Inc.

6. Black, J.G. (2002). *Microbiology Principles and Explorations*. (9th ed.) NewYork: John Wiley and Sons Publishing.

7. Prescott, L.M., Harley, J.P. & Klien, D.A. (2005). *Microbiology*. (6th ed.)Boston: NY, McGraw - Hill Publishing Company.

8. Talaro, K.P., (2009). *Foundations in Microbiology*. (8th ed.)McGraw - Hill Publishing Company, New York.

9. Pelczar, M.J., Chan, E.C.S., & Krieg, N.R. (1993). *Microbiology* (5th ed.). McGraw Hill Book Company.

Semester – I

18BTP102 CELL BIOLOGY AND MOLECULAR GENETICS 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Understand the structures and functions of basic components of eukaryotic cells, especially macromolecules, membranes, and organelles
- Understand how the cellular components are used to generate and utilize energy in cells
- Understand the cellular components underlying cell division
- To impart knowledge in genetics and genome organizations in organisms
- To understand the principles of extensions to Mendelian inheritance, including multiple allelism, lethal alleles, and gene interactions
- To obtain knowledge on normal chromosome number, structure, and behavior in human cells, and understand the cause and effect of alterations in chromosome number and structure

Course Outcomes

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

1. Describe the structures and basic components of eukaryotic cells
2. Illustrate how the cellular components are used for various cellular activities
3. Demonstrate the pathways involved in various cellular events including cell cycle
4. Understand the inheritance of genes among plants and animals and the genetic makeover as well as the physical appearance of organisms
5. Describe Mendelian inheritance, the interaction of genes among organism and to determine the inheritance of gene in human being
6. Illustrate the effect of chromosomal abnormalities in human diseases

UNIT– I Cell Organization and regulation:

Structure of prokaryotic and eukaryotic cells, Structural organization and function of intracellular organelles (Nucleus, Endoplasmic Reticulum, Golgi complex, Mitochondria, Chloroplast, Lysosomes, Peroxisomes and vacuoles, Cytoskeletons. Chromatin organization and packaging. Nucleic Acid - Replication, Types, Transcription, Post Transcriptional Modification, Translation and Post Translational modification, regulation of gene expression.

UNIT – II Regulation of Gene Expression:

Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, and ion pumps. Intracellular protein sorting- Mechanism and regulation of intracellular transport in mitochondria, chloroplast, endoplasmic reticulum and nucleus. Electrical properties of membranes. Cell cycle and its regulation, Molecular events Check points, Cyclins and protein kinases.

UNIT – III Genetics:

Mendelian and Non-Mendelian principles. Concept of gene : Allele, multiple alleles, pseudoallele, complementation tests. Genetic recombination, Genetic mapping, linkage and crossing over. Mutations- Types of Mutation, Genetic analysis of Mutations, DNA repair Mechanisms.

UNIT – IV Methods of genetic transfers:
Transformation, conjugation, transduction. mapping genes by interrupted mating, Linkage maps, tetrad analysis, mapping with molecular markers, mapping by using somatic cell hybrids. Introduction to Transposable elements – Discovery and types, Nomenclature - Insertion sequences - Mechanism – Transposons of E. coli, Bacteriophage and Yeast.

UNIT – V Microbial and Human genetics:
Gene transfer in Bacteria, Bacteriophages - properties, Structure, Role of phages as vectors. Human genetics - Pedigree analysis, linkage testing, karyotypes, genetic disorders, Eugenics. Epigenetics & Genome Imprinting. Structural and numerical alterations of chromosomes, ploidy and their genetic implications, Quantitative genetics - Polygenetic inheritance, heritability and its measurements, QTL Mapping.

REFERENCES

1. Gardner, E.J. (2001). *Principles of Genetics* (8th ed.). New York: John Wiley and Sons.

2. Karp, G. (2005). *Cell and Molecular Biology: Concepts and Experiments*. (7th ed.) London: John Wiley and Sons, Inc.

3. Maloy, S.R., Cronan, J.E., & Freifelder, D. (2006). *Microbial Genetics*. (5th ed) Sudbury:Massachusetts, Jones and Bartlett Publishers.

4. Cooper, G.M. & Hausman, R.E., (2004). *Cell : A Molecular Approach*. (5th ed.) Sunderland: Sinauer Associates, Inc.

5. Glick, B.R., & Pasternak, J.J. (2003).*Molecular Biotechnology* (3rd ed.). New Delhi: Panima Publishing Corporation,.

6. Frifielder, D. (2001). *Molecular Biology* (2nd ed.). New Delhi: Narosa Publishing House.

7. Lodish, B. (2004). *Molecular and cell biology* (5th ed.). New York: Freeman and company.

8. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2002). *Molecular Biology of the Cell* (4th ed.). New York: Garland Publishing.

Semester – I

18BTP103 ECOLOGY, EVOLUTIONARY AND DEVELOPMENTAL BIOLOGY 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Understand the principles about the evolution
- Understand the concepts about the evolution
- Understand the origin of biotic community
- Understand the problems occur in the biosphere
- Understand the significance of nature using scientific methods
- Understand the significance of Developmental Aspects Of Living Organism

Course Outcomes

On successful completion of course, students should be able to

1. Learn the fundamental principles and concepts of evolutionary theory and ecology
2. Use this knowledge to explore the evolution
3. Students will also learn basic ecological theory
4. Students will also learn principles in understanding and proposing solutions to the major environmental problems facing the biosphere
5. Describe evolutionary and ecological patterns & processes related to the survival, diversity
6. Describe relationships, distribution, abundance and interactions of organisms, their populations and environments

UNIT– I Ecological principles:

The Environment: Physical, biotic environment; interactions. Habitat and Niche: Concepts, types. Population Ecology: Characteristics, growth curves; regulation; life history strategies (r and K selection); concept of metapopulations. Species Interactions: Types. Community Ecology, Ecological Succession: Types; mechanisms; changes, concept of climax.

UNIT – II Ecosystem, Applied and conservation Ecology:

Ecosystem structure; function; energy flow and mineral cycling (C,N,P), structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine). Biogeography: Major terrestrial biomes; theory; biogeographical zones of India. Applied Ecology: pollution; global change; biodiversity: status, monitoring and documentation; major drivers, management approaches. Conservation Biology: Principles, approaches, Indian case studies on conservation/management strategy (Project Tiger, Biosphere reserves).

UNIT – III Evolutionary Biology:

Emergence, Lamarck; Darwin–concepts, Mendelism; Origin of cells and unicellular evolution: Concept of Oparin and Haldane; The first cell; Evolution of prokaryotes, eukaryotic, unicellular eukaryotes. Origins of unicellular and multi cellular organisms; plants and animals; Molecular Evolution: Concepts, tools.

UNIT – IV Population genetics:

Populations, Hardy-Weinberg Law, Speciation; Convergent evolution. Brain, Behavior and Evolution: Approaches, methods. Biological clocks; Development of behavior; Social communication; Habitat, Domestication and behavioral changes

Developmental Biology:

Concepts, determination and differentiation; morphogenetic gradients; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development

UNIT – V Gametogenesis, fertilization and early development:

Production, development in animals, plants; formation, germination or establishment in plants, animals. Morphogenesis and organogenesis in animals: Cell aggregation and differentiation Dictyostelium, Drosophila, amphibia and chick; organogenesis (*Caenorhabditis elegans*, vertebrates), development- environmental regulation of normal development; sex determination. Morphogenesis and organogenesis in plants: Organization, development and transition - shoot, root, leaf, floral in Arabidopsis and Antirrhinum

REFERENCES

1. Eugene P Odum (1996) Fundamentals of Ecology, Nataraj Publishers.

2. K.V.Krishnamoorthy (2004) An advanced Text Book of Biodiversity, Oxford &IBH, New Delhi.

3. Joshi PC and Namitha Joshi (2004) Biodiversity and Conservation, APH Publishing Company, New Delhi.

4. Melchias (2001) Biodiversity and Conservation, Oxford and IBH Publishing Company Pvt. Ltd., New Delhi

18BTP104 **BIOINSTRUMENTATION AND BIOSTATISTICS** **Semester – I** **4H – 4C**

Instruction Hours / week: L: 3 T: 1 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Understand fundamental principles of bioinstrumentation commonly used in biomedical engineering research labs and hospitals
- Comprehend the colorimetric principles
- Recognize the concepts on centrifugation and chromatography
- Obtain key knowledge on electrophoresis
- Understand key concepts on biostatistics and its various parameters
- Attain strong knowledge on the applications of biostatistics and its relevant softwares

Course Outcomes

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

1. Demonstrate an understanding the bioinstrumentation principles with respect to device design and applications
2. Identify, explain and judge safety issues related to biomedical instrumentation
3. Apply the principles in the context of bioinstrumentation interactions with tissues, organs and human body to explain the measurement results and to develop the instrumentations
4. Recognize the definition of statistics, its subject and its relation with the other sciences
5. Collect data relating to variable/variables to be examined
6. Calculate descriptive statistics from the acquired data

UNIT – I Colorimetry:

Color and absorption spectra, Beer's and Lambert's law. Principle of photoelectric colorimeter, Spectroscopy – Properties of electromagnetic radiations, Instrumentation and applications of – UV Visible light spectroscopy, Spectrofluorimeter, atomic spectroscopy, NMR spectroscopy and MALDI –TOF, Mass spectroscopy GC – MS, IR and FTIR.

UNIT – II Centrifugation:

Principle, types of centrifuges, Principles and applications of analytical- and preparative centrifuge, density gradient and ultra-centrifuge. **Chromatography:** Principles, Type – Paper, thin layer, ion-exchange, affinity, gel filtration, HPLC and HPTLC

UNIT – III Electrophoresis:

Principle, instrumentation and applications of agarose gel electrophoresis, sodium dodecyl sulphate – polyacrylamide gel (SDS-PAGE), native PAGE, isoelectric focusing, immuno, pulsefield, gel, capillary, 2D electrophoresis, gel documentation.

UNIT- IV Biostatistics:

Data collection, classification and presentation of tabulation. Measures of central tendency – mean, median and mode. Measures of dispersion – mean deviation, standard deviation, standard error and analysis of variance.

UNIT- V Applications of biostatistics:

Probability and probability distribution – theorems, binomial, poisson and normal distribution. Correlation and regression – simple correlation, correlation co-efficient, simple and linear regression analysis. Test of significance - F, t, DMRT and chi-square test. Randomized block design. Statistical and graphical software.

REFERENCES

1. Glover,T., & Mitchell, H. (2008). *An Introduction to Biostatistics*. (2nd ed.) Boston: Mc Graw- Hill Co. Inc.

2. Friedfelder,D. (2001). *Physical Biochemistry* (5th ed.). New York: Oxford Publishers.

3. Sharma, B.K. (2004). *Instrumental Methods of Chemical Analysis* (24th ed.). Meerut: Goel Publishing House.

4. Chatwal, G.R., & Anand, S.K. (2003). *Instrumental Methods of Chemical Analysis* (5th ed.). Mumbai: Himalaya Publishing House.

