DEPARTMENT OF BIOTECHNOLOGY

COURSE STRUCTURE & SYLLABI

(For the students admitted from year 2023-2024 onwards)

Programme : M.Sc. Biotechnology

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JAMAL MOHAMED COLLEGE (AUTONOMOUS)

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(Affiliated to Bharathidasan University)

TIRUCHIRAPPALLI – 620 020

M.Sc. BIOTECHNOLOGY

Sem	Course Code	Course Category	Course Title	Ins. Hrs/ Week	Credit	Marks		Total
						CIA	ESE	
I	23PBT1CC1	Core - I	Bioinstrumentation	6	5	25	75	100
	23PBT1CC2	Core - II	Advanced Biochemistry	6	5	25	75	100
	23PBT1CC3	Core - III	Immunology and Immunotechnology	6	5	25	75	100
	23PBT1CC4P	Core - IV	Bioinstrumentation, Advanced Biochemistry, Immunology and Immunotechnology - Practical	6	5	20	80	100
	23PBT1DE1A/B	Discipline Specific Elective - I		6	4	25	75	100
			Total	**30**	**24**			**500**
II	23PBT2CC5	Core - V	Enzyme Technology	6	5	25	75	100
	23PBT2CC6	Core - VI	Molecular Biology	6	5	25	75	100
	23PBT2CC7	Core - VII	Recombinant DNA Technology	6	5	25	75	100
	23PBT2CC8P	Core - VIII	Enzyme Technology, Molecular Biology, Recombinant DNA Technology - Practical	6	4	20	80	100
	23PBT2DE2A/B	Discipline Specific Elective - II		6	4	25	75	100
	23PCN2CO	Community Outreach	JAMCROP	-	@	-	-	@
	@ Only Grades will be given		**Total**	**30**	**23**			**500**
III	23PBT3CC9	Core - IX	Plant Biotechnology	6	5	25	75	100
	23PBT3CC10	Core - X	Animal Biotechnology	6	5	25	75	100
	23PBT3CC11	Core - XI	Bioinformatics and Biostatistics	6	6	25	75	100
	23PBT3CC12P	Core - XII	Plant Biotechnology, Animal Biotechnology, Bioinformatics and Biostatistics - Practical	6	4	20	80	100
	23PBT3DE3A/B	Discipline Specific Elective - III		6	4	25	75	100
	23PBT3EC1	Extra Credit Course - I*	Online Course	-	*	-	-	-
			Total	**30**	**24**			**500**
IV	23PBT4CC13	Core - XIII	Microbial Technology	6	6	25	75	100
	23PBT4CC14	Core - XIV	Environmental Biotechnology	6	5	25	75	100
	23PBT4CC15	Core - XV	Bioprocess Technology	6	5	25	75	100
	23PBT4PW	Project	Project Work	12	8	-	200	200
	23PCNOC	Mandatory Online Course**	Online Course	-	1	-	100	100
	23PBT4EC2	Extra Credit Course - II*	Online Course	-	*	-	-	-
	*** Programme Specific Online Course for Advanced Learners** **** Any Online Course for Enhancing Additional Skills**		**Total**	**30**	**25**			**600**
					Grand Total	**96**		**2100**

DISCIPLINE SPECIFIC ELECTIVES

Semester	Course Code	Course Title
I	23PBT1DE1A	Biodiversity and Bioprospecting.
	23PBT1DE1B	Research methodology, IPR and Biosafety.
II	23PBT2DE2A	Genomics and Proteomics
	23PBT2DE2B	Pharmacognosy, Pharmacology and Nanomedicine
III	23PBT3DE3A	Stem Cell Biology
	23PBT3DE3B	Marine Biotechnology

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PBT1CC1	Core – I	6	5	25	75	100

Course Title	Bioinstrumentation

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Microscopy and Colorimetry:** Microscope – Bright field, Dark field, Phase contrast, Microscopy - Fluorescent Microscope, Electron microscopy - Scanning Electron Microscope, SEM EDX, Transmission Electron Microscope, Confocal Laser Scanning Microscope, *Atomic Force Microscope*.	**18**
II	**Centrifugation, Colorimetry and Spectroscopy:** Principles of centrifugation, concepts of RCF. Different types of Centrifuges and their uses. General design and components of Colorimetry, General design and components of spectroscopy, UV –Visible, IR- Raman spectroscopy, 2D NMR Spectroscopy, Atomic absorption spectroscopy (AAS) and *FTIR*.	**18**
III	**Separation Techniques:** Chromatography – Principles of adsorption and partition chromatography, Ion exchange, Gel permeation chromatography, Affinity chromatography, Gas liquid chromatography and HPLC, Electrophoretic techniques – Principles of Electrophoresis, Continuous, Zonal and Capillary electrophoresis, Electrophoresis of Proteins-SDS-PAGE, Native PAGE, IEF, 2D-PAGE, Agarose Gel Electrophoresis of DNA**, ***GCMS, GC TOF MS*.	**18**
IV	**Radio labelling techniques:** Radio Isotopes ,GM Counter, Scintillation Counter, Autoradiography, Half Life Periods, Radio labelling Technique, Detection and measurement of different types of radioisotopes normally used in biology, molecular imaging of radioactive material, safety guidelines. *Current trend in application of radioisotopes in Biology*.	**18**
V	**Bioinformatics and cheminformatics:** Bioinformatics: NCBI, BLAST, FASTA, Clustalw, PROSPECT (Protein Structure Prediction and Evaluation Computer Toolkit), Pattern Hunter, COPIA (Consensus Pattern Identification and Analysis). Cheminformatics: Programming in PERL and PYTHON, Molecular Modelling and Drug Design: Drug designing software's, Drawing 2D and 3D structure of chemical compounds, *Determination of three dimensional structure of protein*.	**18**
VI	**Current Trends (For CIA only) –** Robotic Devices (Robotic surgery in cancer care) and Pacemakers (Cardiac Pacemakers).	

..... Self Study

Text Book(s):

1. Chatwal and Anand, Instrumental Methods of Chemical Analysis, Himalaya Publishing House, Himalaya Publishing House, 2006.
2. Upadhyay, Upadhyay and Nath, Biophysical Chemistry (Principles & Technology), Himalaya Publishing House, 9th edition, 2009.
3. Willard, H.H., Merrit, J.A., Dean, L.L. and Setlle, F.A., Instrumental Methods of Analysis, , CBS Publishers, 7th Edition and Distributors, 2004.

Reference Book(s):

1. Wilson and Walker, Principles and techniques of Biochemistry and Molecular Biology, Cambridge University Press, 6th Edition, 2005.
2. Skoog, D., Instrumental Methods of Analysis, David Hariss Publishers, 5th Edition, 2000.
3. Williams, Dudley H., Spectroscopic methods in organic chemistry. London : McGraw-Hill, 5th Edition, 1995.

Web Resource(s):
1.https://www.epictraining.ca/course/15958/mississauga/bioinstrumentation-distance%202. 2. https://www.egr.msu.edu/classes/ece445/mason/Files/ECE445_1-Intro.pdf 3.https://nptel.ac.in/courses/102108082

Course Outcomes		
U**pon successful completion of this course, the student will be able to:**		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Apply the advanced microscopic and spectroscopic methods in their study efforts and use them to evaluate the unique complex structure.	K3
CO2	Motive knowledge of the theories, tools, and applications of centrifugation.	K4
CO3	Examine various separation techniques used in purification, their principle, and applications	K4
CO4	Explain the various medical equipment and apprehend their applications in various diagnostic and therapeutic procedures.	K5
CO5	Perform programming in PERL & PYTHON	K6

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes**					**Programme Specific Outcomes**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	2	3	3	2	2	2	2.5
CO2	3	3	1	3	2	3	3	2	2	2	2.4
CO3	3	3	1	3	2	3	3	2	2	2	2.4
CO4	3	3	1	3	2	2	3	2	2	2	2.4
CO5	3	3	1	3	3	3	3	3	2	2	2.6
Mean Overall Score											**2.4**
Correlation											**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. M. Habibunisha

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PBT1CC2	Core - II	6	5	25	75	100

Course Title	Advanced Biochemistry

SYLLABUS

Unit	Contents	Hours
I	**Bioenergetics:** Free energy and entropy. Phosphoryl group transfers and ATP. Enzymes involved in redox reactions. The electron transport chain–organization and role in electron capture. Oxidative phosphorylation- F1/F0 ATPase- structure and mechanism of action.*chemiosmotic theory*. Inhibitors of respiratory chain and Oxidative phosphorylation – uncouplers, ionophores and bacterial electron transport chain.	**18**
II	**Carbohydrate metabolism:** Classification, Structure and Isomerism. Monosaccharides, Oligosaccharides, Polysaccharides– Structure and Properties. Metabolism of Carbohydrates - Glycolysis, Mechanism of pyruvate Dehydrogenase, Citric acid cycle, HMP shunt, Gluconeogenesis, Glycogenesis, Glycogenolysis. *Metabolic disorders associated with carbohydrate metabolism- glycogen storage diseases and diabetes mellitus* CSDB (Carbohydrate Structure Database, GlycomeDB, Calvin cycle.	**18**
III	**Lipid metabolism:** Biosynthesis of fatty acid and its regulation, biosynthesis of triacylglycerol, phospholipids and cholesterol. β Oxidation of fatty acids– Role of carnitine cycle in the regulation of β -oxidation. *Ketogenesis and its control. Lipoprotein types and its functions*. Metabolic disorders associated with lipid metabolism, LMSD (Lipid Maps Structure Database), Lipid Bank.	**18**
IV	**Metabolism of Amino acids, Proteins:** Overview of biosynthesis of nonessential amino acids. Catabolism of amino acid- transamination, deamination, ammonia formation, urea cycle and its significance. Catabolism of carbon skeletons of amino acids. Protein – classification, types, characteristics and structures, PDB (Protein Data Bank), Ramachandran plot, PROCHECK Solid state synthesis of peptides, Sequence determination. *metabolic disorders associated with aminoacid metabolism*.	**18**
V	**Metabolism of Purines and Pyrimidines:** Digestion and absorption of nucleoproteins, Fractionation, sequencing and chemical synthesis of oligonucleotides. Metabolism of purines - *de novo* and salvage pathways for purine biosynthesis, regulation of biosynthesis of nucleotides. *Purine catabolic pathway*.Metabolism of pyrimidines - biosynthesis and catabolism. .Disorders of purine and pyrimidine metabolism Genome Net and KEGG pathway.	**18**
VI	Current Trends (For CIA only) – Eating at Inappropriate Times can Induce Obesity and Metabolic Disorders within a Short Period, Carbohydrate influences on body composition in polycystic ovary syndrome, Marine carbohydrate related drugs.	

