DEPARTMENT OF BIOTECHNOLOGY
FACULTY OF ARTS, SCIENCE AND HUMANITIES
PG PROGRAM (CBCS) – M.Sc. Biotechnology
(2020–2021 Batch and onwards)

Course code	Name of the course	Objectives and Outcomes		Instruction hours / Week			Credit (s)	Marks			Category	Page. No.
		PEOs	POs	L	T	P		CIA	ESE	Total		
SEMESTER – I												
20BTP101	Biochemistry and Microbiology	I	a	4	0	0	4	40	60	100	CC	5
20BTP102	Cell Biology and Molecular genetics	I	a	4	0	0	4	40	60	100	CC	7
20BTP103	Ecology, Evolutionary and Developmental Biology	I	a	4	0	0	4	40	60	100	CC	9
20BTP104	Bioinstrumentation and Biostatistics	I, II	a, b	3	1	0	4	40	60	100	CC	11
20BTP105A 20BTP105B 20BTP105C	Biodiversity, Biosafety And IPR Nano-Biotechnology Microbial Biotechnology	I	a	4	0	0	4	40	60	100	EC	13-18
20BTP111	Biochemistry and Microbiology-Practical – I	II	b, c	0	0	4	2	40	60	100	CC	20
20BTP112	Cell Biology and Molecular Genetics - Practical – II	II	b, c	0	0	4	2	40	60	100	CC	22
Journal Paper Analysis & Presentation		III, IV	d	2	0	0	-	-	-	-	CC	24
Semester total				**21**	**1**	**8**	**24**	**280**	**420**	**700**		
SEMESTER – II												
20BTP201	Recombinant DNA technology	I, III	a, e, f	4	0	0	4	40	60	100	CC	25
20BTP202	Fermentation and Bioprocess Technology	I, III	a, e, f	4	0	0	4	40	60	100	CC	27
20BTP203	Pharmaceutical Biotechnology	I, III	a, e, f	3	1	0	4	40	60	100	CC	29
20BTP204	Immunotechnology	I, III	a, e, f	4	0	0	4	40	60	100	CC	31
20BTP205A 20BTP205B 20BTP205C	Enzyme Technology Agricultural Biotechnology Industrial Toxicology	I, III	a, e, f	4	0	0	4	40	60	100	EC	35-37
20BTP211	Recombinant DNA, Fermentation and	II, III	b, c	0	0	4	2	40	60	100	CC	39

	Bioprocess Technology - Practical – III											
20BTP212	Immuno and Enzyme Technology -Practical – IV	II, III	b, c	0	0	4	2	40	60	100	CC	41
Journal Paper Analysis & Presentation		III, IV	d	2	0	0	-	-	-	-	CC	43
Semester total				**21**	**1**	**8**	**24**	**280**	**420**	**700**		

Course code	Name of the course	Objectives and Outcomes		Instruction hours / Week			Credit (s)	Marks			Category	Page. No.
		PEO´s	PO´s	L	T	P		CIA	ESE	Total		
SEMESTER - III												
20BTP301	Plant and Animal Biotechnology	I, III	a, e, f	4	0	0	4	40	60	100	CC	44
20BTP302	Genomics, Proteomics and Bioinformatics	I, III	a, e, f	4	0	0	4	40	60	100	CC	46
20BTP303	Food Biotechnology	I, III	a, e, f	4	0	0	4	40	60	100	CC	48
20BTP304	Environmental Biotechnology	I, III	a, e, f	3	1	0	4	40	60	100	CC	50
20BTP305A 20BTP305B 20BTP305C	Applied Biotechnology Systems Biology Tissue Engineering and Regenerative Medicine	I, III	a, e, f	4	0	0	4	40	60	100	EC	52-58
20BTP311	Plant and Animal Biotechnology- Practical – V	II, III	b, c	0	0	4	2	40	60	100	CC	59
20BTP312	Genomics, Proteomics and Bioinformatics - Practical – VI	II, III	b, c	0	0	4	2	40	60	100	CC	61
Journal Paper Analysis & Presentation		III, IV	d	2	0	0	-	-	-	-	CC	63
Semester total				**21**	**1**	**8**	**24**	**280**	**420**	**700**		
SEMESTER – IV												
20BTP491	Project and *Viva Voce*	III, IV	d,e,f,g	-	-	-	15	80	120	200	CC	64
Semester total				**-**	**-**	**-**	**15**	**80**	**120**	**200**		
				42	**3**	**45**	**87**	**920**	**1380**	**2300**		

Elective courses*

Elective – 1 (20BTP105)		Elective – 2 (20BTP205)		Elective – 3 (20BTP305)	
Course code	**Name of the course (Theory)**	**Course Code**	**Name of the course (Theory)**	**Course Code**	**Name of the course (Theory)**
20BTP105A	Biodiversity, Biosafety and IPR	20BTP205A	Enzyme Technology	20BTP305A	Applied Biotechnology
20BTP105B	Nano-Biotechnology	20BTP205B	Agricultural Biotechnology	20BTP305B	System Biology
20BTP105C	Microbial Biotechnology	20BTP205C	Industrial Toxicology	20BTP305C	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) Ability to design and conduct experiments as well as to interpret the results.

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

d) Making the graduates to demonstrate their communication effectively and scientifically in both verbal and written form as independent researcher.

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

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

g) Graduates will be able to recognize need for self learning and lifelong learning.

PROGRAMME SPECIFIC OUTCOMEs (PSOs)

To enable the student to emerge as:

a) An expert to work on biotechnological concepts and allied fields (medical, microbial, agricultural, environmental, plant and animal) with modern tools and techniques towards product and process development for academic, industrial and research applications.

b) Proficiency 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 the 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 to learn to update and to become an entrepreneur in a competitive world of technology update 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				×	×	×	×		×

BIOCHEMISTRY AND MICROBIOLOGY

20BTP101 **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 know the classification of microorganisms
- To obtain strong knowledge on industrial application of microorganisms
- To obtain necessary knowledge on diseases and causative agents

Course Outcomes

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

1. Obtain the knowledge on the structure of amino acids, proteins, enzymes, chemical messengers, carbohydrates, lipids, and nucleic acid
2. Understand fundamental properties of elements, their role in formation of biomolecules and in chemical reactions within living organisms
3. Write the chemical reactions involved in biochemical pathways that produce ATP such as citric acid cycle and electron transport
4. Be familiar with the enzymes (biocatalysts), and their salient attributes including unique conformation and amazing catalytic properties
5. Describe the metabolic pathways in microorganisms
6. Designate the infectious organisms and treatment measures

UNIT –I Biomolecules:

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

UNIT –II Metabolisms:

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

UNIT – III Bioenergetics:

Concepts of free energy – Thermodynamics- TCA Cycle, glycolysis, gluconeogenesis, Pentose phosphate shunt, Embden-Meyerhof pathway, urea cycle, interconnection of pathways, Metabolic regulation, Bioenergetics: Respiratory chain, ATP cycle and energy-rich compounds, Mitochondria and ATP synthesis Inhibitor.

UNIT- IV Introduction to Microbiology:

History of Microbiology. Five kingdom classification of microorganism. Classification, distribution and reproduction of Bacteria, fungi, algae and virus. Sterilization techniques, Cultivation of microbes, Culture media, Isolation of pure cultures and preservation, Microbial growth curve, Microscopy-Principle, types and application

- Staining techniques.

UNIT –V Applications, Diseases and control measures:

Industrial applications: Biomass production (Single cell Protein) and antibiotic production. Microbial Diseases - Causative agent, pathology, diagnosis, control and treatment of Bacterial - TB, Cholera and Typhoid. Protozoan

– Amoebiasis and Malaria.Viral - AIDS.Control of microorganisms – drugs, chemotheraphy, antimicrobial agents.