5. Boyer, R. (2000). *Modern Experimental Biochemistry* (3rd ed.). New Delhi: Addision Wesley Longman.

6. Sawhney, S.K., & Singh,R. (2000). *Introductory practical Biochemistry*. New Delhi: Narosa Publishing House.

7. Wilson, K., & Walker, J. (2006). *Principles and Techniques of Biochemistry and Molecular Biology*. (7 th ed.) India : Cambridge University Press.

8. Sawhney, S.K., & Singh, R. (Eds.). (2005). *Introductory Practical Biochemistry*. Alpha Science International Ltd.

Semester – I

18BTP105B **BIODIVERSITY, BIOSAFETY AND IPR** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Introduce basic concepts of biodiversity and how to conserve biodiversity
- Discuss about various aspects of biosafety regulations and IPR concerns arising from the commercialization of biotech products
- Understand balanced integration of scientific and social knowledge in sustainable development
- Attain the benefits of GM technology and related issues
- Identify and discuss the issues and concepts salient to the research process
- Recognize and discuss the complex issues inherent in selecting a research problem, selecting an appropriate research design, and implementing a research project

Course Outcomes

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

1. Apply the knowledge to protect endangered species
2. Recognize importance of biosafety practices and guidelines in research
3. Apply intellectual property law principles including copyright, patents, designs and trademarks to real problems and analyze the social impact of intellectual property law and policy
4. Comprehend the importance of protection of new knowledge and innovations and its role in business.
5. Gain more insights into the regulatory affairs
6. Demonstrate knowledge of research processes such as reading, evaluating, and developing, and to identify, explain, compare, and prepare the key elements of a research proposal and report

UNIT – I Biodiversity:

Introduction, types, Concepts. Values, uses, Measures of biodiversity. Vegetation types of India. Hotspot biodiversity areas in India, Red Listed plants and RED Data Book, Threatened plants and animals of India. Role of biotechnology; Conservation biodiversity - In situ and ex situ methods. Molecular markers and their application in plant conservation.

UNIT – II Biosafety:

Introduction; Background; Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels; Recommended Biosafety Levels, Cartagena protocol on biosafety.

Biological risk assessment: Biosafety guidelines for Genetically Modified Microorganisms (GMM) and Plants (GMP)-Risk assessment, guidelines for research activities, Guidelines for environmental release of GMM, GMP and GLP. GATT and World Trade Organizations. Establishment and functions of GATT, WTO and WIPO.WTO Guidelines and Summits. Physical and Intellectual Property. Tangible and Intangible property. Roles of IBSC, RCGM and GEAC.

UNIT – III Intellectual Property Rights:

Types of IP: Patents, Trademarks, Copyright and Related Rights. **Agreements and Treaties:** History of GATT and TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 and recent amendments.

UNIT – IV Patent application:
Rules governing patents. Patent related cases. Licensing - Flavr Savr™ tomato as a model case. Biopiracy and case studies on patents (Basmati rice, Turmeric, and Neem). Biotechnological examples of patent, trademark, trade secret, copy right. Traditional Knowledge.

UNIT – V Bioethics:
Introduction. Animal Rights. General issues related to environmental release of transgenic plants, animals and microorganisms. Ethical issues related to research in embryonic stem cell cloning. Ethical, Legal and Social Implications (ELSI) of Human Genome Project.

REFERENCES

1. Martin. M.W., & Schinzinger, R. (2003). *Ehics in engineering* (3rd ed.). New Delhi: Tata McGraw-Hill.
2. BAREACT, (2007). *Indian Patent Act 1970*. Acts and Rules, Universal Law Publishing Co. Pvt. Ltd.
3. Kankanala, C. (2007). *Genetic Patent Law and Strategy* (1st ed.). India: Manupatra Information Solution Pvt. Ltd.
4. *Biosafety issues related to transgenic crops.* DBT guidelines, New Delhi: Biotech Consortium Ltd,.
5. http://www.actahort.org/members/showpdf?booknrarnr=447_125.
6. http://www.biomedcentral.com/content/pdf/1472-6939-2-2.pdf.
7. http://www.wipo.int/portal/index.html.en.
8. http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html.

Semester – I

18BTP105B **NANO BIOTECHNOLOGY** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Obtain fundamental concepts of nanobiotechnology
- Offer a strong knowledge in the interface between chemistry, physics and biology on the nanostructural level with a focus on biotechnological usage
- Provide advanced training in the area of nanobiotechnology
- Understand the interaction of nanomaterials with biological molecules and cells
- Learn nanomaterials and their use with biocomponents to synthesize and address larger systems
- Produce highly skilled individuals suited for the fast-changing requirements of today's advanced workforce

Course Outcomes

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

1. Recognize the role of bio nanotechnology as an interdisciplinary tool and to understand how to use these new tools in to solve problems in biological systems
2. Demonstrate knowledge and understanding of biomolecules and biomolecular interactions, and the relationship between molecular dynamics, nanoscale physics and macroscopic system behavior
3. Explain biophysical mechanisms in the context of nanobiotechnology application areas
4. Analyze and discuss the engineering requirements of multidisciplinary technology based on biology
5. Explain the challenges of commercializing new technologies
6. Demonstrate technical and cognitive skills associated with nanobiotechnology

UNIT – I Nanotechnology:

Definition, The fundamental Science behind nanotechnology- electrons, atoms and ions, molecules, metals, biosystems. Nanoanalysis

UNIT– II Microfluidics and Lab-on-a-chip:

Materials of Microfluidic Components. Silicon, Glass, polymers, fluid structure, fabrication methods. Surface modifications, Spotting, Detection mechanics.

UNIT– III Natural Nano-scale sensors:

Biosensors. Biomedical applications: drugs, drug delivery, molecular motors. Neuro electronic interfaces, Nanoluminescent tags, imaging and mapping. Defined networks of Neuronal cells *in vitro,* physiology of information processing within Neuronal Networks, Topographical patterning, Photolithographic patterning, Photochemical patterning.

UNIT – IV Microcontact printing of proteins:

Strategies for printing proteins on surfaces, Contact processing with hydrogel stramps, Affinity contact printing, Micro contact printing polypeptides and proteins, Printing one type of biomolecules, substrates, resolution and contrast of patterns, Activity of printed molecules, Printing multiple types of proteins, Molds and stamps, Surface chemistry, Characterization of printed patterns.

UNIT – V Nanotechnology & Environment:

Nanoparticles in bio- degradation, nano-material-based adsorbents for water treatment, possible mutagenic properties of nanoparticles, nanoparticle bioaccumulation.Nanoparticles in biomedical and clinical applications

REFERENCES

1. Niemeyer, C.M.. & Mirkin, C. A. (2004). *Nanobiotechnology Concepts, Application and Properties*. New York: Wiley – VCH Publishers.

2. Rao, C.N.R. (2006). *The Chemistry of Nanomaterial: Synthesis, Properties and Applications* (Vols 1 &3). Springer.

3. Muralidharan, V.S., & Subramanian, A. (2009). *Nanoscience and technology*. New Delhi: CRC Press.

4. Ratner, M., & Ratner, D. (2005). *Nanotechnology- a Gentle Introduction to the Next Big idea*. London: Pearson Education, Inc.

5. Dinh, T.V. (2007). *Nanotechnology in Biology and Medicine: Methods, Devices and Applications*. (1st ed.) New Delhi: CRC Press.

Semester – I

18BTP105C BIO-ENERGY TECHNOLOGY 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Provide an overview of the basic process of bioenergy
- Understand different strategies to convert biomass to biofuels
- Obtain knowledge on the available technologies and how these could meet the growing demand for energy in the future
- Understand biomass biodegradability and bioconversion rate in relation to energy yields
- Describe biochemical processes of biomass conversion to bioenergy production with focus on fermentation and anaerobic digestion
- Understand technological potentials of biogas, bioethanol, biofuel and biohydrogen

Course Outcomes

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

1. Demonstrate bioenergy production processes adequate to diverse biomass characteristics
2. Discuss state-of-the-art technologies of generating biofuels from sustainable bioresources
3. Discuss and propose feasible biofuel technologies and biofuel products from selected biomasses
4. To illustrate a bio-energy thermo-chemical conversion process
5. Design biogas reactor capacity and propose optimal and economically viable technical operational condition
6. Demonstrate sequential bioethanol and biogas production and compare bioethanol and biogas scenarios with respect to energy recovery

UNIT – I Biofuel:

Introduction, features, undesirable features, Energy crops – wood, sugar and starch crops, hydrocarbon producing crops. Modes of utilization of biomass.

UNIT – II Biogas:

Substrate, digester, microorganisms, process of biogas production, factors affecting biogas yield, precautions, advantages and disadvantages.

UNIT – III Bioethanol:

Introduction, bioethanol vs. petrol, production of bioethanol – yeast, sugar and starch crops, ethanol recovery.

UNIT – IV Biodiesel:

Introduction, lipids as a source of biodiesel – algae, sunflower, rapeseed, linseed, soybean, jatropha, peanut, biodiesel from hydrocarbons. Biobutanol – *Clostridium,* molasses.

UNIT – V Biohydrogen:

Hydrogen as fuel – production - methods - electrolysis of water, gasification, biological agents. Biohydrogen production – anaerobic fermentation, photolyses and photosynthetic methods.

REFERENCES

1. Mazumdar, B. **(**2003). *A Textbook of Energy Technology*. New York, NY: McGraw-Hill, Inc.

2. Shepard, & Marion L. (2000). *Introduction to Energy Technology*. NewYork, NY: McGraw-Hill, Inc.

3. Grant, W.D., & Long, P.E. (2001). *Environmental Microbiology*. Glasgow: Blakie publications.

4. Reddy, G. M., Reddy, M.N., Saigopal, D.V.R., & Mallaiah, K.V. (2007). *Laboratory Experiments in Microbiology* (2nd ed.). Mumbai: Himalaya Publishing House.