..... Self Study

Text Book(s):

1. D. and Voet, JG. Biochemistry, John Wiley & Son, 3rd Edition 2004.
2. Lehninger, Principles of Biochemistry, Nelson& Cox, Macmillan Worth Publishers,7th edition 2013.
3. Harper's, Illustrated Biochemistry, Victor W. Rodwell , David Bender , Kathleen M. Botham , Peter J. Kennelly , P. Anthony Weil, Thirty-First Edition, 2018.

Reference Book(s):
1.Jeremy Berg; Gregory Gatto Jr.; Justin Hines; John L. Tymoczko; Lubert Stryer, Biochemistry, Macmillan Learning, 10th Edition, 2023 2. Lehninger's, McMillan, Worth, Principles of Biochemistry, Nelson Cox., 8th ed, 2021. 3. Donald Voet, J.G.Voet, John Wiley, Biochemistry, Stryer W.H Freeman. J O H NWI VP & Publisher Kaye Pace, 5th edition, 2018.
Web Resource(s):
1. https://csdb.glycoscience.ru/database/ 2. http://www.glycome-db.org/ 3. https://www.lipidmaps.org/data/structure/index.php

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Analyse the knowledge about bioenergetics and its principles.	K4
CO2	Assess the metabolic pathways of carbohydrate and its regulatory mechanisms.	K5
CO3	Determine the structure, biological functions and metabolism of lipids.	K5
CO4	Compile the structures of amino acids, their chemical properties and their metabolism.	K6
CO5	Elaborate the synthesis of purines and pyrimidines along with their regulation and explain and provide the inter-relationships of biomolecules and their consequences for interpreting & solving clinical problems.	K6

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	3	3	1	1	2	3	2.5
CO2	3	1	2	0	3	2	1	1	2	1	1.6
CO3	3	1	1	3	3	2	2	3	3	3	2.4
CO4	3	1	1	3	3	2	2	2	3	3	2.3
CO5	3	1	1	3	3	2	1	2	3	3	2.2
Mean Overall Score											2.2
Correlation											**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. T. Nargis Begum

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PBT1CC3	Core - III	6	5	25	75	100

Course Title	Immunology and Immunotechnology

SYLLABUS

Unit	Contents	Hours
I	**Components of Immune system:** Immunity: innate immune-factors, acquired immunity-comparison of active and passive acquired immunity. Haematopoiesis , Cells of the immune system and their role - lymphoid cells (T and B lymphocytes, NK cells), Macrophages, Dendritic cells, Eosinophils, Basophils, Neutrophils, Mast cells, Antigen presenting cells and Platelets, Organs of the immune system - Primary and secondary lymphoid organs. *therapeutic role of haematopoietic stem cells*	18
II	**Antigens and Antibodies:** Antigens- structure, Types of antigens – factors of antigenicity. T cell and B cell epitopes, hapten, *adjuvants and super antigens*. T dependent and independent antigens, antigenic determinants. Immunogens and chemical nature. Antibodies: Ultra structure of immunoglobulin types and functions. Monoclonal and polyclonal antibodies and its application.	18
III	**Immune response of B cells and T cells:** Antibody receptors - T cell receptors (TCR), B cell receptor (BCR). B cell - Activation, humoral immune response, T cell - Activation and Cell mediated response, Antigen processing and presentation pathway, Induction of immune response-Cytokines, lymphokines and chemokines - interferons and interleukins. Generation of Antibody diversity *Clonal selection theory and process*, Complement activation – classical and alternative pathways.	18
IV	**Immunity to infectious diseases:** Auto immunity: Classification and mechanisms of autoimmune diseases. Structure and functions of class I and class II MHC molecules. Transplantation immunology: types, allograft rejection, Graft versus host reactions, Histocompatibility testing, HLA typing, application of transplantation immunology, Principles of tumour immunology: Tumour antigens, immune response to tumour, and immunotherapy of malignancy. Vaccines: classification - inactivated, live attenuated, subunit, *Synthetic and DNA vaccine and its importance*.	18
V	**Immunology based techniques and technology:** Clinical methods for detection of antigens and antibodies: Immunodiffusion: Ouchterlony analysis (Single radial diffusion), Double immunodiffusion. Immunoelectrophoresis, RIA, ELISA, Western blot, FISH technique, Hepatitis – B virus test. *Immune complex detection: Rosettes Forming Assay, Plaque Forming Assay*	18
VI	**Current Trends (For CIA only) –**Therapeutic mAb development with qPCR and dPCR (QualTrak), Vaccines and MAb therapy for SARS-COV2.	

..... Self Study

Text Book(s):

1. R. A. Goldsby, T. J.Kindt, B.A.Osborne, J. Kuby. Immunology, W.H. Freeman and Comp, New York, 6th Edition, 2007.
2. A. K. Abbas, A. H. Lichtman, S. Pillai. Cellular and Molecular Immunology, 7th Edition, Elsevier Health Sciences.,2011
3. P. M. Latha. A Text Book of Immunology, S. Chand& Company Ltd, New Delhi,, Revised Edition, 2012.

Reference Book(s):
1. Kuby, Immunology, Macmillan learning, 8th edition, 2019. 2. Peter J. Delves, Seamus J. Martin, Dennis R. Burton, Ivan M. Roitt, Essential Immunology, Wiley-Blackwell Scientific Publication, 13th Edition, 2017. 3. Male, Peebles, S., & Male, V., Immunology, Eds.; 9th edition, Elsevier, 2021.
Web Resource(s):1 1. https://www.nature.com/subjects/immunology 2.https://www.immunology.org/public-information/bitesized-immunology 3**.** https://nptel.ac.in/courses/102105083

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Outline and classify the functions of major immune components and comprehend the mechanism of immunity and protection against various pathogens	K4
CO2	Compare and categorize the types of antigens and antibodies and apprehend the concepts of nonspecific and specific immunity, polyclonal and monoclonal antibodies.	K4
CO3	Explain the structure, function, characteristics and clonal selection of lymphocytes and analyse their role in cell-mediated and humoral immune responses	K5
CO4	Critically evaluate and predict the significance of immune responses for therapy and for design and construction of vaccines against various illnesses.	K6
CO5	Adapt the current immunological techniques used for various diagnostic and therapeutic purposes.	K6

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	1	3	3	2	3	2	2	3	2.5
CO2	3	3	1	3	2	3	3	2	3	3	2.6
CO3	3	2	1	3	2	3	3	3	3	2	2.5
CO4	3	3	2	3	2	3	3	3	3	3	2.8
CO5	3	3	1	3	2	3	3	2	3	2	2.5
Mean Overall Score											**2.58**
Correlation											**High**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. S. Geet Andrea

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PBT1CC4P	Core – IV	6	5	20	80	100

Course Title	Bioinstrumentation, Advanced Biochemistry, Immunology and Immunotechnology – Practical

SYLLABUS

S.NO	Contents	Hours
1	Validating Beer- Lambert's law using KMnO4	90
2	Absorption spectra of proteins/pigment.	
3	Paper chromatography	
4	Column chromatography	
5	Thin layer chromatography	
6	Extraction and Estimation of sugar from natural sources – glucose by DNS method	
7	Extraction and Estimation of protein by Lowry's method	
8	Estimation of amino acid by Ninhydrin method	
9	Estimation of serum cholesterol by Zak's method	
10	Quantitative analysis of blood urea/ creatinine	
11	Quantitative analysis of sugar in urine by Benedict's reagent	
12	Blood Grouping and agglutination	
13	Total count, Differential count (RBC & WBC)	
14	Ouchterlony double diffusion	
15	Immunoelectrophoresis	
16	ELISA	

Text Book(s):

1. Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology - Practical Approach by Andreas Hoffman and Samuel Clokie, 8th edition, 2018.
2. Collins and Lyne's Microbiological methods, Butterworth-Heinemann Ltd, 8th edition,2004.
3. R. A. Goldsby, T. J. Kindt, B.A.Osborne, J. Kuby. Immunology, W.H. Freeman and Comp, New York, 6th Edition, 2007.

Reference Book(s):

1. S. Sadasivam, V.A Manickam , Biochemical methods - New Age International Publishers, 2nd Edition, 2009.
2. Anil Kumar, SarikaGarg and NehaGarg, Biochemical Tests- Principles and Protocols,Vinod Vasishtha Viva Books Pvt Ltd, 3rd edition, 2018.
3. Prem Prakash Gupta, Neelu Gupta, Essentials of Practical Biochemistry, JaypeePublishers, 1st

edition, 2017.
Web Resource(s):
1. https://nptel.ac.in/content/storage2/courses/102103044/module/lec1/1.htm 2. https://nptel.ac.in/content/storage2/coureses/102103047/pdf/modl.pdf 3. https://archive.nptel.ac.in/courses/104/105/104105102/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Develop the scientific methods and instruments are used to natural phenomena	K3
CO2	Explain the handling equipment for electrophoresis, spectrophotometer and chromatography.	K5
CO3	Acquired skill-based knowledge on techniques associated with Biochemistry	K6
CO4	Adapt immunological markers in different diseases through various immune assays.	K6
CO5	Generate hypotheses, evaluate data, and design experiments to investigate a scientific problem.	K6

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	3	1	3	2	3	2	2.5
CO2	3	3	2	3	2	2	2	2	2	2	2.3
CO3	3	3	2	3	2	2	2	3	3	3	2.6
CO4	3	3	1	3	2	3	3	2	3	3	2.6
CO5	3	3	3	3	2	2	2	2	2	2	2.4
										Mean Overall Score	**2.4**
										Correlation	**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. S. Geet Andrea

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PBT1DE1A	Discipline Specific Elective - I	6	4	25	75	100

Course Title	Biodiversity and Bioprospecting

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Components of Biodiversity**: Biodiversity crisis and biodiversity loss. Importance of biodiversity in daily life. Biodiversity and climate change. Types of Ecosystems: India as mega biodiversity Nation. Hotspots and biodiversity In India. Biodiversity and Ecosystem Functioning. Biotechnology and Conservation; IUCN red list of threatened species; Germplasm, *National Parks, Botanical Gardens, Wildlife Sanctuaries*. IMTECH.	**18**
II	**Bioprospecting of micro-algae:** Phyco-remediation, Animal feed, feedstock for anaerobic processes, algal vaccines, algal biofuels, biological hydrogen production from algae, biofertilizer, Lipid identification and extraction techniques, other value added products from microalgae (Pigments, vitamins, food supplements, fatty acids), cosmetics, applications of spent biomass, diatomaceous earth in industries. *Antimicrobial and anticancer compounds from microalgae*.	**18**
III	**Bioprospecting of macro- algae:** Bioprospecting of marine algae, Present and future prospects of seaweeds in developing functional foods, bioactive metabolites from seaweeds, *In-vivo* and *in-vitro* studies of seaweed compounds, chemical ecology of seaweeds, anticoagulant effect. Conventional and alternative technologies for the extraction of algal polysaccharides, (alginates, agar), *Phlorotannins*.	**18**
IV	**Bioprospecting of Fungi:** An *Arbuscular mycorrhiza* fungi and their application in forestry, agro forestry and restoration/reclamation of wasteland. Therapeutic proteins from fungi, bioactive compound from endophytic fungi. Medicinal fungi: antibiotics from fungi, Product of pharmaceutical importance of fungi, *Fungi as biosensors*, Industrially important fungal enzymes.	**18**
V	**Bioprospecting of plants:** Cellulose, lignin, starch, waxes, suberins, rubber – Their chemical diversity, localization and uses. Other useful plant products – Oils, pigments, phenolics, terpenoids, alkaloids, enzymes, antibiotics, antiviral agents; Immunosuppressive agents and other therapeutic agents' *Anticancer compounds from plants*.	**18**
VI	**Current Trends (For CIA only) –** invasive species, impact of habitat encroachment and fragmentation.	