SUGGESTED READINGS:

1. Black, J.G. & Black, L.J. (2015). *Microbiology: Principles and Explorations*(9th ed.). Wiley Publishers, New York, United States.
2. Jain, J. L., Jain,S., &Jain,N. (2016). *Fundamentals of Biochemistry* (7th ed.). S. Chand & Co. New Delhi, India.
3. Nelson, D.L., & Cox, M.M. (2017). Lehninger: *Principles of Biochemistry* (7th ed.). W.H. Freeman and Company, New York, United States.
4. Pelczar, M.J., Chan, E.C.S., & Krieg, N.R. (1993). *Microbiology: Concepts and Applications* (6th ed.). McGraw - Hill Education/Medical, London, United Kingdom.
5. Rodwell, V.W., Bender, D., Botham, K.M., Kennelly, P.J., & Weil, P.A. (2018). *Harper's illustrated Biochemistry* (31st ed.). McGraw-Hill Education/Medical, London, United Kingdom.
6. Talaro, K.P. & Chess, B. (2017). *Foundations in Microbiology*. (10th ed.). McGraw - Hill Education/Medical, London, United Kingdom.
7. Voet, D., Voet, J.G., & Pratt, C.W. (2016). *Fundamentals of Biochemistry* (5th ed.). Wiley Publishers, New York, United States.
8. Willey, J., Sandman, K., & Wood, D. (2019). *Prescott'sMicrobiology* (11th ed.). McGraw - Hill Education/Medical, London, United Kingdom.
9. Zubay, G.L., Parson, W.W., & Vance D.E. (1995). *Principles of Biochemistry* (1st ed.). W.C. Brown Publishers, Iowa, United States.

CELL BIOLOGY AND MOLECULAR GENETICS

20BTP102 **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 structures and functions of basic components of eukaryotic cells, especially macromolecules, membranes, and organelles
- To understand how the cellular components are used to generate and utilize energy in cells
- To 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 behaviors in human cells, and understand the cause and effect of alterations in chromosome number and structure

Course Outcomes

On successful completion of the course, the learners 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 and the inheritance of gene in human beings
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 Structure of membrane system:

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, Cell cycle 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, Linkage and Crossing over. Mutations- Types of Mutation, Genetic analysis of Mutations, DNA repair Mechanisms.

UNIT - IV Genetic transformation, Genome Mapping and Transposable elements:

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, Mechanism of Insertion sequences – 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 its genetic implications, Quantitative genetics - Polygenetic inheritance, Heritability and its measurements, Quantitative Trait Llocus (QTL) mapping.

SUGGESTED READINGS:

1. Alberts, B. (2017*). Molecular Biology of the Cell* (Sixth ed.). Garland Science Publication.
2. Cooper, G.M. (2018). *The Cell: A Molecular Approach* (Eighth ed.). Sinauer Associates (Oxford University Press).
3. Krishnaiya, G.R. (2019). *A Textbook of Microbial Genetics & Molecular Biology* (First ed.). Blue Rose Publishers.
4. Strachan, T., Read, A. (2018). *Human Molecular Genetics* (Fifth ed.). Garland Science Publication.
5. MOOC: https://nptel.ac.in/courses/102103012/
6. MOOC: https://nptel.ac.in/courses/102104052/
7. Ranzoni, A.M., Cvejic, A. (2018*). Single-cell biology: resolving biological complexity, one cell at a time*. Development. The Company of Biologists Publication.
8. E-content: http://172.16.25.76/course/view.php?id=1602

ECOLOGY, EVOLUTIONARY AND DEVELOPMENTAL BIOLOGY

20BTP103 **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 comprehend the principles of evolution
- To know the concepts of community ecology
- To realize the origin of biotic community
- To escalate the basic concepts of population genetics
- To recognize the significance of morphogenesis and organogenesis in plants
- To understand the significance of developmental aspects of living organism

Course Outcomes

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

1. Learn the fundamental principles and concepts of evolutionary theory and ecology
2. Use this knowledge to explore the evolution
3. Learn the basic ecological theory
4. Understand the principles and proposing solutions to the major environmental problems facing the biosphere
5. Describe evolutionary and ecological patterns and processes related to the survival
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, estuarine). 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 and tools.

UNIT – IV Population genetics:

Populations, Hardy-Weinberg Law, Speciation; Convergent evolution. Brain, Behavior and Evolution: Approaches, methods. Biological clocks; 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:

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 Arabidopsisand Antirrhinum.

SUGGESTED READINGS:

1. Gilbert, S.F. & Barresi, M.J.F. (2016). *Developmental Biology* (11thed.). Sinauer Associates (Oxford University Press), Sunderland, United Kingdom.
2. Joshi, P.C. & Joshi, N. (2004). *Biodiversity and Conservation*. APH Publishers, New Delhi, India.
3. Krishnamoorthy, K.V. (2017). *An advanced Text Book on Biodiversity: Principles and Practice* (1sted.). Oxford &IBH Publishers, New Delhi, India.
4. Melchias, G. (2001). *Biodiversity and Conservation*. Science Publishers (CRC Press), Florida, United States.
5. Minelli, A. (2018). *Plant Evolutionary Developmental Biology: The Evolvability of the Phenotype* (1sted.). Cambridge University Press, Cambridge, United Kingdom.
6. Nielsen, R. &Slatkin, M. (2013). *An Introduction to Population Genetics: Theory and Applications* (1st ed). Sinauer Associates (Oxford University Press), Sunderland, United Kingdom.
7. Odum, E.P. & Barrett, G.W. (2004). *Fundamentals of Ecology* (5thed.). Cengage Learning Publishers, Massachusetts, United States
8. Pontarotti, P. (2016). *Evolutionary Biology: Convergent Evolution, Evolution of Complex Traits, Concepts and Methods* (1st ed.). Springer Publishers, New York, United States.

BIOINSTRUMENTATION AND BIOSTATISTICS

20BTP104 **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 main objectives of the course are

- To understand the fundamental principles of bioinstrumentation commonly used in biomedical engineering research labs and hospitals
- To comprehend the colorimetric principles
- To recognize the concepts on centrifugation and chromatography
- To obtain key knowledge on electrophoresis
- To understand key concepts on biostatistics and its various parameters
- To attain strong knowledge on the applications of biostatistics and its relevant softwares

Course Outcomes

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

1. Demonstrate 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 of chromatography for the separation of bioactive compounds
4. Recognize the definition of statistics and its relation with the other sciences
5. Collect data relating to variable/variables which will be examined and calculate descriptive statistics from these data
6. Apply the statistical knowledge in analyzing biological problems

UNIT – I Colorimetry and Spectroscopy:

Spectroscopy: Calorimetry, basic principles, Color and absorption spectra, Beer's and Lambert's law., Instrumentation and applications of UV Visible light spectroscopy, Spectrofluorimeter, FTIR, atomic spectroscopy, NMR spectroscopy – 2D and 3D structure prediction, Peptide Mass Finger printing - MALDI –TOF, Mass Spectrometry - GC-MS, LC- MS.

UNIT – II Centrifugation and Chromatography:

Principle, types of centrifuges, Principles, g and RPM value, Applications of analytical and preparative centrifuge, density gradient and ultra-centrifuge. Chromatography: Principles, Type - Paper, thin layer, ion-exchange, affinity, gel filtration, FPLC, HPLC and HPTLC

UNIT – III Electrophoresis:

Principle, instrumentation and applications of Electrophoresis: Agarose gel electrophoresis, Sodium dodecyl sulphate - polyacrylamide gel (SDS-PAGE), native PAGE, immuno, pulse field, gel, capillaryelectrophoresis,2D-Electrophoresis, isoelectric focusing, gel documentation and image analysis, Immuoblotting.

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. Probability and probability distribution – theorems, binomial, poisson and normal distribution. Correlation and regression – simple correlation, correlation co-efficient, simple and linear regression analysis.

UNIT- V Applications of biostatistics:

Randomized block design, ANOVA, Test of significance -F, t, DMRT and chi-square test. Statistical and graphical software – SPSS and other softwares. Case studies.

SUGGESTED READINGS:

1. Boyer, R.F. (2000). *Modern Experimental Biochemistry* (3rded.). Pearson Publishers, London, United Kingdom.
2. Chatwal, G.R.&Anand, S.K. (2014). *Instrumental Methods of Chemical Analysis* (5thed.). Himalaya Publishing House,Mumbai, India.
3. Glover,T. & Mitchell, H. (2015). *An Introduction to Biostatistics* (3rded.). Waveland Press, Illinois, United States.
4. Hofmann, A. &Clokie, S. (2018). *Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology* (8thed.). Cambridge University Press, Cambridge, United Kingdom.
5. Rosner, B. (2015). *Fundamentals of Biostatistics* (8thed.). Cengage Learning Publishers, Massachusetts, United States.
6. Sawhney, S.K.& Singh, R. (2005). Introductory *Practical Biochemistry* (2nded.). Alpha Science International Ltd. Publishers, Oxford, United Kingdom.
7. Sharma, B.K. (2011). *Instrumental Methods of Chemical Analysis* (1sted.). Krishna Prakashan Media Publishers, Meerut, India.
8. Veerakumari, L. (2009). *Bioinstrumentation*. MJP Publishers, Chennai, India.