Semester – I

18BTP111 **BIOCHEMISTRY AND MICROBIOLOGY – PRACTICAL I** **4H – 2C**

Instruction Hours / week: L: 0 T: 0 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Give knowledge on Biochemistry, microbiology and its application
- Offer knowledge to execute the experiments flawlessly
- Understand quantification of sugars, aminoacids and lipids
- Understand various cell types and its components
- Understand how to perform fractionation of cellular components
- Get practiced with the tools and techniques for analyzing chromatography

Course Outcomes

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

1. Describe the quantification of sugars, aminoacids and lipids
2. Interpret the outcome of experiments that involve cell biology techniques
3. Interpret the outcome of experiments that involve microbiology techniques
4. Discuss the various macromolecular components of cells and their functions
5. Describe cell permeability in plants and animal cells
6. Discuss the various staining techniques

List of Practicals

Biochemistry

1. Quantification of proteins – Lowry *et al/* Bradford method
2. Quantification of sugars – Anthrone method
3. Total free amino acids
4. Quantification of lipids
5. Quantification of Ascorbic acid
6. Thin Layer Chromatography (Amino acids / fatty acids/ sugar/ nucleic acids)
7. Effect of pH, temperature, substrate concentration (any one enzyme - Catalase / SOD / amylase by OD method)

Microbiology

1. Pure culture technique –pour spread, loop out technique and streaking, preservation,
2. Staining technique –grams and fungal.
3. Motility –Flagellar staining, hanging drop and soft agar analysis.
4. Growth curve (Bacteria and Fungi) and Biomass estimation

REFERENCES

1. Boyer, Rodney. (2010). *Biochemistry Laboratory: Modern Theory and Techniques.* New Jersey: (3 rd ed.) Pearson Education, Inc.
2. Palanivelu, P. (2001). *Analytical Biochemistry and Separation Techniques.* Madurai: Kalaimani Printers.
3. Sadasivam. S., & Manickam, A. (2008). *Biochemical Methods.* (3 rd ed.) New Delhi: New Age International Private Limited Publishers.
4. Keith Wilson, & John Walker (Eds.). (2010). *Principles and Techniques of Biochemistry and Molecular Biology.* New York, NY: Cambridge University Press.

Semester – I

18BTP112 CELL BIOLOGY AND MOLECULAR GENETICS - PRACTICAL II **4H – 2C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Give knowledge on, Cell Biology and Molecular Genetics and its application
- Understand various cell types and its components
- Understand how to perform fractionation of cellular components
- Get practiced with the tools and techniques for analyzing cells
- Understand how to view Cell division stages
- Know about practical handling techniques

Course Outcomes

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

1. Interpret the outcome of experiments that involve the use of cell biology and molecular genetics techniques
2. Discuss the various macromolecular components of cells and their functions
3. Describe cell permeability in plants and animal cells
4. Explain the basic steps involved in chromosome preparation and nuclear staining.
5. Perform cell division experiments

List of Practicals

Cell Biology

1. Identification of cell types- Microbe/plant /Human
2. Fractionation of cellular component – Nuclear Components, Mitochondria, Chloroplast.
3. Sucrose Fractionation of Castor Bean
4. Lipid Solubility of Membranes
5. Cell permeability – RBC/plant cells.
6. Cell division (Mitosis/Meiosis)

Molecular Genetics

1. Drosophila Giant Chromosome preparation
2. Nuclear staining (Giemsa / acridine orange /feulgen)
3. Metaphase preparation and karyotyping (Human leucocytes/ onion root tip)
4. Conjugation
5. Transduction

REFERENCES

1. Cappuccino, P., & Sherman, D. (2004). *Microbiology-A Lab Manual*. (7th ed.) Singapore: Pearson Education.

2. Dubey, R., & Maheswari, E. (2004). *Practical Microbiology*. New Delhi: S. Chand & Co.

3. Goldman, E., & Green, L.H. (2008). *Practical Handbook of Microbiology*. (2nd ed.). London: CRC press.

4. Kannan, P. (2002). *Laboratory Manual in General Microbiology*. (1st ed.) Tamilnadu: Palani Paramount Publishers.

Semester – I

JOURNAL PAPER ANALYSIS AND PRESENTATION

2H – 0C

Semester – II

18BTP201 RECOMBINANT DNA TECHNOLOGY 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Be familiarize with emerging field of biotechnology: Recombinant DNA Technology
- Understand the basic concepts of recombinant DNA Technology and genetic engineering
- Acquaint versatile tools and techniques employed in recombinant DNA technology
- Obtain the principles of versatile DNA modifying enzymes, cloning strategies, and vector types for selection and screening of recombinant clones
- Understand the concepts of nucleic acid labeling techniques
- Illustrate creative use of modern tools and techniques for manipulation and analysis of genomic sequences and to use recombinant DNA technology in biotechnological research

Course Outcomes

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

1. Outline the fundamental steps in recombinant DNA technology
2. Demonstrate the mechanism of action and the use of restriction enzymes in biotechnology research and recombinant protein production
3. Explain the value of plasmid preparations and how the concentration and purity of plasmid samples can be determined
4. Confer cloning strategies and techniques used in DNA probing for specific genes of interest
5. Conceptualize PCR technique in clinical research
6. Recapitulate various applications of recombinant DNA technology in human health care and safety regulations

UNIT – I Tools in Genetic Engineering:

Nucleic acid manipulating enzymes- restriction- nucleases, ligases, polymerases, modification enzymes - kinases, phosphatases, adapters and linkers. Polynucleotide tailing.

UNIT – II Cloning Vectors:

Plasmid - conjugative and non-conjugative plasmid, Types of Plasmid- Natural plasmids, Artificial plasmid- pBR322 and PUC series. Phage vectors. Plant Vector – Ti plasmid. Animal viral vectors - Retroviral viral vectors, Shuttle vectors, cosmid, phagemid, fosmid. Artificial chromosomes –BACs, YACs.

UNIT- III Gene transfer methods:

Physical, chemical and biological methods of gene transfer- prokaryotes - eukaryotes. Screening and analysis of recombinants, DNA and RNA probes – construction. Analysis of cloned foreign genes. Hybridization techniques – Southern Blotting, Northern Blotting and Western Blotting.

UNIT – IV Analytical Techniques:

PCR, RAPD, RFLP, AFLP, SSCP, protein engineering- site directed mutagenesis, PCR mediated. Alteration of restriction sites, Molecular diagnosis and therapy of cancer, DNA based detection of microbial infection/ contamination, sequence analysis, SNP, NGS, gene editing tool CRISPR.

UNIT – V Application:

Antisense technology, RNAi technology, terminator gene technology, gene therapy- *in vivo* and *ex vivo*. Gene delivery systems - viral and non viral; DNA marker technology in plants, DNA fingerprinting, genetically engineered biotherapeutics and vaccines.

REFERENCES

1. Glick, B.R., & Pasternack, J.J. (2009). *Molecular Biotechnology*. (5th ed.) New Delhi: Panima Publication.

2. Primrose, S.B., Twyman, R. M., & Old, R. W. (2006).*Principles of Gene Manipulation* (7th ed.). Germany: Blackwell Science Publishing Company.

3. Brown, T.A., (2006). *Gene Cloning and DNA Analysis* (6th ed.) Oxford: UK, Blackwell Publishing.

4. Brown, T.A., (2006). *Gene cloning - An introduction* (7th ed.). New York, NY: Stanley thrones Publishers Ltd,.

5. Winnacker, E.L., (2003). *From Genes to Clones*. (1st ed.)New Delhi: Panima Educational Book Agency.

6. Watson, J.D., Gilman, M., & Witkowski, J. (2000). *Recombinant DNA*. (2nd ed.) New York: Freeman Publication.

Semester – II

18BTP202 FERMENTATION AND BIOPROCESS TECHNOLOGY 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Be familiarize with knowledge about biological and biochemical technology, with a focus on biological products, the design and operation of industrial practices
- Describe power requirements in bioreactors, modeling of bioprocesses, and traditional and new concepts in bioprocess monitoring, and the biological basis for industrial fermentations
- Understand biological and engineering principles for cultivating microorganisms in fermentors
- Obtain knowledge on assessing biological and engineering principles for cultivating microorganisms in fermentors
- Understand the importance of monitoring foam control, nutrient dosing, sterile sampling and filter sterilization
- Attain key concepts in calibration and maintenance of process critical for fermentation such as aeration, agitation and pH

Course Outcomes

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

1. Evaluate factors that contribute in enhancement of cell and product formation during fermentation process
2. Analyze kinetics of cell and product formation in batch, continuous and fed-batch cultures
3. Differentiate the rheological changes during fermentation process
4. Develop protocol for scale-up and harvesting from shake flask to bench top fermentor
5. Analyze the bioprocess paradigms including scale-down, bioprocess simulation and economics in biological manufacturing
6. Examine considerations in bioprocess simulation and economics, sterilization in biological manufacturing, and clinical implications of bioprocesses

UNIT –I Introduction:

Isolation and screening of industrially important strains- primary and secondary screening. Strain improvement, mutation, selection of mutants, recombination – bacteria, fungi and actinomycetes, assay and fermented products. Fermentations- submerged, solid state.

UNIT – II Media:

Media formulation – sterilization – batch and continuous sterilization, sterilization of air, fibrous filters. Microbial kinetics: batch, fed-batch and continuous cultures, phases of batch growth. kinetics of cell growth, product formation, substrate utilization, product inhibition kinetics, yield concept and productivity.

UNIT – III Design of fermenter:

Types – CSTR, Tower, jet loop, air lift fermenter, bubble column, packed bed. Fundamentals of process control and monitoring – on line and off line analysis, feedback control, PID controller, computer aided control.

UNIT – IV Downstream processing:

Cell distribution methods for intracellular products; foam separation, precipitation. Filtration – micro and ultra-filtration; Solvent extraction-, chromatographic separation- FPLC, HPLC, dialysis, centrifugation, distillation, drying, crystallization, turbidity analysis and cell yield determination. Fermentation products- available in market.

UNIT –V Kinetics:

Transport phenomena – Rheological properties, determination of O_2 mass transfer, heat transfer, role of aeration and agitation, factors affecting O_2 transfer. Production of chemicals – alcohol, antibiotics – Penicillin and Streptomycin, Single cell proteins.

REFERENCES

1. Stanbury PF, Whitaker A and Hall SJ. (2006). *Principles of Fermentation Technology* . (2nd ed.)Elsevier Science Ltd.

2. James Bailey, E., & David Follis. (1999). *Biochemical Engineering Fundamentals* (2nd ed.). Boston: Mc Graw Hill Book Company.

3. Wulf Crueger, & Anneliese Crueger. (2004).*Textbook of Industrial Biotechnology* (2nd ed.). New Delhi : Panima Publishing Corporation.

4. Pauline Doran, M., (2013). *Bioprocess Engineering*. (2 nd ed.) New York: Academic press.

5. Rajiv Dutta, (2008). *Fundamentals of Biochemical Engineering*. India: Ane Books.

6. Shuler, M.L., & Kargi, F. (2008). *Bioprocess Engineering Basic concepts* (2nd ed.) NJ: Prentice Hall International Series in the Physical and Chemical Engineering Sciences.