..... Self Study

Text Book(s):

1. R.A. Andersen, Algal Culturing Techniques. Elsevier Academic Press, 2005.
2. L. Barsanti and P.Gualtieri, Algae: Anatomy, Biochemistry and Biotechnology. CRC Press, 2006.
3. E.E. Benson. Plant Conservation Biotechnology. Taylor & Francis, 2012.
4. D. Bhattacharya. Origin of Algae and Their Plastids. Springer-Verlag, New York, 2013

Reference Book(s):

1. E.D. and U.Summer, Seaweeds biology- Novel insights into ecophysiology, ecology and utilization. Springer-Verlag, 2012.
2. H. Dominguez, Functional ingredients from algae for foods and nutraceuticals. Wood head Publishing Ltd., UK., 2013.
3. V. Evangelista, L. Barsanti, A. M. Frassanito, V. Passarelli, and P. Gualtieri, Algal toxins: nature, occurrence, effect and detection. Springer, 2008.

Web Resource(s):
1. https://nptel.ac.in/courses/102104068/ 2. https://www.youtube.com/watch?v=Ps8_IT6vzrA 3. https://www.slideshare.net/bharathirathinam/bioprospecting

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Applying knowledge on a concept of biodiversity and its advantages.	**K3**
CO2	List the application of micro and macroalgae in different sectors.	**K4**
CO3	Examine various separation techniques and category potentialities of biological products.	**K4**
CO4	Importance the new discovery and commercialization of new products based on biological resources.	**K5**
CO5	Construct the knowledge on different scientific research designs and methods in field biology.	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	3	2	2	3	3	3	2.8
CO2	3	3	3	3	1	1	1	3	3	3	2.4
CO3	3	3	3	3	1	1	1	2	2	3	2.2
CO4	3	3	2	3	2	2	1	2	3	3	2.4
CO5	3	3	2	3	3	2	1	2	3	3	2.5
Mean Overall Score											**2.4**
Correlation											**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. K. Gobalan

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PBT1DE1B	Discipline Specific Elective – I	6	4	25	75	100

Course Title	Research Methodology, IPR and Biosafety

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Research design and formulation:** Selection of a research problem- experimental approach and research design, library and research documentation- literature review- sources of information- technical papers- peer reviewed journals-e-journals- citation index- impact factor- *H-index* - reference collection from internet- index card and arrangement of reference collected.	**18**
II	**Interpretation, Analysis and Thesis Writing:** Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Thesis writing- components of a thesis, preparation of research documents (Abstracts, Papers etc). Thrust areas and research priorities in biotechnology at National and International levels. Planning of research: Research proposals, time scheduling of research, available sources and generation of funds and facilities. *Data analysis with statistical package* (Sigma stat, SPSS for student T-test, Anova, etc.), Hypothesis testing.	**18**
III	**Research Ethics, IPR and Scholarly Publishing:** Introduction to IPR, Types of IP - Patents, Trademarks, Copyright and Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications. Importance of IPR – patentable and non patentable, patenting life, legal protection of Biotechnological inventions. Scholarly publishing- IMRAD concept and design of research paper, citation and acknowledgement, *plagiarism*, reproducibility and accountability.	**18**
IV	**Research Patenting:** Objectives of the patent system - Basic, principles, and Classification of Patents and general requirements of patent law. Biotechnological inventions and patent law - Legal development - Patentable subjects and protection in Biotechnology. Introduction to ethics and bioethics. *Ethical limits of Animal use*.	**18**
V	**Biosafety:** Introduction to Biosafety & Regulatory mechanism for GMO: Overview of Biosafety, risk assessment, Cartagena protocol on biosafety. International regulatory bodies, National regulatory bodies, regulatory measures for biosafety. *Biosafety guidelines in India evolved by DBT*, rules for the manufacture, storage and disposal of hazardous microorganisms, genetically modified organisms and biosafety management.	**18**
VI	**Current Trends (For CIA only):** Competing with a pandemic: Trends in research design in a time of Covid-19, Patenting Trends and Innovation in Industrial Biotechnology, Discovering trends and hotspots of biosafety and biosecurity research via machine learning.	

..... Self Study

Text Book(s):

1. Deepa Goel and Shomini Parashar., "IPR, Biosafety and Bioethics", Dorling Kindersley Pvt. Ltd. (2013).
2. M.W. Martin. Ethics in engineering, and Schinzinger. R. III Edition, Tata McGraw-Hill, New Delhi. 2003.
3. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
4. Kankanala, K. C. 2007. Genetic Patent Law & Strategy, 1st Edition. Manupatra Information Solution Pvt.Ltd.,.Noida, India

Reference Book(s):

1. F.K.Beier, Crespi R.S., and Straus, T., "Biotechnology and Patent protection", Oxford and IBH Publishing Co. New Delhi, (2007).
2. Biosafety issues related to transgenic crops- DBT guidelines, Biotech Consortium India Limited, New Delhi, (2010).
3. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., An introduction to Research Methodology, RBSA Publishers. 2002.
4. Kothari, C.R., Research Methodology: Methods and Techniques. New Age International. 418p, 1990.

Web Resource(s):

1. https://www.researchgate.net/publication/329170462_IPR_Biosafety_Bioethics
2. https://www.elsevier.com/books/an-introduction-to-ethical-safety-and-intellectual property rights-issues-in-biotechnology/nambisan/978-0-12-809231-6
3. https://academic.oup.com/bib/article/23/5/bbac194/6590367

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Comprehend the important concepts of Research and learn the techniques of writing research articles.	K3
CO2	Apply the Technique of Interpretation and analysis of data with statistical package.	K3
CO3	Analyze ethical aspects related to biological, biomedical, health care and biotechnology research.	K4
CO4	Distinguish different types of intellectual property rights and protection OF research outcomes and issues related to application and obtaining patents.	K4
CO5	Construct the knowledge of biosafety and risk assessment of products derived from biotechnology research.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	2	1	1	2	3	2	2.3
CO2	3	3	3	3	2	1	1	2	3	2	2.3
CO3	2	3	3	3	3	2	1	3	3	2	2.5
CO4	3	3	3	3	2	1	1	3	2	3	2.4
CO5	3	3	2	3	2	3	1	2	3	2	2.4
Mean Overall Score											2.38
Correlation											Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. M. Habibunisha

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PBT2CC5	Core -V	6	5	25	75	100

Course Title	Enzyme Technology

SYLLABUS

Unit	Contents	Hours
I	**Historical aspects of Enzymology:** History, nomenclature and classification of enzymes, according to IUB-EC-1964.Intracellular localization of enzymes, isolation and fractionation of enzymes - classical methods of purification and crystallization, criteria of purity. Units of enzyme activity- turn over number, specific activity. *Active site definition, organization and determination of active site residues*.	18
II	**Kinetics of catalysed reaction:** Single substrate reactions, bisubstrate reactions, Concept and derivation of Michaelis – Menten equation, Lineweaverburk plot. Determination and significance of kinetic constants, Limitations of Michaelis-Menten Kinetics. Factors affecting enzyme action. Inhibition kinetics - competitive, non-competitive and uncompetitive. *Allosteric enzymes- Allosteric inhibition, cooperative, cumulative, feedback inhibition*.	18
III	**Mechanism of enzyme catalysis:** Collision & transition state theories, specificity of enzymes. Proximity and orientation effects, general acid-base catalysis, covalent and electrostatic catalysis - nucleophilic and electrophilic attacks, catalysis by distortion, metal ion catalysis. Theories on mechanism of catalysis. Coenzymes - structure and function- FAD, NAD and Biotin. Mechanism of enzymes action: mechanism of action of lysozyme and chymotrypsin. *Isoenzymes*. Multi-enzyme complexes.	18
IV	**Enzyme Regulation:** General mechanisms of enzyme regulation, Reversible (glutamine synthase & phosphorylase) and irreversible (proteases) covalent modifications of enzymes. Mono cyclic and multicyclic cascade systems with specific examples. *Protein ligand binding measurement, analysis of binding isotherms, enzyme regulation and its biomedical applications*.	18
V	**Applications of enzymes in Industry:** Immobilization and Immobilized enzymes. Various methods of immobilization - ionic bonding, adsorption, covalent bonding (based on R groups of amino acids), microencapsulation and gel entrapment. Applications of immobilized enzymes. Biosensors – glucose oxidase, cholesterol oxidase, urease and antibodies as biosensors. Enzymes as biomarkers, *Abzymes and Ribozymes* - RNAase, Industrial applications of enzymes-textiles, biofuels, chemical production, food and beverage, consumer products, enzymes of clinical importance - diagnostic significance and therapeutic effects.	18
VI	**Current Trends (For CIA only) –** Enzyme Engineering, cold and hot extremozymes and their industrial relevance, Streptokinase from marine sources.	

..... Self Study

Text Book(s):

1. Zubay, Principles of Biochemistry –William C.Brown Publication,4th edition, 1998.
2. Lehninger: Principles of Biochemistry (Textbook) David Nelson and Michael Cox, Macmillan Learning, 8th edition, 2021.
3. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry (Textbook) Trevor Palmerjm, Albion Press 2nd edition, (2008).