BIODIVERSITY, BIOSAFETY AND IPR

20BTP105A **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 introduce basic concepts of biosafety that is essential for different disciplines of science
- To know the procedures involved in protection of intellectual property and related rights
- To discuss about various aspects of biosafety regulations and IPR concerns arising from the commercialization of biotech products
- To understand balanced integration of scientific and social knowledge in sustainable development
- To attain knowledge on the benefits of GM technology and its related issues
- To identify the patent related cases

Course Outcomes

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

1. Interpret basics of biosafety and its impact on all the biological sciences and the quality of human life
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. Describe various agreements and treaties related to the protection of intellectual property

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. National Biodiversity Authority. Protection of environment and biodiversity

UNIT –II Bioethics:

Introduction. Animal Rights. ethical conflicts in biological sciences - interference with nature, 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.

UNIT – III 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 Micro organisms (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. Roles of IBSC, RCGM and GEAC. GM labeling – Food Safety and Standards Authority of India (FSSAI).

UNIT –IV Intellectual Property Rights:

Types of IP: Patents, Trademarks, Copyright and Related Rights. Physical and Intellectual Property. Tangible and Intangible property. **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 – V Patent application:

Rules governing patents. International Patent guidelines. 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.

SUGGESTED READINGS:

1. Balasubramanian, S. (2017). India: Traditional Knowledge and Patent Issues: An Overview of Turmeric, Basmati, Neem Cases.
2. Biodiversity and Conservation. http://ncert.nic.in/ncerts/l/lebo115.pdf
3. Gaston, K.J. &Spicer, J.I. (2013) *Biodiversity: An Introduction* (2nd ed.). Wiley-Blackwell Publishers, New Jersey, United States.
4. GEAC India. http://geacindia.gov.in/resource-documents/biosafety-regulations/guidelines-and- protocols/GuidelinesfortheERAofGEplants.pdf
5. Goel, D. & Parashar, S. (2013). *IPR, Biosafety and Bioethics* (1st ed.). Pearson Publishers, London, United Kingdom.
6. http://www.mondaq.com/india/x/586384/Patent/Traditional+Knowledge+And+Patent+Issues+An+Overview+Of+Turmeric+Basmati+Neem+Cases
7. Intellectual Propertry India. The Patents Act, 1970. http://www.ipindia.nic.in/writereaddata/Portal/IPOAct/1311_patent-act-1970-11march2015. pdf
8. IPR in UK. https://www.wilsongunn.com/guide-to-ip/
9. Kankanala, C. (2007). *Genetic Patent Law and Strategy* (1st ed.). Manupatra Information Solution Pvt. Ltd. India.
10. Legal and Public Aspects of Biotechnology. http://www.actahort.org/members/showpdf?booknrarnr=447_125.
11. Llewelyn, D. & Aplin, T. (2019). Intellectual Property: Patents, Copyrights, Trademarks & Allied Rights (9th ed.). Sweet & Maxwell Publishers, London, United Kingdom.
12. Ministry of Environment, Forest and Climate Change, India.

http://moef.gov.in/environment/biodiversity/
13. National Biodiversity Authority of India. http://nbaindia.org/.
14. Office ofthe Controller General of Patents, Designs & Trade Marks, India. http://www.ipindia.nic.in/
15. Transgenic Crops-Biosafety Concerns and Regulations in India. http://vikaspedia.in/agriculture/crop-production/advanced-technologies/transgenic-crops-biosafety-concerns-and-regulations-in-india
16. U.S. Department of Health and Human Services. (2016). Biosafety in Microbiological and Biomedical Laboratories. Lulu Publishers, North Carolina, United States.
17. World Intellectual Property Organization. http://www.wipo.int/portal/index.html.en

NANO BIOTECHNOLOGY

20BTP105B **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 obtain sufficient knowledge on the fundamental concepts of Nano biotechnology
- To offer a strong knowledge in the interface between chemistry, physics and biology on the nano-structural level with a focus on biotechnological usage
- To provide advanced training in the area of Nano biotechnology
- To understand the interaction of nanomaterials with biological molecules and cells
- To learn nanomaterials and their use with biocomponents to synthesize and address larger systems.
- To produce highly skilled individuals suited for the fast-changing requirements of today's advanced workforce

Course Outcomes

On successful completion of the course, the learners 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 solving biological problems
2. Demonstrate the interactions and relationship between molecular dynamics, nanoscale physics and macroscopic system behaviour
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. Nanobiotechnology – concepts, definitions, prospects; nanoparticles – size, shape, properties. Types - nanoparticles, quantum dots, nanotubes and nanowires.

UNIT – II: Synthesis and Characterization:

Methods – Physical, Chemical and Biological synthesis – Principle, Applications; Nanoanalysis –Optical (UV-Vis/Fluorescence); X-ray diffraction; Imaging and size (Electron microscopy, light scattering, Zeta potential); Raman Spectroscopy, Surface and composition (ECSA, EDAX, AFM/STM etc); Vibrational (FT-IR and RAMAN), Magnetic, Electrical and Electrochemical analysis.

UNIT – III Nano biotechnology and Biomedical:

Nanoparticles in biomedical and clinical applications. Cytotoxicity, Geno-toxicity *In vivo* tests/assays. Biosensors. Biomedical applications: drugs, drug delivery, molecular motors, photodynamic therapy. Neuro electronic interfaces, Nanoluminescent tags, imaging and mapping. Microfluidics and Lab-on-a-chip - Materials of Microfluidic Components - Silicon, Glass, polymers, fluid structure, fabrication methods. Surface modifications, Spotting, Detection mechanics.

UNIT – IV Nano biotechnology and Agriculture:

Nanoparticles – Phytotoxicity tests/assays; Nano-materials to improve crop productivity, Seed pretreatment, Growth promotion, Nano- fertilizers, Nano- pesticides, Nano-nutrient.

UNIT – V Nanotechnology and Environment:

Nanoparticles in bio- degradation, nano-material-based adsorbents for water treatment, possible mutagenic properties of nanoparticles, nanoparticle bioaccumulation. Ecological effects of nanoparticles.

SUGGESTED READINGS:

1. Muralidharan, V.S. & Subramania, A. (2008). *Nanoscience and technology* (1st ed.). CRC Press, Florida, United States.
2. Niemeyer, C.M. & Mirkin, C. A. (2004). *Nanobiotechnology Concepts, Application and Perspectives* (1st ed.). Wiley – VCH Publishers, New York, United States.
3. Rao, C.N.R. (2006). *The Chemistry of Nanomaterial: Synthesis, Properties and Applications* (Vols 1 &3). Springer Publishers, New York, United States.
4. Ratner, M., & Ratner, D. (2002). *Nanotechnology- a Gentle Introduction to the Next Big idea*. Pearson Education, London, United Kingdom.
5. Vo-Dinh, T. (2017). Nanotechnology in Biology and Medicine: Methods, Devices and Applications. (2nd ed.). CRC Press, Florida, United States.

MICROBIAL BIOTECHNOLOGY

20BTP105C **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 provide an in-depth look at how microbes and their metabolic pathways and products can be used in biotechnology
- To develop their own interests in other aspects of biotechnology
- To acquire knowledge on the use of genetically manipulated organisms, biotechnologically important enzymes and specific biochemical pathway
- To understand the microbial bio-conservation rate in yield of agriculture
- To describe the waste utilization of sewage
- To understand and industrial applications of algal biomass

Course Outcomes

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

1. Critically evaluate the role of micro-organisms in specific biotechnological processes.
2. Explain the complex processes behind the development of genetically manipulated organisms**.**
3. Demonstrate a clear understanding of how biochemical pathways relate to biotechnological applications.
4. Discuss state-of-the-art technologies of genetics of antimicrobial metabolite production in biocontrol bacteria.
5. Identify microbiological techniques, the defining characteristics of the major groups of microorganisms and apply to study microbial phylogeny
6. Collect the proficient knowledge of living systems in the energy production, utilization of waste to commercially important compounds and bioremediation process

UNIT I Introduction

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

UNIT II Microalgae

History and biotechnological potentials of microalgae, food, feed. Colorant, fuel and pharmaceutically valuable compounds. Cultivation methods of algae with reference to *Dunaliella sp.* and *Phormidium valderianum*. Industrial Applications of microalgae.