Semester – II

18BTP203 **ENZYME TECHNOLOGY** **4H – 4C**

Instruction Hours / week: L: 3 T: 1 P: 0

Marks: Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Understand about the characteristics of enzyme system
- Obtain key concepts on enzyme- Nomenclature and classification of enzymes
- Comprehend the principles of enzymewith Thermal stability and catalytic efficiency of enzyme
- Understand strong fundamental knowledge in enzymology
- Attain the principals involved in enzyme technology including Methods for large scale production of enzymes.
- Recognize the application of Enzymes used in different industries

Course Outcomes

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

1. Demonstrate various enzyme process including Delivery system for protein pharmaceuticals, structure function relationship in enzymes
2. Describe the organization Artificial enzymes; Isolation and purification of industrially important enzymes
3. Recognize how pathways and regulatory networks
4. Appreciate the underlying mechanisms of Immobilized and soluble enzyme in health and industry
5. Illustrate the role of enzyme system
6. Apply the knowledge of this course in research and enzyme

UNIT – I Definition:

Nomenclature and classification of enzymes, Isozymes, characteristics of enzymes, Enzyme cofactors, Catalytic power, Catalytic strategies, Substrate specificity, Lock and key model, Induced fit hypothesis, Active site- structure, substrate binding, role of catalytic amino acid residues, Catalytic mechanisms of enzymes with representative examples, Types of enzyme inhibition, regulation, kinetics of enzyme-catalyzed reactions, effect of pH and temperature, Thermodynamics, Enzyme pathways and regulatory networks.

UNIT – II Properties of Enzymes:

Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering– selected examples, Delivery system for protein pharmaceuticals, structure function relationship in enzymes, structural motifs and enzyme evolution. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *in vitro* & *in vivo*.

UNIT – III Improvement of enzymes:

Strategies for the discovery of improved and novel enzymes for industrial applications (homology and structure based approaches, screening methods, use of mutants). Optimization of industrial enzymes by mutagenesis; Protein engineering strategies to improve enzyme stability, specificity and activity; Enzyme immobilization - types, advantages, drawbacks and applications; Artificial enzymes; Isolation and purification of industrially important enzymes.

UNIT – IV Enzyme Technology:

Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry. Enzyme electrodes.

UNIT – V Applications of enzymes:

Enzymes used in different industries, Enzyme catalysis in organic solvents, enzyme replacement therapy – definition, modes of administration, enzyme deficiency disorders and enzyme therapy; Application of enzymes: Cosmetic benefits, Enzyme-based biosensors; Enzymes in clinical diagnosis: primary and secondary serum enzymes, Intracellular distribution of diagnostic enzymes, Enzyme markers of Xenobiotic toxicity - Pharmacogenomics related to polymorphism of drug metabolizing enzymes, , KEGG (Kyoto Encyclopedia of Genes and Genomes) pathway.

REFERENCES

1. Robert Murray, K., David Bender, A., Kathleen Botham, M., Peter Kennelly, J., Victor Rodwell, W., Anthony Weil, P. (2009). *Harper's illustrated Biochemistry* (28th ed.). McGrawHill.

2. Lubert Stryer, (2006). *Biochemistry* (6th ed.). WH Freeman.

3. Donald Voet, & Judith Voet, (1995). *Biochemistry* (2nd ed.). John Wiley andSons.

4. Mary K., & Shawn O.Farrell, (2005). *Biochemistry* (5th ed.). Cenage Learning.

5. Nicholas Price, & Lewis Stevens (1999) *Fundamentals of Enzymology*. Oxford University Press.

Semester – II

18BTP204 **IMMUNOTECHNOLOGY** **4H – 4C**

Instruction Hours / week: L:4 T: 0 P: 0 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Understand about our immune system and the immune response of cells and organs
- Obtain key concepts on gene-re-arrangement of immunoglobulin and T-cell receptor genes, and antigen processing and presentation
- Comprehend the principles of immunological techniques like hybridoma technology and catalytic antibodies synthesis
- Understand strong fundamental knowledge in tumor immunology
- Attain the principles involved in vaccine technology including recombinant vaccines
- Recognize the basic concepts in bone marrow and other organs transplantation

Course Outcomes

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

1. Demonstrate various immunological process including innate and adaptive immunity, cells and organs of immune system, antigen and antibody interaction, immunogenicity and antigenicity, epitopes and antibody structure
2. Describe the organization of Ig genes, class switching in constant regions of genes and expression and regulation of Ig genes
3. Recognize how antigens are processed, presented and immune activation occurs via B- and T- cells activation
4. Appreciate the underlying mechanisms of auto-immune diseases and allergic reactions
5. Illustrate the role of immune system in tumor formation
6. Apply the knowledge of this course in research and pharmacological industries.

UNIT – I Introduction:

History and scope, Immunity – types, Antigen and Antibody - biology, structure and functions, super antigens, antigen- antibody interactions, primary and secondary immune response. Humoral and cell mediated immunity**.**

UNIT – II Immune system:

Hematopoiesis and differentiation, Lymphocytes, Lymphoid organs**:** Primary and secondary lymphoid organs. Antigen recognition and presentation, activation of B and T lymphocytes, cytokines and their role in immune regulation. **Complement system** - Classical and alternate pathway. MHC I and II complex.

UNIT– III Transplantation:
MLR, MHC and HLA typing, bone marrow transplantation, organ transplants, immunosuppressive therapy. Hybridoma technology and monoclonal antibodies, immuno-diagnosis and application of monoclonal antibodies in biomedical research, human monoclonal antibodies and catalytic antibodies, Xeno transplantation from various species.

UNIT – IV Hyper-sensitivity reactions, auto-immune disorders. Tumor immunology:
Tumor antigens, immune response to tumours, cancer immunotherapy. Immunodeficiencies – primary and secondary.

UNIT –V Vaccines:
Vaccine technology including DNA vaccines, identification of B and T epitopes for vaccine development. Immunodiagnosis of infectious diseases, immuno screening of recombinant library.

REFERENCES

1. Goldsby, R.A., Kindt, T. J., Osborne, B. A., & Kuby, W.H.J. (2004). *Immunology* (6th ed.). USA: Freeman and Company.

2. Tizard, I.R. (2004). *Immunology* (6th ed.). New York: Saunders College Publishing.

3. Abbas,A.K., Lichtman,A. H., &Pillai,S. (2007). *Cellular and Molecular Immunology: With student consult*. (7 th ed.) Australia: Online Access. Elsevier Science.

4. Abbas,A.K., Lichtman,A. H., &Baker, D.L. (2008). *Basic Immunology: Functions and Disorders of the Immune System*. (5 th ed.) Australia: Elsevier Health Sciences.

5. Roitt, I., Brstoff, J., & Male, D. (2002). *Immunology* (3rd ed.). London: Mosby Yearbook Europe Ltd,.

6. Goldsby, R. A., Kind, T.J., &. Osborne, B.A. (2004). *Immunology* (6th ed.). New York: Freeman and Company.

7. Turgeon, M. L. (2008). *Immunology and Serology in Laboratory Medicine*.(5 th ed.) Australia: Elsevier Health Sciences.

8. Surendranath, A., & Narain, R. (2004). *Immunobiotechnology*. New York: Dominant Publishers and Distributors.

Semester – II

18BTP205 A PHARMACEUTICAL BIOTECHNOLOGY 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40**External: **60** Total:**100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Obtain basic skills necessary for employing biotechnology principles in together with various pharmaceutical parameters
- Understand novel formulation approaches for better delivery of biotechnology derived drugs, such as reverse micelles, liposomes, microemulsions and microencapsulation
- Attain knowledge on the delivery of peptides and proteins by the parenteral, oral, transdermal and nasal routes of administration
- Recognize novel biotechnology products and their use in therapeutics and diagnostics
- Comprehend the physical and chemical properties of the solution/colloidal/dispersion that influence physical stability of the bioactive macromolecule with emphasis on aggregation behavior, its identification and its impact on bioactivity
- Learn about special storage, handling, reconstitution and administration conditions and techniques for drug delivery systems containing bioactive macromolecules

Course Outcomes

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

1. Evaluate different pharmaceutical parameters of current biotechnology products
2. Determine parameters related to stability and formulation of biotechnology products
3. Discuss quality control procedures related to biotechnology products
4. Demonstrate novel formulation methods for better delivery of biotechnology derived drugs
5. Evaluate different techniques related to separation and purification of cell types; conduct techniques for measuring cell turnover and growth, conduct cytotoxicity assays
6. Join pharmaceutical biotechnology labs and industries as a research assistant

UNIT –I Introduction:

Classification of Pharmaceuticals - Solutions, suspensions, tablets, capsules. Drugs and its sources, Routes of Drug Administration, Absorption and Bioavailability, Distribution, Drug metabolism, Drug theories, Drug Receptor interactions, Pro-drug concept.

UNIT – II Biotechnology and health:

Drug design; drug development; random screen up, target identification and validation, drug discovery, drug delivery. Drug abuse, self-poisoning. pharmacogenomics, biochip.

UNIT – III Biotechnology and Pharmacy:

Genetically engineered protein and peptide agents, novel drug delivery systems – non convectional routes of administration, Anti-AIDS drug development, oncogenes as targets for drugs, Multi-drug resistance, vaccine

development and role of genetic engineering in controlling infectious diseases, gene therapy, and stem cell therapy.

UNIT – IV Enzyme Technology:
Sources of enzymes, extraction and purification: Applications pharmaceutical, therapeutic and clinical. Production of amyloglucosidase, glucose isomerase, amylase and trypsin, Techniques of immobilization of enzymes and their applications in the industry. Reactors for immobilized systems and perspective of enzyme engineering.

UNIT -V Novel Drug Delivery Systems:
Introduction to the drug carrier, liposome as a drug carrier, biodegradable polymers as a drug-carrier. Modified Drug Release: The sustained release, first order release approximation, multiple dosing.

REFERENCES

1. Jay Rho, P., Stan Louie, G., (2003). *Hand book of Pharmaceutical Biotechnology*. (4th ed.) New York: Pharmaceutical products press.

2. Ajay Banga, K. (2004). *Therapeutic Peptides and Proteins: Formulation, Processing, and Delivery Systems.* (3 rd ed.).USA: Mercer University.

3. Satoskar, R. S., Bhandhakan, S. D., & Alinaoure, S.S. (2000). *Pharmacology and Pharmacotherapeutics* (23 rd ed.). Mumbai: Popular Prakashan Publishers.

4. Bhagvan, N.V. (2002). *Medical Biochemistry*.(4th ed.) New York: Academic Press.

5. Harvey,R.E., Lipin, & Walters, W. C. (2002). *Pharmocology*(4th ed.). New York: Kluwer Company.

6. Daan, J. A., Crommelin, & Sindelar, R. D. (2002). *Pharmaceutical Biotechnology* (3rd ed.). New York : Routledge Taylor and Francis Inc.

7. Sethi, P.D. (2005). *Quantitative Analysis of Drugs in Pharmaceutical Formulations* (3rd ed.). New Delhi: CBS Publishers and Distributers.

8. Manfred Wolff, E. (2000). *Burger's Medicinal Chemistry and Drug Discovery* (7th ed.). USA: Wiley and Sons.

9. Daan Crommelin, & Robert Sindelar, D. (2002). *Pharmaceutical Biotechnology*. (2nd ed.) New York: Taylor and Francis Publications.