Reference Book(s):

1. Donald Voet and Judith G. Voet. Fundamentals of Biochemistry, John Wiley, New York, 5thEdition. 2019.

2. Allan Fersht, Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding: Vol 9, 2017**.**

3. Cornish-Bowden, A., Fundamentals of Enzyme Kinetics (4th ed.), Wiley Library, 2012.

4. Enzyme: Catalysis, kinetics and mechanisms. N.S. Punekar. ISBN 978-981-13-0784-3.

Web Resource(s):

1. https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/104105076/lec8.pdf
2. https://onlinecourses.nptel.ac.in/noc23_bt05/preview
3. https://archive.nptel.ac.in/courses/102/102/102102033/

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Classify the history, classification, purification and separation of enzymes.	K3
CO2	Develop the kinetics of enzymes, determine the mechanisms of enzyme inhibition and different approaches to design inhibitors.	K3
CO3	Examine and apprehend the different mechanisms of catalysis and enzyme action.	K4
CO4	Determine categorize and compare regulatory mechanisms of various enzymes and recognize their pivotal role in metabolic reactions.	K5
CO5	Adapt the role of enzymes in cell metabolism, physiology and study the application of different enzymes.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	3	3	3	3	2	2	3	3	3	2.8
CO2	3	3	3	3	1	1	1	3	3	3	2.4
CO3	3	3	3	3	1	1	1	2	2	3	2.2
CO4	3	3	2	3	2	2	1	2	3	3	2.4
CO5	3	3	2	3	3	2	1	2	3	3	2.5
										Mean Overall Score	**2.46**
										Correlation	**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Mrs. S. Geet Andrea

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PBT2CC6	Core – VI	6	5	25	75	100

Course Title	Molecular Biology

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Beginning of Molecular biology:** History of Central dogma of Molecular biology, stability of nucleic acid structure, chemical composition of DNA and RNA, *Unusual nucleotides*.	**18**
II	**Mechanism of DNA replication in prokaryotes and eukaryotes:** Prokaryotic and eukaryotic DNA replication – mechanism of replication, enzymes and necessary proteins in DNA replication, telomeres, telomerase and end replication, role of telomerase in aging and cancer. Extra chromosomal replicons (plasmid replication). DNA Mutation and Repair - mutation subtypes, mismatch, base-excision, nucleotide excision and direct repair. DNA recombination - homologous, non - homologous and site-specific. DNA transposition, *Inhibitors of DNA replication*.	**18**
III	**Transcription and Translation in prokaryotes and eukaryotes:** Transcription - Initiation, Elongation and Termination, Transcriptional Factors, Transcription in Eukaryotes, Alternative Splicing, Post-Transcriptional and mRNA Transport. Translation - Genetic Code, Protein Synthesis - Initiation, Elongation and Termination. Post Translational Modification Of Proteins, *****Translational Control*****, Inhibitors Of Transcription And Translation.	**18**
IV	**Regulation Of Gene Expression, Transposable Elements:** Operon Systems: Lactose Operon - Induction & Repression. Tryptophan Operon - Repression & Attenuation, *****Arabinose Operon*. Mutations - Biochemical Basis, Spontaneous Mutations, Isolation of Mutants, Mutagenesis, Reversion and Suppression. Transposons and Transposable Elements. Promoters - Types and Role of Promoters; Hormone Response Element and Metal Response Elements	**18**
V	**Epigenetics and its regulation, Bacterial genetics:** The Basis of transcription process, regulation - DNA methylation and demethylation, histones and nucleosomes, Polycomb complex and Trithorax complex, Epigenetic regulation in stem cells and cell reprogramming**.** Bacterial genetics- *conjugation, transformation and transduction*	**18**
VI	**Current Trends (For CIA only) –** Chip analysis, transcriptomics**.**	

..... Self Study

Text Book(s):

1. D. Freifelder. Molecular Biology, Jones and Barlett Publishers, 2nd Edition, 2004.
2. Nicholl, Introduction to Genetic Engineering, Cambridge University Press, 3rd edition,2008.
3. S. B. Primrose and R. M. Twyman. Principles of gene manipulation and Genomics, Blackwell Scientific Publications, 7thedition, 2006.

Reference Book(s):

1. J. D. Watson, T. A. Baker, S. P. Bell, A. Gann, M. Levine, R. Losick. Molecular Biology of the gene, Pearson Education, Inc. 5th Edition, 2004.
2. G. Karp Cell and Molecular Biology: Concepts and Experiments, John Wiley and Sons Inc. 2009.
3. Genes IX - Benjamin Lewis. Oxford University & Cell Press, 2008. Unit 1: TB.1, Chapter - Page No. 79-112, Chapter - 12 & 13, Page No. 333-337, 379.

Web Resource(s):

1. https://study.com/articles/Genetic_Engineering_Courses_and_Classes_Overview.html
2. https://www.edx.org/learn/genetic-engineering
3. https://nptel.ac.in/content/syllabus_pdf/102103013.pdf

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Explain the Structure and form of DNA.	K2
CO2	Analyse the mechanism of DNA replication and its confirmation	K4
CO3	Examine Discuss the mechanism of Transcription and Translation.	K4
CO4	Explain the mechanism of gene expression and gene regulation	K5
CO5	Predict the appropriate selection and screening technique for a specific recombined.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	3	2	2	3	3	3	3	2	2	3	2.6
CO2	3	2	2	3	3	2	3	2	2	2	2.4
CO3	3	2	2	2	2	3	2	2	2	3	2.3
CO4	3	3	2	2	3	2	2	2	2	2	2.3
CO5	3	3	2	3	3	2	2	2	2	3	2.5
										Mean Overall Score	2.42
										Correlation	Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. S. Deborah

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PBT2CC7	Core - VII	6	5	25	75	100

Course Title	Recombinant DNA Technology

SYLLABUS

Unit	Contents	Hours
I	**Basic techniques involved in rDNA technology:** Enzymes used in cloning: Restriction and modification enzymes - specificity, sticky and blunt ends, isoschizomers, processing of restriction fragments; DNA ligase – optimizing ligating conditions; alkaline phosphatase; double digest; modification of restriction fragment ends - trimming and filling, linkers and adapters, homopolymer tailing; other ways of joining DNA molecules – TA cloning of PCR products and *DNA topoisomerase*.	**18**
II	**Vectors:** Plasmid vectors – properties of plasmid vectors, plasmid replication and transformation; Lambda vectors – biology of lamba phage; invitro packaging, insertion vectors – gt10, replacement vectors – EMBL4; cosmids; M13 vectors; expression vectors - pGEM; and mammalian cell vectors; *yeast vectors - YEp; YCp; Yip, YAC and BAC*.	**18**
III	**Genomic and cDNA Libraries:** Genomic library – partial digest, choice of vectors, construction and evaluation of genomic library; growing and storing of libraries; *cDNA library – isolation of mRNA, cDNA synthesis*, bacterial cDNA; random, ordered and arrayed libraries.	**18**
IV	**Screening libraries with gene probes**: In-situ hybridization, labeling probes, steps in hybridization, screening procedure, Probe selection; Screening expression libraries with Antibodies; Rescreening; *Subcloning*; Characterization of Plasmid clones – Restriction Digest.	**18**
V	**UNIT V gene transfer and Genome Editing:** Gene transfer method- Physical methods of gene transfer - Gene gun method, Microinjection, Electroporation and Lipofection or *Liposome mediated gene transfer*, Gene editing: Definition, process - zinc finger nucleases, talents, CRISPR/Cas9 mechanism and its applications.	**18**
VI	**Current Trends (For CIA only):** Review committee on genetic manipulation and genetic engineering approval committee.	

..... Self Study

Text Book(s):

1. Jeremy W Dale and Malcom von Schantz, From Genes to Genomes: Concepts and Applications of DNA Technology, John Wiley & Sons, Ltd. 2002.
2. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten, Molecular Biotechnology- principles and applications of Recombinant DNA, 4th edition, ASM press, Washington DC, 2010.
3. V.A. Saunders, Microbial Genetics Applied to Biotechnology: Principles and Techniques of Gene Transfer and Manipulation. Springer Science & Business Media, 2012.

Reference Book(s):
1. T.A. Brown, Gene cloning and DNA analysis: an Introduction. John Wiley & Sons, 2016. 2. S.B. Primrose and R. Twyman, Principles of Gene Manipulation and Genomics. John Wiley & Sons, 2013. 3. J.W. Dale, M. Von Schantz and N. Plant, From genes to Genomes: Concepts and Applications of DN Technology. John Wiley & Sons, 2012.
Web Resource(s):
1. https://nptel.ac.in/courses/102103013/ 2. https://genomebiology.biomedcentral.com/articles/10.1186/s13059-018-1586-y

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Simplify the principles of enzymes and vector which serves indispensable tools in recombinant DNA technology.	**K4**
CO2	Explain the principle and the concept of cloning strategies.	**K5**
CO3	Develop skills associated with constructing cDNA libraries and finding right clone.	**K6**
CO4	Discuss the mechanism associated with PCR and sequence analysis.	**K6**
CO5	Improve the genome editing and societal concerns of recombinant DNA technology.	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	3	3	1	1	2	3	2.5
CO2	3	1	2	0	3	2	1	1	2	1	1.6
CO3	3	1	1	3	3	2	2	3	3	3	2.4
CO4	3	1	1	3	3	2	2	2	3	3	2.3
CO5	3	1	1	3	3	2	1	2	3	3	2.2
										Mean Overall Score	**2.2**
										Correlation	**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. J. Sebastin Raj

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PBT2CC8P	Core - VIII	6	4	20	80	100

Course Title	Enzyme Technology, Molecular Biology, Recombinant DNA Technology – Practical

SYLLABUS

S.No	Contents	Hours
1	Extraction and estimation of enzymes (Peroxidase and Catalases) from either plant or microbial source	90
2	Determination of effect of pH and temperature on the activity of enzyme (Peroxidase and Catalases).	
3	Determination of effect of substrate and enzyme concentration on the activity of enzyme (Peroxidase and Catalases).	
4	Isolation and Quantification of genomic DNA from bacteria.	
5	Isolation and Quantification of plasmid DNA from bacteria.	
6	Agarose gel electrophoresis.	
7	Characterization of DNA by Spectrophotometric Assay and Melting Temperature (Tm).	
8	Restriction digestion and ligation.	
9	Preparation of *E.coli* competent cells and Transformation.	
10	SDS– PAGE/Native PAGE.	
11	Western blot – Demonstration.	
12	Polymerase chain reaction (PCR).	

Text Book(s):

1. James G. Cappuccino and Natalie Sherman. Microbiology: A laboratory Manual, Benjamin Cummings, 10th Edition 2013.
2. J. Sambrook and D.W. Russel, Molecular Cloning: A Laboratory Manual, Vols (1-3), CSHL, 2001

Reference Book(s):

1. Hans Bisswanger, Practical EnzymologyWiley-VCH Verlag GmbH & Co, Second Edition. 2012.
2. Bernard R. Glick, Jack J. Pasternak, Cheryl L. Patten, Molecular Biotechnology- principles and applications of Recombinant DNA, 4th edition, ASM press, Washington DC, 2010.
3. S.B. Primrose and R. Twyman, Principles of Gene Manipulation and Genomics. John Wiley & Sons, 2013.