UNIT III Agricultural Microbiology

Plant Microbes Interaction; Microbial herbicides, Agricultural antibiotics, Microbial Bio-fertilizers and Bio- insecticides; Biological pest control. Mode of action of biological control involved in different biocontrol agents. Genetics of antimicrobial metabolite production in biocontrol bacteria. Risks associated with GMOs, Potential impacts on the environment and human health.

UNIT IV Microbial Bioconversion

Bioconversion of cellulosic and non-cellulosic wastes. Mechanism of novel carboxylase genes involved in bioconversion. Agro byproducts. Bioremediation of wood, fuels lubricants, rubber, plastics.

UNIT V Waste utilization

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

SUGGESTED READINGS:

1. Bernad. R. Glick and Jack J. Pasternak. (2002). Molecular Biotechnology Principles and Applications of Recombinant DNA. WCB.
2. Glazer, A.N. and Nikaido, H. (2007) Microbial Biotechnology. Cambridge, New York.
3. Harzevili, D.F. and Chen, H. (2015). Microbial Biotechonology: Progress and trends. Taylor and Francis group.
4. Kun, Y.L (2013). Microbial Biotechnology: Principles and applications. World Scientific Publishing Company; 3rd revised ed. Edition.

BIOCHEMISTRY AND MICROBIOLOGY – PRACTICAL I

20BTP111 **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 main objectives of the course are

- To train the students of the subject on handling various experimental methods and techniques in order to analyze the given biological samples from biochemical stand points
- To gain experience in microbiological laboratory practices and skills in the design and execution of microbiology related research
- To provide foundation in various methods to cultivate the microbes and maintenance of the microorganism
- To provide quantitative analysis of the macromolecules in the given sample and analyze the results
- To provide students with a deep insight of the various biochemical reactions and cellular processes through quantitative and qualitative analysis of the samples provided
- To execute the laboratory experiments, independently using the standard methods and techniques in Biochemistry and Microbiology

Course Outcomes

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

1. Acquire skills to quantitatively estimate various biomolecules and as well to carryout enzyme kinetics
2. Comprise out line knowledge on isolation, sub culture and maintenance of microbes
3. Understand nutritional requirements of bacteria
4. Apply knowledge of cell biology and biochemistry in various cellular functions, inculcate a knowledge of various issues related to life processes and the application of research involved in functioning of the different cell organelles and accessories
5. Apply the scientific method by stating a question; researching the topic; determining appropriate tests; performing tests; collecting, analyzing, and presenting data and effective communicate with both specialist and non-specialist audiences/community
6. Evaluate how microorganisms interact with the environment in beneficial or detrimental ways

Biochemistry

1. Quantification of proteins by Lowry *et al method*
2. Quantification of carbohydrates by Phenol sulphuric acid method
3. Estimation of Total free amino acids by Ninhydrin method
4. Quantification of lipids by Folch method
5. Quantification of Ascorbic acid
6. Separation of Amino acids / fatty acids/ sugar/ nucleic acids by Thin Layer Chromatography
7. Purification of any one enzyme - Catalase / SOD / amylase by precipitation and dialysis

Microbiology

1. Pure culture technique –pour plate, spread plate and streaking methods.
2. Staining technique –grams staining and fungal staining
3. Motility test –hanging drop and soft agar analysis.
4. Growth curve (Bacteria and Fungi) - turbidity cell counting with reference to dilution and Biomass estimation.
5. Screening of antibiotic sensitive test by agar well diffusion and disc diffusion methods.

SUGGESTED READINGS:

1. Boyer, R.F. (2011). Biochemistry Laboratory: Modern Theory and Techniques (2nded.). Pearson Education Publishers, New Jersey, United States.
2. Hofmann, A. & Clokie, S. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology (8thed.). Cambridge University Press, Cambridge, United Kingdom.
3. Palanivelu, P. (2016). Analytical Biochemistry and Separation Techniques (5thed.). Twentyfirst Century Publications, Coimbatore, India.
4. Sadasivam. S. &Manickam, A. (2008). Biochemical Methods. (3rded.). New Age International Private Limited Publishers, New Delhi, India.

CELL BIOLOGY AND MOLECULAR GENETICS - PRACTICAL II

20BTP112 **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 main objectives of the course are

- To gain knowledge on Cell Biology and Molecular Genetics and its application
- To understand various cell types and its components
- To understand how to perform fractionation of cellular components
- To get practiced with the tools and techniques for analyzing conjugation and transduction
- To know the nuclear staining techniques
- To comprehend lipid solubility of membranes

Course Outcomes

On successful completion of the course, the learners 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 *Drosophila* giant chromosome preparation and nuclear staining
5. Perform conjugation and transduction experiments
6. Do cell cycle analysis experiments

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 – Plasmolysis - 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
6. Transformation

SUGGESTED READINGS:

1. Current Protocols in Cell Biology (First ed.). (2019). WILEY Publication.
2. https://academicworks.cuny.edu/cgi/viewcontent.cgi?article=1008&context=ny_oers
3. https://indiabioscience.org/media/articles/DBT-Life-Science-Protocol-Manual.pdf
4. https://www.bjcancer.org/Sites_OldFiles/_Library/UserFiles/pdf/Cell_Biology_Laboratory_Manu al.pdf
5. Laboratory Manual for Principles of Genetics (First ed.). (2019). LAMBERT Academic Publishing.
6. Sundararaman, G. and Arumugam, A. (2017). Lab in Cell Biology, Microbiology and Bioinstrumentation: Laboratory Manual. Independently Published.
7. E-content: http://172.16.25.76/course/view.php?id=1597

JOURNAL PAPER ANALYSIS AND PRESENTATION

2H-0C

RECOMBINANT DNA TECHNOLOGY

20BTP201 **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 familiarize with emerging field of biotechnology: Recombinant DNA Technology
- To understand the basic concepts of recombinant DNA Technology and genetic engineering
- To acquaint versatile tools and techniques employed in recombinant DNA technology
- To obtain the principles of versatile DNA modifying enzymes, cloning strategies, and vector types for selection and screening of recombinant clones
- To understand the concepts of nucleic acid labeling techniques
- To 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, the learners will be able to

1. Understand 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: Classification of Restriction endonucleases, ligases, polymerases, modification enzymes - kinases, phosphatases, adapters and linkers, Polynucleotide tailing and topoisomerase.

UNIT –II Cloning Vectors:

Plasmid - conjugative and non-conjugative plasmid, Types of Plasmid- Natural plasmids, Artificial plasmid- pBR322 and PUC series. Expression vectors and applications: Phage vectors. Plant Vector – Ti plasmid. Animal viral vectors - Retroviral viral vectors, Shuttle vectors, cosmid, phagemid, phasmid. 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 Techniques in genetic engineering:

Polymerase Chain Reaction-types applications, RAPD, RFLP, AFLP, SSCP, Microarray, protein engineering- site directed mutagenesis, PCR mediated. Alteration of restriction sites, Molecular diagnosis of diseases.

UNIT –V Application:

Antisense technology, RNAi technology, terminator gene technology, CRISPR gene therapy- *in vivo* and *ex vivo*. DNA marker technology in plants, DNA fingerprinting, Epigenetics, genetically engineered biotherapeutics and vaccines.

SUGGESTED READINGS:

1. Brown, T.A. (2016). *Gene Cloning and DNA Analysis: An Introduction* (7th ed.). Wiley-Blackwell Publishers, New Jersey, United States.
2. Glick, B.R. & Patten, C.L. (2017). *Molecular Biotechnology*. (5th ed.) Taylor & Francis Publishers, Abingdon, United Kingdom.
3. http://172.16.25.76/login/index.php
4. https://nptel.ac.in/courses/102103013/
5. Primrose, S.B. & Twyman, R. M. (2016). *Principles of Gene Manipulation and Genomics* (8th ed.). John Wiley and Sons Ltd. Publishers, Chicester, United Kingdom.
6. Recombinant DNA Technology (2019). Siddra Ijaz, Imran Ul Haq – Cambridge scholars publishing
7. Watson, J.D., Caudy, A.A., Myers, R.M., & Witkowski, J.A. (2007). *Recombinant DNA: Genes and Genomes* (3rd ed.). W.H. Freeman and Company, New York, United States.
8. Winnacker, E.L. (2013). *From Genes to Clones* (1st ed.). Panima Educational Book Agency, New Delhi, India.