Semester – II

18BTP205B **AGRICULTURAL BIOTECHNOLOGY** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40** External:**60** Total:**100**
End Semester Exam: 3 Hours

Course Objective:

The objectives of the course are to make the students to

- To provide various techniques and aspects regarding agribiotechnology
- To equip students with theoretical knowledge regarding the techniques and applications of agribiotechnology
- This paper has been designed to give the students comprehensive training in the agribiotechnology and its application for increasing agricultural production, environment improvement
- To help students to get a career in Industry/R&D/Academic
- To learn about genome organization in plants, basic techniques in tissue culture and its applications
- To know about Genetic transformation in plants, metabolic engineering, production of pharmaceuticals and industrial products and plant molecular farming

Course Outcomes:

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

1. Describe the genome organizations in plants
2. Elaborate on the plant cell and tissue culture systems
3. Explain the genetic transformation techniques in plants
4. Demonstrate the application of genetic transformation techniques in plants
5. Evaluate the importance of metabolic engineering
6. Carryout agricultural farming with plants

UNIT –I Plant tissue culture and its application:

Recombinant DNA technology, methods of gene transfer in plants, Development of transgenics for abiotic & biotic stress tolerance Tools and techniques used in agriculture biotechnology.

UNIT –II Genetic and Molecular basis:

Heterosis and Apomixis and their significance, Mutations and polyploidy in crop improvement, Molecular markers, Marker assisted breeding, QTL mapping, Origin, evolution and cultivation practices of the major crop plants

UNIT –III Improvement of crop plants:

Increase in iron, protein and amino acids, golden rice colours – anthocyanins, betalaines, crocin and crocetins. Flavours–capsaicin, vanillin, stevioside thaumatin. Developing vaccine and plantibodies, terminator technology and male sterility;

UNIT – IV Biotic and abiotic resistance:

Virus -coat protein mediated, nucleocapsid gene, antisense and RNAi, Fungal diseases: chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins, PR proteins, Insect pests resistance: Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor, nematodes resistance and herbicide resistance: phosphoinothricin, glyphosate, sulfonyl urea, atrazine. Drought, salinity, thermal stress, flooding and submergence tolerance

UNIT – V Genetic engineering for increasing crop productivity:

Enhancing photosynthetic, nutrient use and nitrogen fixing efficiencies of plants, Genetic Engineering for quality improvement: Seed storage proteins; essential amino acids, Vitamins and minerals, heterologous protein

production in transgenic plants, biodegradable plastics, Plants as biofactories, Biosafety and risk assessment of GM crops.

REFERENCES

1. Adrian Slater, Nigel Scott and Mark Fowler (2003). Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press.

2. BR Jordan, (2006). The Molecular Biology and Biotechnology of Flowering, 2nd Edition, CABI,

3. Jaiwal P K & Singh R P (eds) (2006). Plant Genetic Engineering Vol-1 to Vol. 9. Studium Press, USA.

4. Denis Murphy (2007). Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press.

Semester – II

18BTP205 C **INDUSTRIAL TOXICOLOGY** **4H – 4C**

Instruction Hours / week: L: 4 T: 0 P: 0 **Marks:** Internal: **40**External:**60** Total:**100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Students will acquire knowledge and learn the terminology of the field of Industrial toxicology, understand and be able to describe in detail the toxicological effects of certain dangerous substances
- Describe the relationship of dose - response, and the principle of determining the theoretical expertise on the mutagenic, teratogenic and carcinogenic effects of toxic substances.
- Obtain knowledge of current legislation on health protection while working with chemical agents, carcinogenic and mutagenic factors, and biological factors
- Learn about toxic effects of elements and their compounds. Toxic effects of heavy metals.
- Understand the classification of substances under the new legislation.
- Gather and critically interpret toxicological information from diverse resources for human health hazard and risk assessment

Course Outcomes

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

1. Describe toxicology as a discipline in the overall health sciences framework
2. Explain the basic concepts of chemical hazard and exposure as determinants of chemical toxicity
3. Describe key pathways and mechanisms of chemical absorption, distribution, metabolism, storage and excretion in the human body
4. Explain dose-response relationships as the basis of toxicity
5. Outline the derivation of reference dose and other related measures of occupational exposure
6. Describe the scientific basis of occupational exposure assessments and practical methods for their determination

UNIT – I Introduction

Scope, Divisions of Toxicology, General principles of toxicology, - Classification of Toxic Agents. Mechanism of action of toxicants, Routes of exposure-absorption and translocation.

UNIT – II Toxicokinetics:

Absorption, Distribution, Metabolism and Excretion, Factors influencing Toxicity, Dose-effect and Dose response relationship- LD50, LC50.

UNIT – III Human Toxicology:

Pollution induced biochemical, hematological and pathological changes, Immunotoxicity, genotoxicity and carcinogenic effects

UNIT – IV Ecotoxicology:

Influence of ecological factors on the effects of toxicity; Pollution of the Ecosphere by industries; degradable and non-degradable toxic substances; food chain. Eco-system influence on the fate and transport of toxicants.

UNIT – V Regulatory issues and testing:

Bacterial mutation assays, Mammalian cell mutation assays, *in vitro* chromosome aberration assays, *In vivo* carcinogenicity assays and Comet assay.

REFERENCES

1. Finkol, A.J. (1983). *Hemitton and Hardy's Industrial toxicology.* London: John Wright, PSG Inc.
2. Mohammad Khan, (2013). *Pesticides in Aquatic Environments*. Springer Science & Business Media
3. Murthy, A.S. (1999). *Toxicity of pesticides to fish.* Florida: CRC Press Inc.
4. Jim Riviere, E. (2006).*Biological Concepts and Techniques in Toxicology: An Integrated Approach.* CRC Press.

Semester – II

18BTP211 **RECOMBINANT DNA, FERMENTATION AND BIOPROCESS TECHNOLOGY – PRACTICAL III** **4H – 2C**

Instruction Hours / week: L:0 T: 0 P:4 **Marks:** Internal: **40** External:**60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Be familiarize with practical knowledge in the emerging field of biotechnology: Recombinant DNA technology
- Perform basic molecular biology techniques including DNA and RNA isolation from microbes, plants and animals
- Acquaint versatile tools and techniques employed in recombinant DNA technology such as restriction and digestion, ligation, transformation and PCR
- Gain adequate knowledge on screening of industrially important microorganisms
- Comprehend the enzyme immobilization technique
- Get knowledge on wine production

Course Outcomes

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

1. Carry out DNA and RNA isolation from microbes, plants and animals
2. Perform recombinant DNA techniques including restriction and digestion, ligation, transformation and PCR
3. Explain the wine production and alcohol determination
4. Extract amylase enzyme from microbial sources
5. Perform the enzyme immobilizing technique
6. Join in research and clinical labs as a project/ research assistant

List of Practicals

Recombinant DNA Technology

1. Isolation and analysis of total DNA from Microbes (*E. coli*), plant
2. Isolation and analysis of plasmid DNA
3. Isolation and analysis of total RNA
4. Restriction digestion of DNA, Ligation of DNA
5. Transformation of plasmid DNA using calcium chloride
6. Amplification by PCR
7. Southern blotting (Demonstration)
8. Northern blotting (Demonstration)
9. Western blotting (Demonstration)

Fermentation Technology

1. Isolation and secondary screening of industrially important microorganisms
2. Production of amylase or protease, Enzyme immobilization
3. Wine Production an alcohol determination by chromic acid method
4. Downstream processing by Solvent extraction

REFERENCES

1. Glover, D.M., & Hames, B.D. (2000). *DNA Cloning- a Practical Approach.* (2 nd ed.) Oxford: IRL Press.

2. James, J.G., & Rao, V.B. (2001). *Recombinant DNA Principles and Methodologies*. (2 nd ed.) New York: Marcel Dekker Publications.

3. Maliga, P. (2000). *Methods in Plant Molecular Biology. A Laboratory Course Manual.* (3 rd ed.) New York: Cold Spring Harbour Laboratory Press

4. Brook, J.S., Fritsch, E.F., & Maniatis, T. (2000). *Molecular Cloning: A Laboratory Manual*. (2 nd ed.) New York: Cold Spring Harbor Laboratory Press.

Semester – II

18BTP212 **IMMUNO - AND ENZYME TECHNOLOGY – PRACTICAL IV** **4H – 2C**

Instruction Hours / week: L: 0 T:0 P: 4 **Marks:** Internal: **40**External: **60** Total:**100**
End Semester Exam: 3

Course Objectives

The objectives of the course are to make the students to

- Be familiarize with practical knowledge in the emerging field of biotechnology: immuno technology
- Perform and understand basic immuno techniques
- Acquaint versatile tools and techniques employed in immuno technology such as methods of immunoelectrophoresis
- Gain hands on experience in immunological tools used in diagnosis, such as immunoelectrophoresis, ELISA and WIDAL test
- Comprehend the applications of Immunological techniques in human health care

Understand the calculations of kinetic parameters such as Km, V_{max}, K_{cat}

Course Outcomes

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

1. Carry out the immuno laboratory techniques
2. Perform the enzyme related assays
3. Explain the preparation of sample for analysis.
4. Describe the basic knowledge about antigen and antibody interaction using rocket immune electrophoresis.
5. Perform various techniques like Immunoelectrophoresis, and ELISA etc.
6. Join in research and clinical labs as a project/ research assistant

List of Practicals

Immuno-technology

1. ABO blood grouping, Preparation of serum from blood
2. Methods of immunization, Methods of bleeding, Hemolysis
3. Single and Double radial immunodiffusion
4. Immunoelectrophoresis
5. Rocket Immunoelectrophoresis
6. Counter Current Immunoelectrophoresis
7. WIDAL test
8. DOT-ELISA

Enzyme technology

1. Purification of an enzyme from any natural resource
2. Quantitative estimation of proteins by Bradford/Lowry's method.
3. Perform assay for the purified enzyme.
4. Calculation of kinetic parameters such as Km, V_{max}, K_{cat}

REFERENCES

1. Aneja, K.R. (2004). *Experiments in Microbiology Plant Pathology and Biotechnology.* (4 th ed.) New Delhi: New Age International.

2. Metcalf, L., & Eddy, R. (2005). *Waste Water Engineering.* (4 th ed.) New Delhi: Tata McGraw Hill.

3. Palvannan,T., Shanmugam, S., & Sathishkumar, T. (2005). *Laboratory Manual on Biochemistry, Bioprocess and Microbiology.* (1 st ed.) Chennai: SciTech Publications India Pvt. Ltd,.