Web Resource(s):

1. https://www.kau.edu.sa/Files/0016333/Subjects/Enzymology%20BIOC231.pdf.
2. https://www.youtube.com/watch?v=S-6177IEUMo.
3. https://sjce.ac.in/wp-content/uploads/2018/04/Enzyme-Technology-and-Biokinetics-Lab-Manual-BT-47L.pdf.

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Apply the fundamentals of enzymes, the substances that make them up, and the ways in which they function.	K3
CO2	Analyse the activity of various enzymes and their various applications in the future.	K4
CO3	Asses the technical expertise in recombinant DNA technology's diverse methodologies.	K5
CO4	Develop the mechanism of action and use of restriction enzymes in biotechnology research	K6
CO5	Adapt Knowledge in developing and performing genetic manipulation experiments	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	3	3	2	2	2	2	2.5
CO2	3	3	1	3	3	3	3	2	2	2	2.6
CO3	3	3	1	3	2	3	2	3	3	2	2.5
CO4	3	3	1	2	2	3	3	3	2	2	2.4
CO5	3	3	1	2	3	3	3	3	3	2	2.6
Mean Overall Score											**2.5**
Correlation											**High**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. M. Habibunisha

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PBT2DE2A	Discipline Specific Elective - II	6	4	25	75	100

Course Title	Genomics and Proteomics

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Genome Structure:** Genome sizes- microbial and organelle genomes - Centromeres and telomeres, tandem repeats-dispersed repeats. Basic Sanger sequencing - automated sequencing- sequencing simple genomes - Sequencing large genomes - finalizing sequences – *sequencing and Next generation sequencing (NGS)*.	**18**
II	**Microarray:** DNA Micro array, Protein Micro array Transcriptomics, Applications and advantages of Microarrays- DNA chips and SAGE technology- Organization of genome projects- human, plant, animal and microbial genome. Microarray – design – analysis visualization of data - Tools for microarray analysis – MADAM - Gene. *Applications of Microarrays*.	**18**
III	**Human Genome:** Characteristics of human - genome sequence important genes associated with each chromosome - Mendelian and sex-linked traits in human inheritance. Genetic diseases due to defects in autosomal and sex-linked genes. Whole genome sequencing– *Human Genome Project*	**18**
IV	**Proteomics:** Identifying proteins in complex mixtures: Protein profiling, quantitative 2D PAGE, multidimensional chromatography, quantitative mass spectrometry, MALDI–TOF, TOF analysis and analytical protein chips. Protein structure databanks - *protein databank*.	**18**
V	**Phamracogenomics and New Drug Design:** Introduction to drug design and developing new drugs: Procedure followed in drug design; Molecular modification of lead compounds; Prodrug and soft drugs; Physico-chemical parameters in drug design; QSAR. *Protein-protein interaction*.	**18**
VI	**Current Trends (For CIA only) –** Cheminformatics, molecular modeling and drug designing, Auto dock tools virtual screening and immunoinformatics.	

..... Self Study

Text Book(s):

1. Necia Grant Cooper; (Ed.). The Human Genome Project; Deciphering the blueprint of Heredity University Science books, CA, USA.1994.

2. Gary Zweiger. Transducing the Genome; Information, Anarchy and Revolution in Biomedical Sciences. Tata McGraw-Hill Publishers, New Delhi.2003.

3.C. Branden, and J.Troze. Introduction to Protein Structure. Second Edition. Garland Publishing, New Delhi.1999.

Reference Book(s):

1. W.E. Evans and M.V. Relling. Pharmacogenomics: translating functional genomics into rational therapeutics. *Science* 286:487.1999.

2. A.D. Baxevanis, and B.F.F. Ouellette. Eds. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Wiley Interscience. New York.2001.

3. D Higgins, and W. Taylor (Eds). Bioinformatics: Sequence, Structure and Data banks. Oxford University Press, Oxford.2000.

Web Resource(s):
1. https://www.kau.edu.sa/Files/0016333/Subjects/Genomics and protemics%20BIOC231.pdf.
2. https://in.coursera.org/courses?query=genomics
3. https://nptel.ac.in/courses/102103017

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Develop advanced level of genomes and their expressions from structure to functional level.	K3
CO2	Simplify the principle of genome through the process of plant and animal technology and computational analysis.	K4
CO3	Evaluate Protein structure and the different approaches to analyse Proteomics.	K5
CO4	Discuss the different concepts of Microarray and their analysis.	K6
CO5	Elaborate on the Pharmacogenomics, Pharmacogenetics and drug design.	K6

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	2	1	1	2	3	2	2.2
CO2	3	2	3	3	2	1	1	2	3	2	2.2
CO3	2	3	3	2	3	2	1	3	3	2	2.4
CO4	2	2	2	3	2	1	1	3	2	3	2.1
CO5	3	3	2	3	2	3	1	2	3	2	2.4
										Mean Overall Score	**2.2**
										Correlation	**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. K. Gobalan

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PBT2DE2B	DSE – II	6	4	25	75	100

Course Title	Pharmacognosy, Pharmacology and Nanomedicine

SYLLABUS

Unit	Contents	Hours
I	**General Pharmacognosy:** Introduction - Definition, Nature & sources of drugs, dosage forms, drug Nomenclature; Complementary Alternative Medicine; Generic name, trade name. *Fixed dose combinations, Posology*.	18
II	**Pharmacokinetics:** (a) Routes of administration: Advantages & disadvantages of important routes used. (b) Absorption: General Principles for passage of drugs across biological membranes, factors affecting absorption, transport, bioavailability. (c) Distribution: Plasma protein binding, biological barriers (BBB &Placental), volume of distribution, tissue storage. (d) Biotransformation: Principle phases (I & II), sites, types with examples. Factors affecting (Induction, Inhibition, tissue storage). (e) Elimination: Routes, Kinetics Half-Life, Loading dose, Maintenance dose. Methods of prolongation of drug effect, *Factors modifying dose of a drug*.	18
III	BioPharmaceuticals: History of pharmaceutical industry, the age of Biopharmaceuticals, current status and future prospects, traditional pharmaceuticals of biological origin, distinction between chemical drugs versus biopharmaceuticals, *Sources and delivery of biopharmaceuticals*.	18
IV	**Drug discovery and clinical evaluation of new drugs**: Drug discovery phase, preclinical evaluation phase, clinical trial phase, phases of clinical trials and *pharmacovigilance*.	18
V	**Development of nanomedicine:** Introduction - Development of nano medicines – Nano Shells – Nanopores – Tectodendrimers – Nanoparticle drug system for oral administration – Drug system for nasal administration – Drug system for ocular administration – *Nanotechnology in diagnostic application*.	18
VI	**Current Trends (For CIA only)** – Pharmacotyping, clinical trial diversity, Generic Medicine	

..... Self Study

Text Book(s):

1. Karen Whalen, pharmacology, 7th Edition, 2018
2. Gary Walsh. Biopharmaceuticals – Biochemistry & Biotechnology.2nd Edition, John Wiley & Sons. 2003.
3. Kewal K. Jain. The Handbook of Nanomedicine.3rd edition, Humana Press, 2008.

Reference Book(s):

1. Bertram G. Katzung; Susan B. Masters; Anthony J. Trevor, Basic and Clinical Pharmacology, 14th edition, 2017.
2. Christ M. Niemeye and Chad A. Mirkin, Nanobiotechnology: Concepts, Applications and Perspectives. 1st edition. Wiley-VCH. 2004.
3. Mark Kester; Kelly Dowhower Karpa; Kent E. Vrana, Elsevier's Integrated Review Pharmacology, 2nd edition, 2011

Web Resource(s):

1. https://www.classcentral.com/subject/pharmacology
2. https://www.classcentral.com/course/drug-development-7254
3. https://onlinelearning.hms.harvard.edu/hmx/courses/hmx-pharmacology/
4. https://elearninguoa.org/course/health-nanotechnology-nanomedicine/nanotechnology-and-nanomedicine

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Discuss the history and scope of Pharmacognosy.	K3
CO2	Classify the various approaches for development of novel drug delivery systems.	K4
CO3	Predict the Skill in selecting for suitable techniques for analysis of drugs and pharmaceuticals.	K4
CO4	Explain Phases involved in clinical trials Process of monitoring clinical trials through pharmacovigilance.	K5
CO5	Discuss the application of nanotechnology in nanomedicine.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO	**PO**	**PO**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	2	2	3	2	2	3	3	2.5
CO2	3	2	2	2	3	2	3	2	2	2	2.3
CO3	3	3	1	1	2	3	1	1	2	1	1.8
CO4	3	3	2	2	3	2	3	1	2	2	2.3
CO5	3	3	2	1	3	2	1	2	2	3	2.2
Mean Overall Score											**2.22**
Correlation											**Medium**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. S. Deborah

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PBT3CC9	Core – IX	6	5	25	75	100
Course Title	PLANT BIOTECHNOLOGY						

SYLLABUS		
Unit	Contents	Hours
I	**Introduction to plant tissue culture:** History of Plant tissue culture - Tissue culture media Murashige and Skoog - Plant Growth Regulators, Micropropagation - Direct and Indirect Organogenesis; Hardening and acclimatization; Callus and Somatic embryogenesis -Embryo culture and embryo rescue - Artificial seeds. Cryopreservation and germplasm conservation; *Greenhouse technology*	18
II	**Cell culture techniques:** Single cell culture techniques, Cell suspension culture; Haploid and triploids plant production, Protoplast isolation and culture, Soma clonal variation-somatic hybridization; cybrids. Plant secondary metabolites production, alkaloids, *Industrial enzymes*.	18
III	**Techniques in plant transformation:** Gene transfer methods – Direct gene transfer: Physical and chemical method, Indirect-Agrobacterium mediated gene transfer – crown gall disease and Ti plasmid – Hairy root disease of *A. rhizogenes* (Ri plasmid); Virus mediated gene transfer- Caulimovirus, Gemini virus, RNA plant vector; and biological (cyDENT) method. *Genome editing technology in Plant- CRISPR/Cas 9*.	18
IV	**Plant biotechnology tools for crop improvement**: Molecular markers - Restriction based; PCR based markers – RFLP, RAPD, AFLP, ISSR, SNP; Development of SCAR (Sequence Characterized Amplified Regions), SSCP (Single Strand Conformational Polymorphism), STS, Microsatellites, and SSR markers; Marker assisted selection and breeding – Selectable markers, reporter genes and promoters used in plant vectors; SAAT and floral dip transformation technique in Arabidopsis; *Terminator seed technology*.	18
V	**Transgenic plants:** Herbicide resistance: phosphoinothricin, glyphosate-sulfonyl urea and atrazine. Insect resistance: *Bt* genes, non-*Bt* genes like protease inhibitors, alpha amylase inhibitor. Plant disease resistance: plant pathogen interaction, existing approaches to combating disease, Natural disease resistant pathways and RNAi for crop improvement. *Abiotic stress: Drought, cold and salt*. Post-harvest losses: long shelf life of fruits.	18
VI	**Current Trends (For CIA only) –** GMO applications in food and agriculture - Cartegena Protocol and food safety– Ethical issues and resilience of GM crops.	