Semester – II

FERMENTATION AND BIOPROCESS TECHNOLOGY

20BTP202 **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 familiarize with knowledge about biological and biochemical technology, with a focus on biological products, the design and operation of industrial practices
- To describe power requirements in bioreactors, modeling of bioprocesses, and traditional and new concepts in bioprocess monitoring, and the biological basis for industrial fermentations
- To understand biological and engineering principles for cultivating microorganisms in fermenters
- To obtain knowledge on assessing biological and engineering principles for cultivating microorganisms in fermenters
- To understand the importance of monitoring foam control, nutrient dosing, sterile sampling and filter sterilization
- To 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, the learners 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 bioproduct manufacturing

UNIT –I Introduction to Bioprocess technology:

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 Design and types of fermenter:

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, feed back control, PID controller, computer aided control. Role of aeration and agitation.

UNIT – III Upstream process:

Media formulation – sterilization – Air and media sterilisation. 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 – IV Downstream processing:

Introduction, Removal of microbial cells and solid matters, foam separation, precipitation, filtration, centrifugation, cell disruption. Solvent extraction- chromatographic separation-FPLC, HPLC, Dialysis, distillation, crystallization. Effluent treatment. Fermentation products available in market.

UNIT – V Application of fermentation and Bioprocess technology:

Whole cell immobilization, Protein immobilization and their industrial application. Industrial production of chemicals: alcohol, Acids (citric, acetic and gluconic acid), solvents (glycerol, acetone and butanol), Antibiotic (penicillin, streptomycin and tetracycline), Amino acids (Lysine and glutamic acid), Single cell protein, Use of microbes in mineral beneficiation and oil recovery, Probiotics and prebiotics.

SUGGESTED READINGS:

1. Bailey, J.S. & Ollis, D.F. (2017). *Biochemical Engineering Fundamentals* (2nded.). McGraw - Hill Education/ Medical, London, United Kingdom.
2. Crueger, W.&Crueger, A. (2017). Cruegers Biotechnology: A *Textbook of Industrial Microbiology*.Medtech Publishers, New Delhi, India.
3. Doran, P.M. (2013). *Studyguide forBioprocess Engineering Principles*. New York, United States.
4. Dutta, R. (2008). *Fundamentals of Biochemical Engineering*(1sted.). Springer Publishers, New York, United States.
5. Shuler, M.L.&Kargi, F. (2015). *Bioprocess Engineering Basic concepts* (2nded.). Pearson India Education Services Pvt. Ltd., Bengaluru, India
6. Stanbury, P.F., Whitaker, A., & Hall, S.J. (2016). *Principles of Fermentation Technology* (3rded.). Butterworth-Heinemann Publishers, Oxford, United Kingdom.

PHARMACEUTICAL BIOTECHNOLOGY

20BTP203 **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 main objectives of the course are

- To obtain basic skills necessary for employing biotechnology principles in together with various pharmaceutical parameters
- To understand novel formulation approaches for better delivery of biotechnology derived drugs, such as reverse micelles, liposomes, microemulsions and microencapsulation
- To attain knowledge on the delivery of peptides and proteins by the parenteral, oral, transdermal and nasal routes of administration
- To recognize novel biotechnology products and their use in therapeutics and diagnostics
- To 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
- To 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, the learners 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 Introduction:

Introduction to Pharmaceuticals; History and age of Biopharmaceuticals. History and age of Biopharmaceuticals; 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 Drug design and Drug discovery

Drug design; drug development; random screen up, target identification and validation, Biochips, Proteomics, Genomics. DNA/ Protein Micro array, SAGE. Structural Genomics and Pharmacogenetics.

UNIT –III Pharmacokinetics:

Pharmacogenomics. Pharmacokinetics – Order of Kinetics – Drug safety and Effectiveness- Drug Interactions. Pharmacodynamic Interactions- Drug tolerance – Adverse drug reactions. Drug tolerance – Adverse drug reactions, Drug repurposing.

UNIT –IV Genetically engineered protein:

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, stem cell therapy

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.

SUGGESTED READINGS:

1. Abraham, D.J. & Rotella, D.P. (2010). *Burger's Medicinal Chemistry, Drug Discovery and Development* (7th ed.). Wiley Publishers, New York, United States.
2. Banga, A.K. (2015). *Therapeutic Peptides and Proteins: Formulation, Processing, and Delivery Systems* (3rd ed.). CRC Press, Florida, United States.
3. Bhagavan, N.V. & Ha, C-E. (2015). *Essential of Medical Biochemistry* (2nd ed.). Academic Press Publishers, New York, United States.
4. Crommelin, D.J.A., Sindelar, R. D. & Meibohm, B. (2019). *Pharmaceutical Biotechnology: Fundamentals and Applications* (5th ed.). Springer Publishers, New York, United States.
5. Golan, D.E., Armstrong, E.J., & Armstrong, A.W. (2016). *Principles of Pharmacology: The Pathophysiologic Basis of Drug Therapy* (4th ed.). LWW Publishers, Pennsylvania, United States.
6. Rho, J.P. & Louie, S.G. (2003). *Hand book of Pharmaceutical Biotechnology* (1st ed.). CRC Press, Florida, United States.
7. Satoskar, R. S., Rage, N.N., Tripathi, R.K., & Bhandarkar, S. D. (2017). *Pharmacology and Pharmacotherapeutics* (25th ed.). Elsevier India Publishers, Chennai, India.
8. Sethi, P.D. (2008). *Quantitative Analysis of Drugs in Pharmaceutical Formulations* (3rd ed.). CBS Publishers and Distributers, New Delhi, India.

IMMUNOTECHNOLOGY

20BTP204 **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 t the human immune system and the immune response of cells and organs
- To obtain key concepts on gene-re-arrangement of immunoglobulin and T-cell receptor genes, antigen processing and presentation
- To comprehend the principles of immunological techniques like hybridoma technology and catalytic antibodies synthesis
- To understand strong fundamental knowledge in tumor immunology
- To attain the principles involved in vaccine technology including recombinant vaccines
- To recognize the basic concepts in transplantation of bone marrow and other organs

Course Outcomes

On successful completion of the course, the learners 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 cancer immunotherapy
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. Cytokine profile exosomes/ secreted vesicles. Complement system - Classical and alternate pathway. MHC I and II complex.

UNIT-III Transplantation:

MLR, MHC and HLA typing, Bone marrow transplantation, Organ transplants, Iimmunosuppressive therapy. Hybridoma technology and monoclonal antibodies, Immuno-diagnosis and application of monoclonal antibodies in biomedical research, **H**uman monoclonal antibodies and catalytic antibodies, Xeno transplantation from various species.

UNIT –IV Hyper-sensitivity reactions:

Types of Hyper-sensitivity reactions. Auto-immune disorders. Tumor immunology: Tumor antigens, immune response to tumors, Cancer immunotherapy. Immunodeficiencies – primary and secondary.

UNIT –V Vaccines:

Vaccine technology including DNA vaccines, **I**dentification of B and T epitopes for vaccine development. Immunodiagnosis of infectious diseases, Immuno screening of recombinant library.

SUGGESTED READINGS:

1. Abbas,A.K., Lichtman, A. H., & Pillai, S. (2017). *Cellular and Molecular Immunology* (Ninth ed.). Elsevier Publishers, Amsterdam, Netherlands.
2. Abbas,A.K., Lichtman, A. H., & Pillai, S. (2019). *Basic Immunology: Functions and Disorders of the Immune System* (Sixth ed.). Elsevier Publishers, Amsterdam, Netherlands.
3. Delves, P.J., Martin, S.J., Burton, D.R., & Roitt, I.M. (2017). *Roitt's Essential Immunology* (Thirteenth ed.). Wiley-Blackwell, New Jersey, United States.
4. E-content: http://172.16.25.76/course/view.php?id=2099
5. https://www.cell.com/cancer-cell/libraries/tumor-immunology-and-immunotherapy
6. Levine, M.M. et al. (2017). New Generation Vaccines (Fourth ed.). CRC Press.
7. MOOC: https://nptel.ac.in/courses/102103038/
8. Punt, J., Stranford, S., Jones, P., & Owen, J.A. (2018). *Kuby Immunology* (Eighth ed.). W.H. Freeman and Company, New York, United States.
9. Tizard, I.R. (2017). *Veterinary Immunology* (Tenth ed.). Saunders Publishers, New York, United States.
10. Turgeon, M. L. (2017). *Turgeon: Immunology and Serology in Laboratory Medicine*. (Sixth ed.). Elsevier Publishers, Amsterdam, Netherlands.