Semester – II

JOURNAL PAPER ANALYSIS AND PRESENTATION **2H – 0C**

Semester –III

18BTP301 PLANT AND ANIMAL BIOTECHNOLOGY 4H – 4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Introduce biotechnological methods for production of transgenic plants
- Get knowledge about various methods of gene transfer in plants
- Cognize and get the knowledge on animal culture
- Explain the basics of the physiological and molecular processes that occur during plant growth and development and during environmental adaptations
- Use basic biotechnological techniques to explore molecular biology of plants and animals
- Understand the processes involved in the planning, conduct and execution of plant and animal biotechnology experiments

Course Outcomes

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

1. Understand the growth conditions required to culture the plants and animal in *in vitro* conditions
2. Inculcate the deep understanding of Gene expression system of plants
3. Acquire knowledge on producing transgenic plants
4. Inculcate the deep knowledge the processes involved in the planning, conduct and execution of plant biotechnology experiments
5. Discuss the structure and organization of plant and animal genome
6. Demonstrate the basic techniques for hybridization in producing transgenic plants and animals

UNIT – I

Micropropagation: Tissue culture media – composition and preparation, Callus and suspension culture, somaclonal variation, micropropagation, organogenesis, somatic embryogenesis, Embryo culture and embryo rescue. Haploidy; protoplast fusion and somatic hybridization; cybrids; anther, pollen and ovary culture for production of haploid plants and homozygous lines. Plant hardening transfer to soil, green house technology.

UNIT – II

Plant genetic engineering: Methodology; Plant transformation with Ti plasmid of *Agrobacterium tumifacians*; Ti plasmid derived vector systems, Ri plasmids; Physical methods of transferring genes to plants - Microprojectile bombardment, Electroporation; Manipulation of gene expression in plants; Production of marker free transgenic plants.

UNIT – III

Animal Cell culture: Types, disaggregation of tissue, primary culture, established culture; suspension culture, organ culture, embryo culture, three-dimensional culture and tissue engineering, feeder layers; cell synchronization; cryopreservation. Biology and characterization of cultured cells, tissue typing; cell – cell interaction; measuring parameters of growth; measurement of cell death – apoptosis and its determination.

UNIT– IV

Animal genetic engineering: **Molecular cell techniques:** cell transformation- physical, chemical and biological methods; manipulation of genes; cell and organism cloning; green fluorescent protein and its application. Gene

therapy. *In vitro* fertilization and stem cell research.

UNIT – V

Applications of plant and animal genetic transformation:

In Plants: Productivity and performance: herbicide resistance, insect resistance, virus resistance, fungal resistance, nematode resistance, Induction of abiotic stress and cold stress. Delay in fruit ripening, LEA protein, plantibodies, edible vaccines - primary and secondary metabolite modification, biopolymers, plant-based enzyme engineering. **In Animal:** Transgenic animals; transgenic animals as models for human diseases; transgenic animals in live- stock improvement; Ethical issues in animal biotechnology.

REFERENCES

1. Chawla, H.S. (2018). *Introduction to Plant Biotechnology* (3rd ed.). CRC Press, Florida, UnitedStates.
2. Freshney, R.I. (2000). *Animal Cell Culture: A Practical Approach* (3rd ed.). Oxford University Press, Oxford, UnitedKingdom.
3. Glick, B.R. & Patten, C.L. (2017). *Molecular Biotechnology* (5th ed.). Taylor & Francis Publishers, Abingdon, UnitedKingdom.
4. Gordon, I. (2003). *Laboratory Production of Cattle Embryos* (2nd ed.). New Delhi: CABI Publishers, Wallingford, UnitedKingdom.
5. Halford, N. (2006). *Plant Biotechnology: Current and Future Applications of Genetically Modified Crops*. Wiley-Blackwell, New Jersey, UnitedStates.
6. Ignacimuthu, S. (2004). *Plant Biotechnology.* Oxford and IBH Publishing House, New Delhi,India.
7. Nirmala, C.B., Rajalakshmi, G., & Karthik, C. (2009). *Plant Biotechnology.* MJP Publication, Chennai,India.
8. Portner, R. (2016). *Animal Cell Biotechnology: Methods and Protocols* (3rd ed.). Humana Publishers, New York, UnitedStates.
9. Primrose, S.B. & Twyman, R. M. (2016). *Principles of Gene Manipulation and Genomics* (8th ed.). John Wiley and Sons Ltd. Publishers, Chicester, UnitedKingdom.
10. Ranga, M. M. (2007). *Animal Biotechnology* (3rd ed.). Agrobios India Publishers, Jodhpur,India.
11. Slater, A., Scott, N.W., & Fowler, M. R. (2008). *Plant Biotechnology.* Oxford University Press, Oxford, UnitedKingdom.
12. Stewart Jr, C.N. (2016). *Plant Biotechnology and Genetics* (2nd ed.). Wiley-Blackwell Publishers, New Jersey, UnitedKingdom.
13. Yagasaki, K., Miura, Y., Hatori, M. & Nomura, Y. (2008). *Animal Cell Technology: Basic and Applied Aspects* (Vols. 13). Springer Publishers, New York, UnitedStates.

Semester –III

18BTP302 GENOMICS, PROTEOMICS AND BIOINFORMATICS 4H – 4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Import the basic and recent developments in the field of genome sequencing, genome mapping, proteomic data analysis
- Develop the knowledge on gene sequencing methods
- Know the structure and interactions of proteins
- Describe advanced genomics and proteomics technologies and the ways in which their data are stored
- Use bioinformatics techniques to query examples of genomic and proteomic databases to analyze cell biology
- Describe the different types of genome variation and their relationship to human diseases

Course Outcomes

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

1. Have a clear understanding on the application of genetic markers in genome mapping
2. Application of 2D technique to analyze the structure of protein
3. Analyze the genomic and proteomic data
4. Acquire knowledge and understanding of fundamentals of genomics and proteomics, transcriptomics and metabolomics and their applications in various applied areas of biology
5. Discuss how biological systems information relating to genes, proteins and cellular structures can be used to model living cells, and even to create new synthetic cells
6. Solve problems in new or little-known situations within broader (or multidisciplinary) contexts related to the field of study

UNIT – I

Genomics: Genome – Human Genome project (HGP)-Merits and limitations of Chemical sequencing method – Dideoxy method – mRNA sequencing – cDNA library – Shotgun method – Automated sequencing – Next generation sequencing – Pyrosequencing –Genome mappings – Restriction mappings – Fluorescence *in situ* hybridization (FISH) – Genetic markers – SNP, VNTR, RFLP, Minisatellite and Microsatellite – Applications of genome mappings.

UNIT – II

Proteomics: Proteome –SDS-PAGE – IEF – 2D Gel electrophoresis –Sample preparations – Merits and limitations - Mass spectrometry – ESI-MS – Molecular weight estimations – Studying Protein-protein interactions – Structural analysis – Protein folding pathways analysis – Tandem Mass spectrometry - Protein sequencing – MALDI-MS.

UNIT – III

Omics Databases: Genome databases – ENSEMBL - VISTA – FlyBase – OMIM – Protein databases – NCBI – UniProt – Secondary databases – PROSITE - 2D PAGE Database - Structural databases – PDB– SCOP – CATH.

UNIT – IV

Sequence and Structural Alignments: Sequence similarity searching tools – Protein BLAST – Nucleotide BLAST – tBLASTn – BLASTx – Pairwise alignments – Multiple sequence alignments – Clustal Omega - Protein structure alignment – DALI - Phylogenetic tree construction and analysis.

UNIT – V

Structure prediction tools: Secondary structure predictions – Empirical and knowledge-based methods – Predicting three-dimensional structures of proteins – strategies, tools, merits and limitations of comparative modeling – threading/fold recognition and *Ab initio* methods – Stereochemical and structural analysis – Molecular visualization tools.

REFERENCES

1. Bhat, S. (2008). *Genomics*. Duckworth Press, London, United Kingdom.

2. Primrose, SB & Twyman, R. (2006). *Principles of genome analysis and Genomics*. Wiley-Blackwell Publishers, New Jersey, UnitedStates.

3. Palzkill, T. (2007). *Proteomics*. Springer Publishers, New York, United States.

4. Gu, J. & Bourne, P.E. (2018). *Structural Bioinformatics* (2nd ed.). Wiley-Blackwell Publishers, New Jersey, UnitedStates.

5. Mount, D.W. (2005). *Bioinformatics –Sequence and Genome Analysis* (2nd ed.). CBS Publishers, CSHL Press, New York, United States.

6. Attwood, T.K. (2007). *Introduction to Bioinformatics* (1st ed.). Pearson Education, London, United Kingdom.

7. Lesk, A. M. (2014). *Introduction to Bioinformatics* (4th ed.). Oxford University Press, Oxford, United Kingdom.

8. Ibrahim, K.S., Gurusubramanian, G., Zothansanga, Yadav, R.P., Kumar, N.S., Pandian, S.K., Borah, P., & Mohan, S. (2017). Bioinformatics - A Student's Companion. Springer Publishers, New York, UnitedStates.

Semester –III

18BTP303 **FOOD BIOTECHNOLOGY** **4H – 4C**

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal: 40 External:**60** Total:**100**

End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Understand the concepts of food biotechnology
- Attain strong knowledge on primary sources of microorganisms in food
- Explore the methods for development and preservation of fermented foods
- Recognize the nutritive values of fermented foods
- Understand the concepts of food adulteration and food safety
- Obtain strong knowledge on food spoilage

Course Outcomes

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

1. Understand the beneficial role of microorganisms in fermented foods and in food processing and the microbiology of different types of fermented food products
2. Understand the significance and activities of microorganisms in food and role of intrinsic and extrinsic factors on growth and survival of microorganisms in foods
3. Know the spoilage mechanisms in foods and thus identify methods to control deterioration and spoilage
4. Recognize and describe the characteristics of important pathogens and spoilage microorganisms in foods
5. Learn various methods for their isolation, detection and identification of microorganisms in food and employ in industries
6. Identify ways to control microorganisms in foods and thus know the principles involving various methods of food preservation

Unit – I

Introduction: History and Scope of Food Biotechnology, Nutritive value of food, Role of microbes in food biotechnology – bacteria, fungi and yeast. Fermented foods – Types, Changes during Fermentation, Nutritive value of fermented foods.

Unit – II

Food Microbiology: Primary Sources of Microorganisms in food. Food-borne Bacteria, Molds and Yeasts. Intrinsic- and Extrinsic Parameters of food affecting microbial count. Detection of Microorganisms in food - SPC, Membrane filters, Dry films. Bacterial Toxins - Botulism and Staphylococcal toxin. Fungal Toxins - Aflatoxins.

Unit – III

Fermented Foods: Origin, scope and development and preservation- Cheese, Yoghurt, Butter, miso, tempeh, kefir, koumiss, acidophilus milk, sourkraut, pickles and vinegar. Fresh juice production –Mango, orange, and pineapple. Technological aspects of industrial production of beer, wine and baker's yeast.