***.....*Self Study**

Text Book(s):

1. Kalyankumar De. An Introduction to Plant Tissue Culture Techniques. New Central Book Agency, Kolkata. 2007.
2. Adrian Slater, Nigel W. Scott and Mark R. Fowler., Plant Biotechnology (The genetic manipulation of plants). Oxford University press, UK. 2003.
3. R.J. Henry. Practical Application of Plant Molecular Biology. Chapmans and Hall. 2013.

Reference Book(s):

1. Donald Grierson and S.V. Convey. Plant Molecular Biology. Blackie and Son Limited. New York, 2010.
2. M.J. Chrispeels and D.F. Sadava. Plants, genes and agriculture, The American Scientific Publishers, USA. 2010.
3. S.H. Mantell, and H. Smith. Plant Biotechnology by. Cambridge University press, UK. 2001.
4. Mathews and Mickee. An introduction to genetic engineering in plants, Blackwell Scientific Publishers. London. 2015.

Web Resource(s):
1. https://nptel.ac.in/courses/102/103/102103016/ 2. https://nptel.ac.in/courses/102/103/102103013/ 3. https://swayam.gov.in/nd2_cec19_bt01/preview

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Demonstrate the basic principles and techniques involved in plant tissue culture.	**K3**
CO2	Analyse the skills associated with single cell culture techniques and soma clonal variation techniques for production novel plants in plant breeding program.	**K4**
CO3	Explain the applications of production of genetically modified plants for gene transfer techniques.	**K5**
CO4	Summarize the Plant biotechnology tools for crop improvement and production of Useful Genetic Diversity.	**K6**
CO5	Develop of inherent ability of a species to survive in adverse condition by gene transformation techniques.	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes**					**Programme Specific Outcomes**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	2	3	3	2	2	2	2.5
CO2	3	3	1	3	2	3	3	2	2	2	2.4
CO3	3	3	1	3	2	3	3	2	2	2	2.4
CO4	3	3	1	3	2	2	3	2	2	2	2.4
CO5	3	3	1	3	3	3	3	3	2	2	2.6
Mean Overall Score											**2.4**
Correlation											**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. J. Sebastin Raj

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PBT3CC10	CORE - X	6	5	25	75	100
Course Title	ANIMAL BIOTECHNOLOGY						

SYLLABUS		
UNIT	**CONTENT**	**HOURS**
I	**Introduction to Animal Cell Culture-** Media formulation- for cell culture- natural & defined media, Preparation of various tissue culture media, components and their function- serum- and *serum free media*; Basic requirements of cell culture lab, Development and maintenance of cell lines.	**18**
II	**Animal Cell culture techniques:** Primary, secondary culture, cell lines, expression of culture efficiency, cell death and apoptosis. Organ culture methods of introducing of DNA into cell lines–microinjection-calcium phosphate transfection- lipofection- electroporation; Cell hybridization, Cell adhesions- CAM, Cadherins. *Cell synchronization. Preservation of animal cells, American type culture collection (animal cell line) *.	**18**
III	**Vectors**- Biology and methods for the construction of Animal viral vectors - SV40, adeno virus, retro virus, vaccinia virus, herpes virus, adeno associated virus and Baculo virus. Gene transfer in cells; physical, chemical and biological methods. Molecular Pharming for production of medical and diagnostic products- regulatory proteins, *blood products, hormones*.	**18**
IV	**Animal Biotechnology in Reproduction** - Semen storage - Artificial insemination, Super ovulation, Oestrus Synchronization. In vitro culture and maturation of animal oocytes and its storage - Methods of transferring genes into animal oocytes, eggs, embryos, and specific tissues - *IVF - gamete selection*.	**18**
V	**Transgenic animals-** Development and use of transgenic animals – retroviral method- embryonic stem cell method- micro –injection method, cloning of animals -Transgenic livestock production - Transgenic Fish production - *Fish and silkworm as living Bioreactors*. Gene therapy – types, vectors and sites of gene therapy, *ex-vivo* and *in-vivo* methods. Antisense and ribozyme therapy- Protein *Aptamers*- Intrabodies.	**18**
VI	**Current Trends (For CIA only) – Gene knockin and knockout techniques** – Strategies of gene delivery -Targeted gene replacement.	

***…….* Self-study**

Text Books:

1. Butterworthh –Heineman. "*In vitro* cultivation of animal cells", 5th Edition, Butterworth HeinemanLtd. 2004.
2. R.W. John Masters., "Animal cell culture", 3rd Edition, Oxford university press. 2004.

Books for Reference:

1. J. R.W. Masters, "Animal Cell culture", Oxford University Press. 2010.
2. M. M. Ranga, "Animal Biotechnology", Student Edition- Jodhpur. 2013.
3. V.Mehta, Animal Biotechnology. Campus Books International, New Delhi, India, 2016.
4. S.B.Primrose, R.W. Twyman, Principles of Gene Manipulation and Genomics, Seventh edition, Wiley Blackwell, 2006.

Web Source:
1. https://nptel.ac.in/courses/102/104/102104059/ 2. https://nptel.ac.in/content/storage2/courses/104108056/module9/PNR%20lecture%2034.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO NO.	**CO Statement**	**Cognitive Level(K-Level)**
CO1	Demonstrate the basic concepts of animal cell culture.	**K3**
CO2	Analyze the methods used in gene transfer technology in Animal.	**K4**
CO3	Outline the types of vector used for gene transfer in Animal.	**K4**
CO4	Appraise about Animal Biotechnology in Reproduction.	**K5**
CO5	Evaluate the importance of transgenic animals and its application.	**K5**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5	
CO1	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**3**	**3**	**3**	**2.8**
CO2	**3**	**2**	**3**	**2**	**2**	**2**	**2**	**2**	**3**	**2**	**2.3**
CO3	**2**	**3**	**2**	**3**	**3**	**2**	**2**	**3**	**3**	**2**	**2.5**
CO4	**2**	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**3**	**2.4**
CO5	**3**	**3**	**2**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**2.5**
										Mean Overall Score	**2.5**
										Correlation	**High**

Mean Overall Score	**Correlation**
<1.5	**Low**
>-1.5 and <2.5	**Medium**
>-2.5	**High**

Course Coordinator: Dr. S. DEBORAH

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PBT3CC11	CORE - XI	6	6	25	75	100

Course Title	BIOINFORMATICS AND BIOSTATISTICS

SYLLABUS

Unit	Contents	Hours
I	**Structural Biology**: Bioinformatics scope and history, factors determining primary – secondary- tertiary and quaternary structure of proteins - protein information resources- biological databases, primary sequence databases, secondary database. * Composite protein sequence database*.	18
II	**Biological Database & DBMS Databases**: Open access bibliographic resources and literature databases. Introduction to DBMS - Types of databases. Flat file database - Relational databases - Object oriented databases - Database software: Overview of Sequence Retrieval System – Oracle - MySQL. Database design. Visualization of databases and software*.	18
III	**Biological Sequence analysis**: Pair wise sequence alignment comparison - Scoring matrix, Dynamics programming, – FASTA, and BLAST. Multiple sequence alignments -Phylogenetic alignment- Evolution, Element of Phylogeny Methods. Protein structure visualization tools - *RasMol, Swiss PDB Viewer *Protein identification programs- Moscot. Protein interaction*. Molecular modeling and drug design.	18
IV	**Programming In C & Perl**: C-language-Introduction- Type of Operators-variables- input output statements- control statements- function- arrays- pointers-structures- unions- file handling and case studies. Introduction to PERL-variables- strings and numbers- lists conditional loops- strings- pattern matching-*applying PERL to bioinformatics*.	18
V	**Biostatistics Analysis**: Measures of central Tendency - mean arithmetic's-harmonic and geometric median and mode - measures of dispersion - standard deviation and standard error; correlation coefficient- simple linear regress-*SPSS Packages*. **Biostatistics Application:** Properties of Normal Distributions, Point and Interval Estimates of Means and Proportions: *Hypothesis Tests, One Sample Test- t-Test*.	18
VI	**Current Trends (For CIA only):** cheminformatics, molecular docking studies.	

***…….* Self-study**

Textbooks:

1. S.C Rastogi , N. Mendiratta, P.Rastogi. Bioinformatics Methods and Application Genomics, Proteomics and Drug Discovery, 2004.
2. Mike Mc Grath, Perl in Easy steps, 2005.
3. R.S.N. Pillai and V. Bagavathi.Statistics – Theory and Practice.S. and Company Ltd., New Delhi,2006.
4. Glovery and Mitchell. An Introduction to Biostatistics, 2009

Reference Book(s):

1. S.R. Swindell, R.R.Miller and G.S.A. Myers (Eds.), Internet for the Molecular Biologist, Horizon Scientific Press, Wymondham, UK, 1996.
2. Andrea Cabibbo, Richard Grant and Manuela Helmer-Citterich (Eds.), The Internet for Cell and Molecular Biologists (2nd Edn.), Horizon scientific Press, Norwich, 2004.

Web Resource(s):

1. https://www.epictraining.ca/course/15958/biological databases/-distance
2. https://bioinformatics.mit.edu/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Analyse the knowledge about the bioinformatics, programming, software and its future challenges.	K4
CO2	Assess the biological sequence analysis and its derivation.	K5
CO3	Determine the category of measures of central tendency, dispersion and correlation for analysis of data.	K5
CO4	Assess the programs with interactive input and output program c.	K6
CO5	Elaborate the bioinformatics applications, biological information, Retrieval methods for DNA sequence	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	3	3	3	2	1	3	3	2.4
CO2	3	3	3	3	3	2	3	0	3	3	2.3
CO3	3	3	3	2	3	2	2	3	3	3	2.8
CO4	3	3	3	3	2	2	2	3	3	3	3.0
CO5	3	3	2	2	3	2	0	3	3	3	2.6
Mean Overall Score											**2.61**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. K.Gobalan

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PBT3CC12P	Core – XII	6	4	20	80	100

Course Title	PLANT BIOTECHNOLOGY, ANIMAL BIOTECHNOLOGY, BIOINFORMATICS AND BIOSTATISTICS - PRACTICAL

SYLLABUS		
S.NO	**Contents**	**Hours**
1	Organizing plant Tissue Culture Laboratory and Preparation of Tissue Culture Media.	**90**
2	Propagation of plantlets by direct and indirect organogenesis.	
3	Somatic embryogenesis and Artificial seed preparation.	
4	Haploid plant production - Anther and Pollen culture.	
5	Protoplast isolation and culture by Mechanical and enzymatic methods.	
6	Transformation of leaf discs with Agrobacterium.	
7	TMV inoculation.	
8	Industrial visit to National Research Center for Banana (NRCB)	
9	Organizing animal cell culture Laboratory	
10	Preparation of tissue culture media and sterilization.	
11	Primary cell culture and subculture.	
12	Isolation of lymphocyte from human blood.	
13	Cell growth analysis and cell count (RBC/ WBC) using Haemocytometer.	
14	Sequence alignment by BLAST.	
15	Phylogenetic analysis using web tools.	
16	Pair wise Sequence Alignment.	
17	Program to convert DNA to RNA.	
18	Web Publishing: Create a web page for your University / College using HTML. The opening page should provide hyperlinks to other pages (add animation and sound effects appropriately).	