Semester – II

ENZYME TECHNOLOGY

20BTP205A **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 about the enzyme system
- To obtain key concepts on enzyme- nomenclature and classification of enzymes
- To comprehend the principles of enzyme with thermal stability and catalytic efficiency of enzyme
- To understand strong fundamental knowledge in enzymology
- To attain the principles involved in enzyme technology including methods for large scale production of enzymes
- To recognize the application of enzymes used in different industries

Course Outcomes

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

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

UNIT – I Nomenclature and classification of enzymes:

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, structural motifs and enzyme evolution. Methods for analysis of secondary and tertiary structures of enzymes. Protein folding *in vitro* & *in vivo*. Delivery system for protein pharmaceuticals.

UNIT – III Strategies in production of novel 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; 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.

UNIT – V Applications of enzymes:

Enzymes used in different industries, enzyme replacement therapy – definition, modes of administration, enzyme deficiency disorders and enzyme therapy; Application of enzymes: Cosmetic benefits, Application to fundamental studies of biochemistry. Enzyme electrodes. 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.

SUGGESTED READINGS:

1. Berg, J.M., Tymoczko, J.L., Gatto Jr, G.J., & Stryer, L. (2015). *Biochemistry* (8th ed.). W.H. Freeman and Company, New York, United States.
2. Campbell, M.K., Farrell, S.O., & McDougal, O.M. (2017). *Biochemistry* (9th ed.). Cengage Learning Publishers, Massachusetts, United States.
3. Price, N.C. & Stevens, L. (1999) *Fundamentals of Enzymology* (3rd ed.). Oxford University Press, Oxford, United Kingdom.
4. Rodwell, V.W., Bender, D.A., Botham, K.M., Kennelly, P.J., & Weil, P.A. (2018). *Harper's illustrated*
   Biochemistry (31st ed.). McGraw-Hill Education Publishers, Ohio, United States.
5. Voet, D, Voet, J.G., & Pratt, C.W. (2016). *Fundamentals of Biochemistry* (5th ed.). Wiley Publishers, New York, United States.

AGRICULTURAL BIOTECHNOLOGY

20BTP205B **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 provide various techniques and aspects regarding Agri biotechnology
- To equip with theoretical knowledge regarding the techniques and applications of Agri-Biotechnology
- To attain comprehensive training in the agri biotechnology and its application for increasing agricultural production, environment improvement
- To learn about genome organization in plants and basic techniques in tissue culture
- To discuss the applications of genetic transformation in plants, metabolic engineering, production of pharmaceuticals and industrial products and plant molecular farming
- To get a career in Industry / R&D

Course Outcomes

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

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

UNIT –I Plant tissue culture and its application:

Recombinant DNA technology, methods of gene transfer in plants, Development of transgenic 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:

Biofortification - increase in iron, protein and amino acids. Golden rice, Bt Cotton, GM crop Transformations, Plants as biofactories - Developing vaccine and plantibodies, terminator technology and male sterility.

UNIT – IV Stress resistance on crops:

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.

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, Biosafety and risk assessment of GM crops.

SUGGESTED READINGS:

1. Adrian Slater, Nigel Scott and Mark Fowler, Plant Biotechnology: The genetic manipulation of plants, 1st Edition, Oxford University Press, 2003
2. Chakraborty .U, Bishwanath Chakraborty, 2005. Stress biology, Vidhyasekaran, P. 2007. Narosa Publishing House.
3. Denis Murphy, Plant Breeding and Biotechnology: Societal Context and the Future of Agriculture, Cambridge University Press, 2007.
4. Gupta P K Plant Biotechnology, Rastogi Publication, Meerut, India.
5. Jaiwal P K & Singh R P (eds) Plant Genetic Engineering Vol-1 to Vol. 9. Studium Press, USA, 2006.

Semester – II

INDUSTRIAL TOXICOLOGY

20BTP205C **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 acquire knowledge and learn the terminology of the field of Industrial toxicology
- To describe the relationship of dose - response, and the principle of determining the theoretical expertise on the mutagenic, teratogenic and carcinogenic effects of toxic substances
- To obtain knowledge of current legislation on health protection while working with chemical agents, carcinogenic and mutagenic factors, and biological factors
- To learn about toxic effects of elements and their compounds
- To understand the classification of substances under the new legislation
- To gather and critically interpret toxicological information from diverse resources for human health hazard and risk assessment

Course Outcomes

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

1. Describe toxicology as a discipline in the overall health sciences system
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 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 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 –IV Human Toxicology:

Pollution induced biochemical, hematological and pathological changes, Immunotoxicity, genotoxicity and carcinogenic effects, DNA damages, cancer and its types related to toxicity.

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. Bioassay, EIA act.

SUGGESTED READINGS:

1. Harbison, R.D., Bourgeois, M.M., & Johnson, G.T. (2015). *Hamilton and Hardy's Industrial toxicology* (6th ed.). Wiley-Blackwell Publishers, New Jersey, United States.
2. Lins, E.S. (2017). *Pesticides in Aquatic Environments*. Arcler Education Publishers, Oakville, Canada.
3. Murty, A.S. (2017). *Toxicity of pesticides to Fish: Volume II* (1st ed.). CRC Press, Florida, United States.
4. Riviere, J. E. (2006). *Biological Concepts and Techniques in Toxicology: An Integrated Approach* (1st ed.). CRC Press, Florida, United States.

RECOMBINANT DNA, FERMENTATION AND BIOPROCESS TECHNOLOGY - PRACTICAL III

20BTP211 **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 main objectives of the course are

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

Course Outcomes

On successful completion of the course, the learners 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 methods of wine production and alcohol determination
4. Extract amylase enzyme from microbial sources
5. Perform the enzyme immobilization assay
6. Join in research and clinical labs as a project/ research assistant

Recombinant DNA Technology Practical's

1. Isolation and analysis of total DNA from Microbes (*E. coli*) and 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. DNA Amplification by PCR.
7. Southern blotting (Demonstration).
8. Northern blotting (Demonstration).
9. Western blotting (Demonstration)

Fermentation Technology Practical's

1. Isolation and secondary screening of industrially important microorganisms
2. Production of amylase or protease,
3. Enzyme immobilization
4. Wine Production and alcohol determination by chromic acid method
5. Downstream processing by Solvent extraction
6. Operation of fermenter (Demonstration)
7. Production of lactic acid

SUGGESTED READINGS:

1. Green, M.R. &Sambrook, J. (2012). *Molecular Cloning: A Laboratory Manual*. (4thed.). Cold Spring Harbor Laboratory Press, New York, United States.
2. Greene, J.J.&Rao, V.B. (2001). *Recombinant DNA Principles and Methodologies.* (2nded.) CRC Press, Florida, United States.
3. Kulandaivelu, S. &Janarthanan, S. (2012). *Practical Manual on Fermentation Technology*. IK International Publishers, New Delhi, India.
4. Schuler, M.A. & Zielinski, R.E. (2012). *Methods in Plant Molecular Biology.* (1sted.).Academic Press Publishers, New York, United States.

IMMUNO AND ENZYME TECHNOLOGY – PRACTICAL IV

20BTP212 **4H-2C**

Instruction Hours / week: L: 0 T: 02 P: 4 **Marks:** Internal: **40** External: **60** Total: **100**
End Semester Exam: 3 Hours

Course Objectives

The main objectives of the course are

- To familiarize with practical knowledge in the emerging field of biotechnology: immuno technology
- To perform and understand basic immuno techniques
- To acquaint versatile tools and techniques employed in immuno technology such as methods of immunoelectrophoresis
- To gain hands on experience in immunological tools used in diagnosis, such as immunoelectrophoresis, ELISA and WIDAL test
- To purify enzymes from natural resources
- To calculate Km, Vmax, Kcat and other kinetic parameters

Course Outcomes

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

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

Immuno-technology Practical's

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
9. Western Blotting

Enzyme technology Practical's

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

SUGGESTED READINGS:

1. Bisswanger, H. (2019). Practical Enzymology (Fourth ed.). Wiley-VCH Publishers.
2. E-content: http://172.16.25.76/course/view.php?id=2103
3. MOOC: https://nptel.ac.in/courses/102102033/
4. Vashist, S.K. & Luong, J.H.T. (2018). *Handbook of Immunoassay Technologies: Approaches, Performances, and Applications* (First ed.). Academic Press.
5. Webley, W. (2017). Immunology Lab Manual (Twelfth ed.). LAD Custom Publishing.