Unit – IV

Food Spoilage and Preservation: Causes of Food Spoilage, Spoilage of Fruits, Vegetables, Meat, Soft Drinks, Eggs, Dairy products. Food Preservation through chemicals - Acids, Salts, Sugars, Antibiotics, Ethylene oxide, Antioxidants. Other Methods of Food Preservation -Radiations, Low and High temperature, Drying. Food packaging materials and their properties.

Unit – V

Food Adulteration and Food Safety: Adulteration, Responsibility for food safety, Food Additives - Definition, Types and Functional characteristics. Natural Colors -Types, Applications, Advantages of natural colors. Sweeteners - Types and Applications. Adulteration Detection systems and sensors. Food safety - HACCP System to food protection, FSSAI guidelines.

REFERENCES

1. Adam, M.R. & Moss, M.O. (2018). *Food Microbiology*. New Age International Publishers, New Delhi, India.
2. Frazier, W.C., Westhoff, D.C., & Vanitha, N.M. (2017). *Food Microbiology* (5th ed.). McGraw - Hill Education/ Medical, London, United Kingdom.
3. Harrigan, W. F. (2013). *Laboratory methods in Food Microbiology* (3rd ed.). Elsevier Publishers, Amsterdam,Netherlands.
4. Bell, C., Neaves, P., & Williams, A.P. (2005). *Food Microbiology and Laboratory Practice.* Wiley- Blackwell Publishers, New Jersey, United States.
5. Jay, J.M., Loessner, J.M., & Golden, A.D. (2008). *Modern Food Microbiology* (7th ed.). Springer Publishers, New York, United States.
6. Suri, S. & Malhotra, A. *Food Science, Nutrition and Safety*. Pearson Education India Publishers, London, United Kingdom.
7. Export/import policy by Govt. of India.
8. Export/import data by DGCIS-Calcutta.
9. Jain, K.S.& Jain, A. V. (2017) *Foreign Trade-Theory, Procedures, Practices and Documentation* (7th ed.). Himalaya Publishing House, Mumbai, India.
10. Bhatia, S.C. (2017). *Food Biotechnology*. WPI Publishers, New Delhi, India.

Semester –III

18BTP304 ENVIRONMENTALBIOTECHNOLOGY 4H – 4C

Instruction Hours/week: L:3 T:1 P:0 **Marks:** Internal: 40 External:60 Total:100

End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Understand the various components of the environmental biotechnology including ecosystems, biodiversity, threats and policy
- Obtain knowledge on the sources for environmental pollution and its remedial measures
- Understand toxic chemicals and their impact on environment and human health
- Attain key concepts on the role of microbes in remediation of environmental pollutants
- Learn various technologies, tools and techniques in the field of environmental biotechnology
- Understand the importance of biological techniques in controlling air pollution

Course Outcomes

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

1. Demonstrate various types of ecosystems, biodiversity components, environmental threats and Policy
2. Discuss the impact of environmental pollution and its remediation measures
3. Recognize various global and regional environmental concerns due to natural causes and/or human activities
4. Illustrate the role of Toxic chemicals in the environment and their associated health issues in humans
5. Investigate some examples of different types of environmental pollution and their impacts
6. Appreciate the scientific, ethical and/or social issues associated with certain applications of biotechnology for alleviating the environmental concerns

UNIT – I

Ecosystem – Concept and management of ecosystems. Energy budget. Energy Transfer and energy pyramids. Environmental pollution and its problems- Air, water, soil. Biogeochemical cycle (Carbon, nitrogen and phosphorous cycle). Response of plant, animal and microbes to external factors.

UNIT – II

Genetically Engineered Microorganisms (GEMs) in environment: Role of environmental biotechnology in management of environmental problems, Bioremediation, advantages and disadvantages; In situ and ex-situ bioremediation; slurry bioremediation; Bioremediation of contaminated ground water and phytoremediation of soil metals; microbiology of degradation of xenobiotics. Bioleaching.

UNIT – III

Sewage, waste water treatment and solid waste management: chemical measure of water pollution, conventional biological treatment, role of microphyte and macrophytes in water treatment; Recent approaches to biological waste water treatment, composting process and techniques, use of composted materials.

UNIT – IV

Biological decomposition: Organic carbon, Nitrogen and Phosphate removal. Biological removal, biotransformation, and biosorption of metal ions. Aerobic- and Anaerobic degradation of Xenobiotics. Bioaugmentation for degradation of Xenobiotics. Industrial sources of waste water. Treatment strategies.

UNIT – V

Biofuels and biological control of air pollution: plant derived fuels, biogas, landfill gas, bioethanol, biohydrogen; Biodiesel, Microbial Fuel Cell. Use of biological techniques in controlling air pollution; Removal of chlorinated hydrocarbons from air. Sustainability, Maintenance and Swatch Bharat aspects in environmental biotechnology.

REFERENCES

1. Evans, G.M. & Furlong, J.C. (2012). *Environmental Biotechnology: Theory and Applications* (2nd ed.). Wiley Publishers, New York, United States.

2 Jördening, H.J.& Winter,J.(2004).*Environmental Biotechnology : Concepts and Applications.* Wiley-VCH Publishers, Germany.

3. Agarwal, S.K. (2005). *Advanced Environmental Biotechnology*. Ashish Publishing House, New Delhi, India.

4. Mara, D. & Horan, N.J. (2003). *The Handbook of Water and Wastewater Microbiology.* Academic Press, London, United Kingdom.

5. Rittman, B.E. & McCarty, P.L. (2017). *Environmental Biotechnology: Principles and Applications* (1st ed.). McGraw Hill Education Publishers, London, United Kingdom.

18BTP305A	**APPLIED BIOTECHNOLOGY**	**Semester – III** **4H – 4C**

Instruction Hours/week: L:4 T:0 P:0

Marks: Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Obtain basic skills necessary for employing biotechnology principles in together with various plant biotechnology
- Understand novel formulation approaches for better delivery of biotechnology derived drugs, such as reverse micelles, liposomes, microemulsions and microencapsulation
- Attain knowledge on the delivery of peptides and proteins by the parenteral, oral, transdermal and nasal routes of administration
- Recognize novel biotechnology products and their use in therapeutics and diagnostics
- Comprehend the physical and chemical properties of the solution/colloidal/dispersion that influence physical stability of the bioactive macromolecule with emphasis on aggregation behavior, its identification and its impact on bioactivity
- Learn about special storage, handling, reconstitution and administration conditions and techniques for drug delivery systems containing bioactive macromolecules

Course Outcomes

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

1. Evaluate different pharmaceutical parameters of current biotechnology products
2. Determine parameters related to stability and formulation of biotechnology products
3. Discuss quality control procedures related to biotechnology products
4. Demonstrate novel formulation methods for better delivery of biotechnology derived drugs
5. Evaluate different techniques related to separation and purification of cell types; conduct techniques for measuring cell turnover and growth, conduct cytotoxicity assays
6. Join pharmaceutical biotechnology lab and industries as a research assistant

UNIT – I

Plant Biotechnology: Genetic engineering of plants: Insect resistance, Virus resistance, Stress tolerant plants, Flower pigmentation, Modification of plant nutritional content, Delayed fruit ripening, Artificial seeds. Biofertilizers: Definition and advantages, Strain selection – Inoculum development – Mass production – Packaging – Quality control of different Biofertilizers.

UNIT – II

Animal Biotechnology: Transgenic cattle, super ovulation, Embryo transfer, production of recombination products- Growth hormones, Human Interferon, Vaccines, Monoclonal antibody, Gene knockout and mice model

for Human genetic disorder, stem cell therapy.

UNIT – III

Industrial Biotechnology: Fermentors – Types, Production of enzymes- Amylases, proteases and Lipases. Antibiotics – Penicillin. Aminoacids –Glutamic acid. Production of alcohol, Xanthan gum and SCP. **Alcoholic**: Fermented and distilled their preparation and sources. **Production of dairy products:** Cheese. Yoghurt, buttermilk, kefir, koumiss, acidophilus milk. Pickles – Dill pickles, slippery pickles, soft and black pickles. Fermented Vegetables – Sauerkraut.

UNIT – IV

Environmental Biotechnology: Biosensors – Types, xenobiotics degradation, Bioleaching, sewage treatment, Biogas production, Role of superbug in biodegradation, Bioremediation – *Insitu* and *Exsitu.*

UNIT – V

Bioethics and Biosafety: Intellectual property rights. General ethics & ethical issues, Animal rights, Environmental safety of GMOs. Regulation of GMOs, Bioethics for future.

REFERENCES

1. U. Satyanaranya. (2018). *Biotechnology* (12th ed.). Generic Publishers, New South Wales,Australia.

2. Chatterji, A.K. (2011). *Introduction to Environmental Biotechnology* (3rd ed.). Prentice Hall India Learning, New Delhi,India.

3. Jenkins, N., Barron, N., & Alves, P. (2013). *Proceedings of the 21st Annual Meeting of the European Society for Animal Cell Technology*. Springer Publishers, New York, United States.

4. Adam, J. (2016). *Applied Biotechnology in Genetic Engineering, Pharmaceuticals and Agriculture.* Syrawood Publishing House, New York, United States.

5. Goel, D. & Parashar, S. (2013). IPR, Biosafety and Bioethics (1st ed.). Pearson Publishers, London, United Kingdom.

18BTP305B	SYSTEM BIOLOGY	Semester – III 4H – 4C

Instruction Hours / week: L: 4 T: 0 P: 0

Marks: Internal: **40** External: **60** Total: **100**

End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Understand the new concept of system biology applied to the area of biotechnology
- Build the knowledge in computational methods in biotechnology
- Acquire requisite skills for the design and development of high throughput screening and to retrieve and submit the data, genome database and other databases and analysis
- Learn the computational tools for applying biotechnology in research
- Study the techniques involved in structural and functional proteomics
- Utilize the bioinformatics tools to design and development of novel drugs

Course Outcomes

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

1. Understand the basic concepts of System Biology
2. Differentiate various Metabolic Networks and Models in System Biology
3. Understand the various databases available for data collection and interpretation
4. Understand the scope and applications of tools
5. Utilize the computational tools for applying biotechnology in research
6. Study and deduce the molecular characterization of human genome

UNIT – I

Introduction to Systems Biology: Introduction to Systems Biology. Need for System Analysis in Biology. Basic Concepts in System Biology: Component vs System, Links and Functional States, Links to Networks, Hierarchical Organization in Biology.

systems, scales, static/dynamic, approaches, limitations, reductionism; central dogma; mathematical models; computational analysis; statistics of prokaryotes and eukaryotes.

UNIT – II

Metabolic Networks and Models in System Biology: Basic Features of Metabolic Networks. Reconstruction Methods of Metabolic Networks. Models as Dynamical Systems. SYN1, SYN3 and molecular simulation, Parameter Problem. Meanings of Robustness.