Text Book(s):

1. Kalyankumar De. An Introduction to Plant Tissue Culture Techniques. New Central Book Agency, Kolkata. 2007.
2. R.W.John, Masters. “Animal cell culture”, 3rd Edition, Oxford University press. 2004.
3. S.C Rastogi , N. Mendiratta, P.Rastogi. Bioinformatics Methods and Application Genomics, Proteomics and Drug Discovery, 2004.

Reference Book(s):

1. E.M.T.El-Mansi et al. Fermentation microbiology & biotechnology. CRC / Taylor &Francis, 2007.
2. S.R. Swindell, R.R.Miller and G.S.A. Myers (Eds.), Internet for the Molecular Biologist, Horizon Scientific Press, Wymondham, UK, 1996.

Web Resource(s):
1. https://www.researchgate.net/publication/306018037_A_Plant_Biotechnology_Laboratory_Manual 2. https://www.austincc.edu/awheeler/Files/BIOL%201414%20Fall%202011/BIOL1414_Lab%20Manual_Fall%202011.pdf 3. https://microbiologyonline.org/file/7926d7789d8a2f7b2075109f68c3175e.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Acquire the fundamental knowledge for mass multiplication of plantlets for modern agricultural practice.	**K3**
CO2	Understand the processes involved in the planning, conduct and execution of Plant and animal biotechnology experiments	**K3**
CO3	Examine the plant and animal biotechnological techniques to explore molecular biology of plant cell, animal cells	**K4**
CO4	Advance knowledge of the underlying principles of basic bioinformatics tools and its applications.	**K5**
CO5	Predict the various software used in molecular modelling and drug designing.	**K6**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	3	1	3	2	3	2	2.5
CO2	3	3	2	3	2	2	2	2	2	2	2.3
CO3	3	3	2	3	2	2	2	3	3	3	2.6
CO4	3	3	1	3	2	3	3	2	3	3	2.6
CO5	3	3	3	3	2	2	2	2	2	2	2.4
										Mean Overall Score	**2.4**
										Correlation	**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. S. Geet Andrea

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PBT3DE3A	Discipline Specific Elective - III	6	4	25	75	100

Course Title	STEM CELL BIOLOGY

SYLLABUS

Unit	Contents	Hours
I	**Stem cell basics:** Definition, properties of stem cells – self renewal, clonality, pluripotency, totipotency; stem cell niche; Molecular Bases of Pluripotency: signal transduction cascades to the stem cell nucleus – signal molecules. *****Oct4 is a key transcription in pluripotency*****; Present Perspective and Future Challenges.	**18**
II	**Embryonic stem cells:** Derivation of Embryonic Stem Cells, Factors Influencing ES Cell Derivation, Embryonic Germ Cells, Genome manipulation in ES cells – Pluripotent Stem Cells in the Early Embryo, Stem cell isolation and culture techniques, *****Maintenance of ES Cell Pluripotency*****.	**18**
III	**Adult stem cells:** Somatic stem cells – test for identification of adult stem cells – adult stem cell differentiation – stem cell plasticity – different types of adult stem cells: Hematopoietic stem cells, mesenchymal stem cells, *****Bone Marrow Stem Cells, Adipose (fat) Stem Cells*****.	**18**
IV	**Stem cells in tissue engineering:** Reservoirs of postnatal stem cells, current approaches to tissue engineering: ex vivo culture of postnatal stem cells, delivery of stem cells; organ regeneration techniques- reconstruction of the skeleton - bone and cartilage, skeletal and cardiac muscle regeneration; ex vivo reconstructions - cells, scaffolds, and bioreactors:*****activation of local and distant endogenous stem cells*****	**18**
V	**Therapeutic application of stem cells, regulation & ethical considerations:** Stem cells in spinal cord injury, heart disease, diabetes, gene therapy; Genome editing of stem cells; Neurodegenerative disease- Alzheimer's, Diabetes, Kidney failure. Ethics of Human Stem Cell Research; FDA Product and Preclinical Regulatory considerations *****applications of Bioinformatics Tools in Stem Cell Research*****.	**18**
VI	**Current Trends (For CIA only) –** The development of personalized medicine, where patient-specific stem cells can be used to tailor treatments to each patient's needs and genetic makeup.	

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Text Book(s):

1. Robert Lanz, John Gearhart, Brigid Hogan et al, Essential of stem cell Biology, Elsevier Academic Press, 2006.
2. R. Daniel, Marshak, Richard l. Gardner, David Gottlieb, Stem Cell Biology, Cold Spring Harbor Laboratory Press, 2001.
3. Christine L. Mummery,Hans Clevers,Anja Van de Stolpe,Bernard Roelen,Stem Cells:Scientific Facts and Fiction,Academic press,2021.

Reference Book(s):

1. Paul Knoepfler, Stem Cells: An Insider's Guide. World Scientific. 2013.
2. C.Potten, Stem cells,.Elsevier Publication.1996
3. AmitaSarkar, Embryonic stem cells. Discovery Publishing House Pvt. Ltd. 2009

Web Resource(s):

1. http://jprsolutions.info/newfiles/journal-file-56c675c7d3f8c9.27227172.pdf
2. https://dbtindia.gov.in/sites/default/files/National_Guidelines_StemCellResearch-2017.pdf
3. https://stemcellres.biomedcentral.com/articles/10.1186/s13287-019-1165-5

Course Outcomes

Upon successful completion of this course, the student will be able to:

CO No.	CO Statement	Cognitive Level (K-Level)
CO1	Analyse the knowledge about the stem cell, types, signal transduction and its future challenges.	K4
CO2	Assess the embryonic stem cell and its derivation.	K5
CO3	Determine the different types of adult stem cells.	K5
CO4	Assess the stem cells in tissue engineering.	K6
CO5	Elaborate the therapeutic applications, regulations and ethics of stem cell.	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	2	2	2	1	3	3	2.4
CO2	3	3	2	2	3	2	2	0	3	3	2.3
CO3	3	3	3	3	3	2	2	3	3	3	2.8
CO4	3	3	3	3	3	3	3	3	3	3	3.0
CO5	3	3	3	3	3	2	0	3	3	3	2.6
Mean Overall Score											**2.6**
Correlation											**High**

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. T. Nargis Begum

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
III	23PBT3DE3B	Discipline Specific Elective - III	6	4	25	75	100

Course Title	MARINE BIOTECHNOLOGY

SYLLABUS

Unit	Contents	Hours
I	**Marine Ecology:** Benthic and Pelagic Zone; Photic, dysphotic and aphotic zones-importance and their significance. Biological divisions of the sea- estuaries and backwaters, lagoons, mangroves, coastal waters, inshore, offshore, *deep sea/oceanic zone*.	18
II	**Biological Resources and taxonomy:** Sampling, cultivation and taxonomy of organisms. Metagenomics.Flora, Fauna, Bacteria, fungi, algae and archaea.Extremophilic microorganisms; Fisheries and other aquatic potential. Role of marine organisms in carbon, nitrogen, *phosphorus and sulphur cycles*.	18
III	**Marine microbial pathogens and Aquaculture:** Microbial pathogens in marine environment - diversity, sources and detection of pathogens in recreational water, impact of harmful algal blooms, microbial pathogens of seafood. Biofloc technology; Aquaponics; Zero water exchange aquaculture system; Aquamimicry; Hydroponics; Raceway system of aquaculture; *Bioremediation in Aquaculture systems*.	18
IV	**Marine Bioprospecting:** Marine organisms for Biofuels and bioenergy, Bioremediation, Biofouling, Biosurfactants. Marine natural products as cosmetics-cosmeceuticals, algotherapy; Thalassotherapy; Enzymes; food, supplement, nutrition and energy drinks. Marine algae as fish feed, *manure and fertilizers*.	18
V	**Marine Byproducts:** Marine derived drugs in preclinical and clinical trials- FDA and EMEA approved marine derived drugs, their use and mode of action. Screening of drugs High-throughput Screening Assays (HTS). Bioassays- Enzyme assays, cytotoxicity assay; antimicrobial assay; *DNA laddering assay; Apoptosis assays*.	18
VI	**Current Trends (For CIA only)** – Cosmetic benefits of marine microalgae derived compounds, cosmaceuticals and thalassotherapy using marine compounds	

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Text Book(s):

1. T. Scheper, Le Gal Y, Ulber R, Marine Biotechnology II, Springer, 2005.
2. P. Proksch and W.E.G. Müller (Eds.), Frontiers in Marine Biotechnology [Hardcover], Taylor & Francis; edition, 2006.

Reference Book(s):

1. Se Kwon, Essentials of Marine Biotechnology, Springer Nature, 2019
2. G. Karleskint, R. Turner, and J. Small (Eds.), Introduction to Marine Biology, Brooks Cole;3rd edition, 2009.