Semester – II

JOURNAL PAPER ANALYSIS AND PRESENTATION

2H-0C

PLANT AND ANIMAL BIOTECHNOLOGY

20BTP301 **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 introduce biotechnological methods for production of transgenic plants
- To give knowledge about various methods of gene transfer in plants
- To cognize and get the knowledge on animal culture
- To explain the basics of the physiological and molecular processes that occur during plant growth and development and during environmental adaptations
- To use basic biotechnological techniques to explore molecular biology of plants and animals
- To understand the processes involved in the planning, conduct and execution of plant and animal biotechnology experiments

Course Outcomes

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

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

UNIT – I Plant Tissue Culture:

Plant tissue culture media and its types, Hairy root culture, callus and cell suspension culture, organogenesis, Protoplast Culture, Production of haploids, Somaclonal variations, Embryo culture and embryo rescue. Production and processes for enhancing secondary metabolites from cell suspension cultures. Mass multiplication of commercially important crops, Elicitor, Precursor treatment for production, product recovery, scaleup process and products, Virus indexing and genetic fidelity of micropropagated crops.

UNIT - II Genetic engineering of plants:

Ti plasmid, Ti plasmid derived vector systems, Agrobacterium mediated transformation, Ri plasmids; Methods of gene transfer to plants -Gene Gun, Direct transfer, 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 and adherent culture, organ culture, embryo culture, three-dimensional culture and tissue engineering, feeder layers; complete and incomplete medium, cell Trypsinization; Cell count using trypan blue dye, Freezing medium, 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 Genetic engineering of animals:

Production of transgenic mice, ES cells for gene targeting in mice, Applications of gene targeting, Yeast as a model organism to study eukaryotic gene function. Therapeutic products produced by genetic engineering: blood proteins, human hormones, immune modulators and vaccines, transgenic animals, Production of proteins of Pharmaceutical value.

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; genetically humanized animal models for personalized medicine approaches; transgenic animals in live- stock improvement; Ethical issues in animal biotechnology.

SUGGESTED READINGS:

1. Chawla, H.S. (2018). *Introduction to Plant Biotechnology* (3rded.). CRC Press, Florida, United States.
2. Freshney, R.I. (2000). *Animal Cell Culture: A Practical Approach* (3rded.). Oxford University Press, Oxford, United Kingdom.
3. Glick, B.R. & Patten, C.L. (2017). *Molecular Biotechnology* (5thed.). Taylor & Francis Publishers, Abingdon, United Kingdom.
4. Gordon, I. (2003). *Laboratory Production of Cattle Embryos* (2nded.). New Delhi: CABI Publishers, Wallingford, United Kingdom.
5. Halford, N. (2006). *Plant Biotechnology: Current and Future Applications of Genetically Modified Crops*. Wiley-Blackwell, New Jersey, United States.
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* (3rded.). Humana Publishers, New York, United States.
9. Primrose, S.B. &Twyman, R. M. (2016). *Principles of Gene Manipulation and Genomics* (8th ed.). John Wiley and Sons Ltd. Publishers, Chicester, United Kingdom.
10. Ranga, M. M. (2007). *Animal Biotechnology* (3rded.).Agrobios India Publishers, Jodhpur, India.

11. Roberta Smith. 2000. Plant Tissue Culture: Techniques and Experiments. (2 nd Ed), Academic Press.
12. Slater, A., Scott, N.W., & Fowler, M. R. (2008). *Plant Biotechnology.* Oxford University Press, Oxford, United Kingdom.
13. Stewart Jr, C.N. (2016). *Plant Biotechnology and Genetics* (2nd ed.). Wiley-Blackwell Publishers, New Jersey, United Kingdom.
14. Yagasaki, K., Miura, Y., Hatori, M. & Nomura, Y. (2008). *Animal Cell Technology: Basic and Applied Aspects* (Vols. 13). Springer Publishers, New York, United States.

Semester – III

GENOMICS, PROTEOMICS AND BIOINFORMATICS

20BTP302 **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 import the basic and recent developments in the field of genome sequencing, genome mapping, proteomic data analysis
- To develop the knowledge on gene sequencing methods
- To know the structure and interactions of proteins
- To describe advanced genomics and proteomics technologies and the ways in which their data are stored
- To use bioinformatics techniques to construct phylogenetic tree
- To describe the different types of genome variation and their relationship to human diseases

Course Outcomes

On successful completion of the course, the learners 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, Genome editing with CRISPR-Cas 9- 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 and Next Generation Sequencing (NGS).

SUGGESTED READINGS:

1. Attwood, T.K. (2007). *Introduction to Bioinformatics* (1st ed.). Pearson Education, London, United Kingdom.
2. Bhat, S. (2008). *Genomics*. Duckworth Press, London, United Kingdom.
3. Gu, J. & Bourne, P.E. (2018). *Structural Bioinformatics* (2nd ed.). Wiley-Blackwell Publishers, New Jersey, United States.
4. 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.
5. Lesk, A. M. (2014). *Introduction to Bioinformatics* (4th ed.). Oxford University Press, Oxford, United Kingdom.
6. Mount, D.W. (2005). *Bioinformatics –Sequence and Genome Analysis* (2nd ed.). CBS Publishers, CSHL Press, New York, United States.
7. Palzkill, T. (2007). *Proteomics*. Springer Publishers, New York, United States.
8. Primrose, SB & Twyman, R. (2006). *Principles of genome analysis and Genomics*. Wiley-Blackwell Publishers, New Jersey, United States.

Semester – III

FOOD BIOTECHNOLOGY

20BTP303 **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 concepts of food biotechnology along with principles of genetics in food industry
- To attain strong knowledge on primary sources of microorganisms in food
- To explore the methods for development and preservation of fermented foods
- To recognize the nutritive values of fermented foods
- To understand the concepts of food adulteration and food safety
- To obtain strong knowledge on food spoilage

Course Outcomes

On successful completion of the course, the learners 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, Yogurt, Butter, miso, tempeh, kefir, koumiss, acidophilus milk, sauerkraut, pickles and vinegar. 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, Sea food products, 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 and artificial 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.

SUGGESTED READINGS

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

ENVIRONMENTAL BIOTECHNOLOGY

20BTP304 **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 main objectives of the course are

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

Course Outcomes

On successful completion of the course, the learners 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

Biogeochemical cycling in ecological systems, Limiting factors, energy transfer; Response of microbes, plant and animals to environmental stresses; Concept of ecosystems and ecosystem management, Environmental problems- ozone depletion, green house effect, water, air and soil pollution, land degradation.

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. Green audit and carbon credit.

UNIT – III

Sewage and 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 of 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; use of biological techniques in controlling air pollution; Removal of chlorinated hydrocarbons from air**,** Types of environmental hazards and Disasters; Natural - volcanic eruption, earthquakes, landslides, cyclones, lightning, hailstorms. Hazardous Waste Management and Handling rules.

SUGGESTED READINGS:

1. Agarwal, S.K. (2002). *Environmental Biotechnology*. New Delhi: APH Publishing Corporation.
2. Dubey,R.C. (2010) A textbook of Biotechnology, S.Chand and Company Ltd, New Delhi
3. Evans, G.M., & Furlong, J.C., (2003). *Environmental Biotechnology: Theory and Applications*. (2 nd ed.) England: John Wiley & Sons Ltd.
4. Jördening, H.J., & Winter, J. (2005). *Environmental Biotechnology.* Germany: Wiley-VCH Verlag GmbH & Co. KGaA.
5. Mara, D. (2003). *The Handbook of Water and Wastewater Microbiology.* (1 st ed.) London: Academic Press.
6. Wang, L.K. (2010), Environmental Biotechnology, 1st edition, A Product of Humana Press.