UNIT – III

Systems Biology Databases KEGG (Kyoto Encyclopedia of Genes and Genomes). BRENDA (BRaunschweig ENzyme DAtabase). BioSilico. EMP (Embden-Meyerhof-Parnas). MetaCyc and AraCyc. SABIO-RK (System for the Analysis of Biochemical Pathways - Reaction Kinetics). BioModels.

UNIT – IV

Tools for System Biology: Cell Designer. Ali Baba. Cell Profiler. JDesigner. Bio-SPICE (Biological Simulation Program for Intra and Inter Cellular Evaluation). SBML (Systems Biology Markup Language). SBGN (Systems Biology Graphical Notation). SBML-SAT (SBML based Sensitivity Analysis Tool).

UNIT – V

Premises & Promises of Systems Biology: Premise of Systems Biology. Promise of Systems Biology. Challenges of Systems Biology. Applications of Systems Biology.

REFERENCES

1. Palsson, B.O. (2006). *Systems Biology: Properties of Reconstructed Networks.* Cambridge University Press, Cambridge, United Kingdom.

2. Junker, B.H. & Schreiber, F. (2011). *Analysis of Biological Networks.* Wiley-Interscience Publishers, New Jersey, United States.

3. Lodhi, H.M. & Muggleton, S.H. (2010) *Elements of Computational Systems Biology.* Wiley-Blackwell Publishers, New Jersey, United States.

4. Cánovas, M., Iborra, J.L., & Manjón, A. (2006). *Understanding and Exploiting Systems Biology in Biomedicine and Bioprocesses.* CajaMurcia Foundation, Spain.

5. Sensen, C.W. (2002). *Essentials of Genomics and Bioinformatics*. Wiley-VCH Publishers, New Jersey, United States.

6. Pennington, S.R. & Dunn, M.J. (2002). *Proteomics.* Viva Books Pvt. Ltd., New Delhi, India.

7. Voit, E. (2017). *A First Course in Systems Biology* (2nd ed.). Garland Science Publishers, United States.

8. http://www.systemsbiology.org

9. http://www.systems-biology.org

Semester –III

18BTP305C TISSUE ENGINEERING AND REGENERATIVE MEDICINE 4H – 4C

Instruction Hours/week: L:4 T:0 P:0 **Marks:** Internal:40 External:**60** Total:**100**

End Semester Exam: 3 Hours

Course Objectives

The objectives of the course are to make the students to

- Understand tissue growth and development as well as the tools and theoretical information necessary to design tissues and organs.
- Recognize the need of controlling all factors related to biomaterials architecture such as cell biology, biochemistry pathways, and surface characterization and modification.
- Comprehend various physical and chemical stimuli that control the structure of biomaterials
- Get knowledge in which cell types are available to be used in tissue engineering applications
- Understand the relevance of the extracellular matrix and its interaction with materials
- Obtain knowledge on bioreactors used in tissue engineering

Course Outcomes

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

1. Describe and use the fundamental tools and techniques used in tissue engineering
2. Compare and contrast various strategies for repairing tissues
3. Show mastery of fundamental topics in tissue engineering including stem cells, plasticity, transdifferentiation, and cloning
4. Describe and the developments of biomaterials for regenerative therapies and tissue engineering
5. Discuss and give an example of how biomaterials are used to fabricate devices for clinical use
6. Illustrate the basic concepts of cell culture and critical components of bioreactor/tissue design

UNIT – I

Introduction to Tissue engineering and Regenerative medicine. Tissue engineering and cells as therapeutic agents. Tissue structure and organization, extra cellular matrix, and tissue dynamics.

UNIT – II

Cellular fate processes. Cell division and cell death. Coordination of cellular fate processes and malfunctions in soluble signaling. Cell-extra cellular matrix interactions and cell-cell communications.

UNIT – III

Cell and Tissue Culture. Separation, Culture environment and maintenance of cells *in vitro*. Microscopic characterization of tissues. Basic tools to detect cell fate and cell functions.

UNIT – IV

Stem cells and growth factor delivery, and Bioreactors. Stem cell properties, types, resources and application in tissue engineering and regenerative medicine. Gene transfer. Bioreactors in tissue engineering.

UNIT – V

Biomaterials and scaffold fabrication. Introduction and microscopic characterization of biomaterials. Degradable materials, porosity, mechanical strength, 3-D architecture and cell incorporation. Bioengineered scaffolds for bone, cartilage, tendons, ligaments, skin, liver, pancreas and blood vessels. Case study and regulatory issues.

REFERENCES

1. Palsson, B.O. & Bhatia, S. N. (2016). *Tissue Engineering* (1st ed.). Pearson Education Publishers, London, UnitedKingdom.

2. Atala, A., Lanza, R., Mikos, T., & Nerem, R. (2018). *Principles of Regenerative Medicine* (3rd ed.). Academic Press, London, UnitedKingdom.

3. Ravi, B. (2014). *Introduction to Tissue Engineering: Applications & challenges* (1st ed.). Wiley Publishers, New Jersey, UnitedStates.

4. Fisher, J.P., Mikos, A.G., Bronzino, J.D., & Peterson, D.R. (2017). *Tissue Engineering: Principles and Practices* (1st ed.). CRC Press, Florida, UnitedStates.

5. Wong, J.Y., Bronzino, J.D., & Peterson, D.R. (2016). *Biomaterials: Principles and practices* (1st ed.). CRC Press, Florida, United States.

6. Ramalingam, M., Ramakrishna, S., & Best,S. (2017). *Biomaterials and Stem Cells in Regenerative Medicine* (1st ed.). CRC Press, Florida, United States.

7. http://web.mit.edu/langerlab/

8. http://faculty.virginia.edu/laurencin/index.html

Semester –III

18BTP311 PLANT AND ANIMAL BIOTECHNOLOGY – PRACTICAL V 4H – 2C

Instruction Hours/week:L:0T:0 P:4 **Marks:**Internal:**40** External:**60** Total:**100**

End Semester Exam:3 Hours

Course Objectives

The objectives of the course are to make the students to

- Understand the new concept of biology applied to the area of biotechnology
- Gain hands-on experience to learn the principles behind plant and animal biotechnology
- Know the process involved in isolation, separation, manipulation of plant and animal tissues
- Apply the technology in research and development and pharmaceutical industries
- Execute the recent technology involved in plant and animal cell culture
- Describe the principles of gene manipulation

Course Outcomes

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

1. Acquaint with principles, technical requirement, scientific and commercial applications in plant and animal biotechnology
2. Support methodologies in plant and animal tissue/cell culture
3. Be able to describe basic principles and techniques in genetic manipulation and genetic engineering
4. Be able to describe gene transfer technologies in plants and animals
5. Be able to describe techniques and problems in plant and animal cloning
6. Become motivated to set goals towards pursuing graduate school and higher-level positions, such as lab manager and key scientist in plant and animal biotechnological research institutes and industries

List of Practicals

Plant Tissue Culture Techniques

1. *In vitro* Germination of Seeds
2. Micropropagation
3. Callus induction, differentiation and regeneration
4. Suspension culture
5. Embryo Culture
6. Synthetic seed production
7. Protoplast isolation
8. *Agrobacterium*-mediated gene transformation

Animal Biotechnology

9. Preparation and Filter-sterilization of Animal Tissue Culture Medium
10. Chicken embryo fibroblast Culture
11. Quantification of cells haemocytometer
12. Quantification of viable and non-viable cells by trypan blue dye exclusion method
13. Identification of leukocyte subsets and total count.

14. Blood leukocyte culture
15. Soft agar assay
16. Cryopreservation and revival of cell lines.

REFERENCES

1. Bhojwani, S.S. & Dantu, P.K. (2013). *Plant Tissue Culture: An Introductory Text and Practice.* Springer Publishers, New York, United States.
2. Butler, M. (2003). *Animal cell culture and technology: The basics* (2nd ed.). Taylor &Francis Publishers, Abingdon, United Kingdom.
3. Slater, A., Scott, N.W. & Fowler, M.R. (2008). *Plant Biotechnology: The Genetic Manipulation of plants* (2nd ed.). Oxford University Press, Oxford, United Kingdom.

Semester –III

18BTP312 GENOMICS, PROTEOMICS AND BIOINFORMATICS PRACTICAL – VI 4H –2C

Instruction Hours/week: L: 0T:0P:4 **Marks:** Internal:**40** External:**60** Total:**100**

End Semester Exam:3 Hours

Course Objectives

The objectives of the course are to make the students to:

- Give knowledge on Bioinformatics and its application.
- Offer knowledge to assess biological databases.
- Understand and to analyze protein/nucleotide sequences and to predict its 3D structure.
- Understand the various online databases for submitting and retrieving data.
- Understand how the phylogeny plays a vital role in finding ambiguities.
- Get practiced with the tools and techniques for analyzing the data.

Course Outcomes

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

1. Understand The relationship between sequence - structure - function of genes.
2. Familiarize with the algorithms required to compare sequences and require to know the phylogenetic relationship between the gene sequences.
3. Inculcate knowledge on building 3D structures of genes.
4. Locate and use the main databases at the NCBI and EBI resources.
5. Know the difference between databases, tools, repositories and be able to use each one to extract specific information.
6. Use selected tools at RasMol, JMol and PyMol to run simple analyses on genomic sequences

List of Practicals

1. Exploring of primary databases (Proteins and Nucleic acids) and sequence retrieval
2. Physicochemical and structural analyses of primary sequences (Proteins and Nucleic acids)
3. Sequence similarity searches and pairwise alignments
4. Multiple sequence alignments and phylogenetic analysis
5. Comparative modeling using online and standalone tools
6. Molecular visualization tools: RasMol, JMol andPyMol
7. Structural analysis and verification tools
8. Molecular dockings of biological macromolecules

REFERENCES

1. Baxevanis, A.D. & Ouellette, B.F. (2001). *Bioinformatics – A practical guide to the analyze of genes and proteins* (2nd ed.). Wiley-Blackwell Publishers, New York, United States.

2. Leach, A.R. & Gillet, V.J. (2009). *An Introduction to Chemoinformatics*. Springer Publishers, New York, United States.

3. Ibrahim, K.S., Gurusubramanian, G., Zothansanga, Yadav, R.P., Kumar, N.S., Pandian, S.K., Borah, P., & Mohan, S. (2017). *Bioinformatics - A Student's Companion*. Springer Publishers, New York, United States.

Semester – III

JOURNAL PAPER ANALYSIS AND PRESENTATION

2H – 0C

Semester – IV

PROJECT – VIVA VOCE

15C

Instruction Hours/week: L: 0T:0P:0 **Marks:** Internal: 80 External:120 Total: 200

Course Objectives

The main objectives of the course is

- The hands-on training through one full semester project with thesis gives special expertise within one of the research areas represented at The Department of Biotechnology.

Course Outcomes

On completion of the course, students are able to apply their knowledge on

1. This dissertation programme provides the candidate with knowledge, general competence, and analytical skills on an advanced level, needed in industry, consultancy, education and research