APPLIED BIOTECHNOLOGY

20BTP305A **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

- Introduce biotechnological methods for production of transgenic plants
- Cognize and get the knowledge on animal culture
- Apply the knowledge in the unresolved issues in agricultural biotechnology
- Understand the application of biotechnology in food industries
- Attain knowledge on bioremediation and biosensors
- Understand the concepts of bioethics and biosafety

Course Outcomes

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

1. Inculcate the deep knowledge the processes involved in the planning, conduct and execution of plant biotechnology experiments
2. Appreciate the applications of animal cell culture in clinical and biotechnology industries
3. Apply the knowledge of stem cell therapy to cure dreadful diseases
4. Demonstrate the beneficial role of microorganisms in fermented foods and in food processing and the microbiology of different types of fermented food products
5. Appreciate the scientific, ethical and/or social issues associated with certain applications of biotechnology for alleviating the environmental concerns
6. Join biotechnology labs 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. Yogurt, buttermilk, kefir, koumiss, acidophilus milk. Pickles – Dill pickles, slippery pickles, soft and black pickles. Fermented Vegetables – Sauerkraut. Downstream processing: Bioseparation; filtration, membrane filtration, centrifugation, sedimentation, flocculation, purification, solvent extraction, counter current extraction,

ion exchange, affinity techniques, concentration, crystallization, reverse osmosis, ultrafiltration, drying, storage, and packaging

UNIT – IV Environmental Biotechnology:

Bioleaching, sewage treatment, Biogas production, Role of superbug in biodegradation, Bioremediation & Phytoremediation: Biofeasibility, applications of bioremediation, Bioreduction, Phytoremediation. Solid waste pollution and its management: Current practice of solid waste management, composting systems, vermicomposting, sewage treatment.

UNIT – V Bioethics and Biosafety:

Intellectual property rights. General ethics & ethical issues, Animal rights, Environmental safety of GMOs. Regulation of GMOs, Bioethics for future. Patent and Trademark, Biotechnology products and processes, Intellectual property rights. Biosafety and its implementation, Quality control in Biotechnology

SUGGESTED READINGS:

1. Adam, J. (2016). *Applied Biotechnology in Genetic Engineering, Pharmaceuticals and Agriculture.* Syrawood Publishing House, New York, United States.
2. Chatterji, A.K. (2011). *Introduction to Environmental Biotechnology* (3rd ed.). Prentice Hall India Learning, New Delhi, India.
3. Goel, D. & Parashar, S. (2013). IPR, Biosafety and Bioethics (1st ed.). Pearson Publishers, London, United Kingdom.
4. 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.
5. U. Satyanaranya. (2018). *Biotechnology* (12th ed.). Generic Publishers, New South Wales, Australia.

SYSTEMS BIOLOGY

20BTP305B **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 new concept of system biology applied to the area of biotechnology
- To build the knowledge in computational methods in biotechnology
- To 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
- To learn the computational tools for applying biotechnology in research
- To study the techniques involved in structural and functional proteomics
- To utilize the bioinformatics tools to design and development of novel drugs

Course Outcomes

On successful completion of the course, the learners 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. 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, Meanings of Robustness.

UNIT – III Systems Biology Databases.

BioSilico. EMP (Embden-Meyerhof-Parnas). MetaCyc and AraCyc. SABIO-RK (System for the Analysis of Biochemical Pathways - Reaction Kinetics). BioModels, Evolution of computational models in Biomodel Database. Microarray data analysis - Microarray analysis platforms - Introduction to Concepts and principles of Microarray technology - Application of Microarrays.

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.

SUGGESTED READINGS:

1. Cánovas, M., Iborra, J.L., &Manjón, A. (2006). *Understanding and Exploiting Systems Biology in Biomedicine and Bioprocesses.*CajaMurcia Foundation, Spain.
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. Palsson, B.O. (2006). *Systems Biology: Properties of Reconstructed Networks.* Cambridge University Press, Cambridge, United Kingdom.
5. Pennington, S.R. & Dunn, M.J. (2002). *Proteomics.* Viva Books Pvt. Ltd., New Delhi, India.
6. Sensen, C.W. (2002). *Essentials of Genomics and Bioinformatics*. Wiley-VCH Publishers, New Jersey, United States.
7. Voit, E. (2017). *A First Course in Systems Biology* (2nded.).Garland Science Publishers, United States.

TISSUE ENGINEERING AND REGENERATIVE MEDICINE

20BTP305C **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 tissue growth and development as well as the tools and theoretical information necessary to design tissues and organs
- To recognize the need of controlling all factors related to biomaterials architecture such as cell biology, biochemistry pathways, and surface characterization and modification
- To comprehend various physical and chemical stimuli that control the structure of biomaterials
- To get knowledge on cell types, which are available to be used in tissue engineering applications
- To understand the relevance of the extracellular matrix and its interaction with materials
- To obtain knowledge on bioreactors used in tissue engineering

Course Outcomes

On successful completion of the course, the learners 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, trans-differentiation and cloning
4. Describe the developments of biomaterials for regenerative therapies and tissue engineering
5. Discuss about the 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 signalling. 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.

SUGGESTED READINGS:

1. Palsson, B.O. & Bhatia, S. N. (2016). *Tissue Engineering* (1st ed.). Pearson Education Publishers, London, United Kingdom.
2. Atala, A., Lanza, R., Mikos, T., & Nerem, R. (2018). *Principles of Regenerative Medicine* (3rd ed.). Academic Press, London, United Kingdom.
3. Ravi, B. (2014). *Introduction to Tissue Engineering: Applications & challenges* (1st ed.). Wiley Publishers, New Jersey, United States.
4. Fisher, J.P., Mikos, A.G., Bronzino, J.D., & Peterson, D.R. (2017). *Tissue Engineering: Principles and Practices* (1st ed.). CRC Press, Florida, United States.
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

PLANT AND ANIMAL BIOTECHNOLOGY - PRACTICAL V

20BTP311 **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 main objectives of the course are

- To understand the new concept of system biology applied to the area of biotechnology
- To gain hands-on experience and to learn the principles behind plant and animal biotechnology
- To know the process involved in isolation, separation, manipulation of plant and animal tissues
- To apply the technology in research and development and pharmaceutical industries
- To execute the recent technology involved in plant and animal cell culture
- To describe the principles of gene manipulation

Course Outcomes

On successful completion of the course, the learners 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. Explain basic principles and techniques in genetic manipulation and genetic engineering
4. Describe gene transfer technologies in plants and animals
5. Designate problems associated with plant and animal cloning
6. Join as lab manager or key scientist in plant and animal biotechnological research institute and industries.

Plant Tissue Culture Practical's

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
9. Physical methods of gene transfer – demonstration
10. Hardening of PTC plants

Animal Biotechnology practical's

1. Preparation and Filter-sterilization of Animal Tissue Culture Medium
2. Chicken embryo fibroblast Culture
3. Quantification of cells by haemocytometer
4. Quantification of viable and non-viable cells by trypan blue dye exclusion method
5. Identification of leukocyte subsets and total count.
6. Blood leukocyte culture
7. Soft agar assay
8. Cryopreservation and revival of cell lines.

SUGGESTED READINGS:

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* (2nded.). Taylor & Francis Publishers, Abingdon, United Kingdom.
3. Slater, A., Scott, N.W. & Fowler, M.R. (2008). *Plant Biotechnology: The Genetic Manipulation of plants* (2nded.). Oxford University Press, Oxford, United Kingdom.

GENOMICS, PROTEOMICS AND BIOINFORMATICS PRACTICAL VI

20BTP312 **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 main objectives of the course are

- To give knowledge on bioinformatics and its application
- To gain knowledge to assess biological databases
- To understand and to analyze protein/nucleotide sequences and to predict its 3D structure
- To understand the various online databases for submitting and retrieving data
- To understand how the phylogeny plays a vital role in finding ambiguities
- To get practiced with the tools and techniques for analyzing the data

Course Outcomes

On successful completion of the course, the learners 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

Practical's

1. Exploring of primary databases (Proteins) and sequence retrieval
2. Exploring of primary databases (Nucleic acids) and sequence retrieval
3. Exploring of secondary databases (Nucleic acids) and sequence retrieval
4. Physicochemical and structural analyses of primary sequences (Proteins and Nucleic acids)
5. Sequence similarity searches and pairwise alignments
6. Multiple sequence alignments and phylogenetic analysis
7. Comparative modeling using online and standalone tools
8. Structural analysis and verification tools
9. 3D structure prediction and validation tools
10. Molecular visualization tools: RasMol, JMol and PyMol
11. Molecular dockings of biological macromolecules

SUGGESTED READINGS:

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

JOURNAL PAPER ANALYSIS AND PRESENTATION

2H-0C

PROJECT – *VIVA VOCE*

20BTP491 **5C**

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

Course Objectives

The main objective of the course is

- To give 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 successful completion of the course, the learners will be able to

1. Gain knowledge, general competence, and analytical skills on an advanced level, needed in industry, consultancy, education and research.
2. Acquire knowledge about the dissertation writing for their course project