Web Resource(s):

1.http://archives.esf.org/fileadmin/Public_documents/Publications/marine_biotechnology_01.pdf
2. https://marinebio.org/creatures/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Elucidate principle features of marine ecosystems and the microbial diversity	**K4**
CO2	Describe and discuss marine microbes in terms of physiological capability and their biogeochemical role.	**K4**
CO3	Analyze the pathogenic microbes available in an aquatic environment, their role and interaction with the ecosystem.	**K4**
CO4	Evaluate the application of marine organisms as fuel, food and nutrient supplements	**K5**
CO5	Evaluate the mechanisms associated with production of marine by-products.	**K4**

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes (POs)**					**Programme Specific Outcomes (PSOs)**					**Mean Score of COs**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	3	2	2	2	2	1	3	3	2.4
CO2	3	3	2	2	3	2	2	0	3	3	2.3
CO3	3	3	3	3	3	2	2	3	3	3	2.8
CO4	3	3	3	3	3	3	3	3	3	3	3.0
CO5	3	3	3	3	3	2	0	3	3	3	2.6
Mean Overall Score											**2.62**
Correlation											**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Ms. S. Geet Andrea

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PBT3CC13	Core – XIII	6	6	25	75	100
Course Title	MICROBIAL TECHNOLOGY						

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Microbial Technology:** Microbial Diversity: Prokaryotes and Eukaryotes, The Importance of the Identification and Classification of Microorganisms, Plasmids and the Classification of Bacteria, Analysis of Microbial Populations in Natural Environments, Taxonomic Diversity of Bacteria with Uses in Biotechnology, *Characteristics of the Fungi*, Classification of the Fungi, Culture Collections and the Preservation of Microorganisms.	**18**
II	**Agriculture Technology:** Improvement of N2- fixing strain, production of biofertilizers, biopesticides; Development of disease and insect resistant plants; Biocontrol by hyperparasites & hypoparasites. In Health: Production of recombinant vaccines, interferon, and insulin. Biofuel production – *Biogas, biodiesel and H2 as fuel by microbes; microbial fuel cell*.	**18**
III	**Importance of Microbial Therapeutics over Conventional Treatments**: Microbes with Therapeutic Properties, Methods of Implementation of Microbial therapeutics, Challenges Related to Microbial Therapeutics, Human therapeutics - *Production of heterologous proteins*, secondary metabolites as a source of drugs.	**18**
IV	**Microbial Food Technology**: - preparation of fermented foods (NIsin, *Lactobacillus Sakei*: a promising biopreservative and monensin); Probiotics, *Environmental applications of microorganisms*. Production of yeast, Production of single cell protein for use in food and feed.	**18**
V	**Microbes in Industrial fermentation products and Microbial Nanotechnology:** Microbial production of vitamin and aminoacids, antibiotics and enzymes. *Microbial nanotechnology in industrial applications*.	**18**
VI	**Current Trends (For CIA only):** Antimicrobial Resistance (AMR) Surveillance and Analysis.	

***.....*Self Study**

Text Book(s):

1. Uma Shankar Singh and Kiran Kapoor, Microbial Biotechnology, Oxford Book Company, 2010.
2. N. Alexander , Glazer and Hiroshi Nikaido, Microbial Biotechnology - Fundamentals of Applied Microbiology, 2nd Edition, Cambridge University Press, 2007.

Reference Book(s):

1. Yuan Kun Lee, Microbial Biotechnology: Principles and Applications, World Scientific, 2006.
2. Lee Yuan Kun, Microbial Biotechnology: Principles and Applications, World Scientific, 2003.

Web Resource(s):

1. https://nptel.ac.in/courses/102/103/102103013/
2. https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod7.pdf
3. https://portal.abuad.edu.ng/lecturer/documents/1585662755MICROBIAL_BIOTECHNOLOGY Fundamentals_of_Applied_Microbiology,_Second_Edition.pdf

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Categorize the role of industrial important microorganisms.	K4
CO2	Examine the Biotechnological methods are being used to understand agricultural important microorganism.	K4
CO3	Analyse Importance of Microbial Therapeutics over Conventional Treatments	K4
CO4	Evaluate the importance of microbes in Food Technology.	K5
CO5	Appraise the role of Microbes in Industrial fermentation products and Microbial Nanotechnology	K6

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of Cos
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	2	2	2	2	2	2.0
CO2	2	1	2	2	2	2	2	2	2	2	1.9
CO3	2	2	1	2	2	2	2	2	2	2	1.9
CO4	2	2	2	3	3	2	2	2	2	2	2.2
CO5	3	2	2	3	3	3	3	3	3	3	2.8
										Mean Overall Score	**2.16**
										Correlation	Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr.S. Deborah

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PBT4CC14	Core – XIV	6	5	25	75	100

Course Title	ENVIRONMENTAL BIOTECHNOLOGY

SYLLABUS

Unit	Contents	Hours
I	**Global Environmental Problems:** Greenhouse effect and global warming: Greenhouse gases – Measures to control greenhouse effect, global warming and climate change. Problem of ozone: Depletion of ozone – ozone hole– effect of ozone depletion – Measures to control ozone depletion: *Acid rain: Development of acid rain –effect of acid rain* –Measures to control acid rain, El Nino-Southern oscillation and sea level rise.	**18**
II	**Environmental Pollution**: Origin of pollution; Classification and nature of Environmental Pollutants; Industrial pollutions. Overview of Noise pollution. *Radiation Pollution - Types and possible hazards of radioactive substances* Soil Pollution - Waste land formation. Impact of Dams, Loss of soil fertility*.	**18**
III	**Waste water management*:*** Waste water treatment: waste water collection, physico-chemical properties of waste water, physical, chemical and biological (primary, secondary and tertiary) treatment processes. Activated sludge, oxidation ditches, trickling filter, rotating discs, rotating drums, oxidation ponds. *Anaerobic digestion, anaerobic filters*. Biotechnology in tannery, dairy, distillery, textile, pulp, paper and Antibiotic industries effluent treatment.	**18**
IV	**Bioremediation:** Xenobiotic, Ecological considerations, degradative plasmids; hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides. *Bioplastics*, Biopesticides; bioremediation of contaminated soils and wastelands. Phytoremediation: degradation of xenobiotic by plants.	**18**
V	**Environmental Quality Assessment and Monitoring:** Quality of environment for life on earth and man - Deterioration of environmental quality with reference to anthropogenic impact. *Methods of assessment of environmental quality*; Impacts of genetically engineered microbes, plants and animals. Organization for environmental quality and Law of environmental protection.	**18**
VI	**Current Trends (For CIA only) –** Biodiesel production and simultaneous treatment of domestic and livestock wastewater using indigenous microalgae.	

***.....*Self Study**

Text Book(s):

1. K. Rajiv, Sinha, Rohit Sinha, Environmental Biotechnology, Aavishkar Publishers, Distributors, 2008.
2. E. John, Smith, Biotechnology, 5TH edition, Cambridge University Press, 2009.
3. E.Bruce, Rittmann, Perry L. McCarty, Environmental Biotechnology: Principles and applications, McGraw-Hill, 2005.
4. A. K. Chatterji, Introduction to Environmental Biotechnology, Prentice-Hall of India Private Limited, 2011.

Reference Book(s):

1. M. H. Fulekar, Environmental Biotechnology, CRC Press, 2010.
2. K.C. Agrawal, Environmental Biotechnology, Nidhi Publishers (India), Bikaner. 2004.
3. K. Pradipta, Mohapatra. Environmental Biotechnology, I.K. International Publishing House Pvt. Ltd. 2008.

Web Resource(s):
1. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.539.8486&rep=rep1&type=pdf 2. https://www.biotecharticles.com/Bioinformatics-Article/Environmental-Informatics-and-its-Applications-3381.html

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Analyse and understand the global environmental problems.	K3
CO2	Classify the environmental pollutants and the impacts in our environment.	K4
CO3	Analyse the significance of waste water treatment processes for overcome the ground water pollution.	K4
CO4	Evaluate the methods for degradation of synthetic fertilizer and pesticide by using genetically engineered microorganisms.	K5
CO5	Assess the Quality of environment for life on earth for men and living organisms.	K6

Relationship Matrix:

Course Outcomes (COs)	**Programme Outcomes**					**Programme Specific Outcomes**					**Mean Score of Cos**
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	3	3	2	3	2	3	3	2	2	2	2.5
CO2	3	3	1	3	2	3	3	2	2	2	2.4
CO3	3	3	1	3	2	3	3	2	2	2	2.4
CO4	3	3	1	3	2	2	3	2	2	2	2.4
CO5	3	3	1	3	3	3	3	3	2	2	2.6
										Mean Overall Score	**2.4**
										Correlation	**Medium**

Mean Overall Score	**Correlation**
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. J. Sebastin Raj

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
IV	23PBT4CC15	Core - XV	6	5	25	75	100
Course Title	BIOPROCESS TECHNOLOGY						

SYLLABUS		
Unit	Contents	Hours
I	**Introduction to Bioprocess Technology:** Overview of bioprocessing and its applications - Comparison with chemical processing - Bioreactor types and design considerations. **Microbial Fermentation:** Microbial growth kinetics, Batch, fed-batch, and continuous fermentation - Sterilization techniques - *aseptic processing*.	**18**
II	**Cell Culture and Upstream Processing**- Mammalian cell culture techniques -Cell line development and maintenance - Media formulation and optimization; **Downstream Processing:** Separation and Purification -Cell disruption methods - Filtration and centrifugation techniques -Chromatography principles and applications; Recovery and Purification -Protein refolding and renaturation; Ultrafiltration and diafiltration - Formulation and fill-finish operations. Integration of upstream and downstream operations - Process optimization and yield improvement - *Quality by Design (QbD) in bioprocessing*.	**18**
III	**Scale-Up and Scale-Down in Bioprocessing** - Principles of scale-up and scale-down, Pilot plant operations and process validation - Technology transfer and regulatory considerations. Bioprocess Control and Monitoring - Sensors and instrumentation in bioprocessing. Feedback and feedforward control strategies - *Real-time monitoring and data analysis*.	**18**
IV	**Fermentation of Recombinant Microbes -** Engineering genetically modified organisms for bioprocessing - Expression systems and host selection - Safety considerations in bioprocessing. **Bioprocess Economics and Facility Design -** Cost analysis and economic considerations - Facility design and layout for bioprocessing - *Environmental and sustainability considerations*.	**18**
V	**Emerging Trends in Bioprocessing** - Advanced bioreactor technologies (e.g., perfusion systems) - Regulatory Compliance and Good Manufacturing Practices (GMP) - *FDA and international regulatory guidelines*.	**18**
VI	**Current Trends:** Recent trends in integrated bioprocesses: aiding and expanding microbial biofuel/biochemical production.	

***.....*Self Study**

Text Book(s):

1. Fereidoon Shahidi (Editor), Jean-Richard Neeser (Editor), J. Bruce German (Editor), Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals (Nutraceutical Science and Technology Book 2) 1st Edition
2. J.M. Coulson, and J.F. Richardson, Chemical Engineering, Pergamon Press, 2014
3. Kalaichelvan, Bioprocess Technology Paperback – 1 July 2021

Reference Book(s):

1. Mansi and C.F.A. Bryce., Fermentation Microbiology and Biotechnology, Taylor & Francis Ltd.,2004.
2. P.F. A.Stanbury and Whitaker S.J. Hall. Principles of Fermentation Technology Oxford, 2015.

Web Resource(s):

1. https://iubmb.onlinelibrary.wiley.com/doi/full/10.1002/bmb.20860
2. https://www.nap.edu/read/2052/chapter/3

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Demonstrate Understanding of Bioprocess Fundamentals and apply Microbial Physiology and Kinetics.	**K4**
CO2	Prioritize the Execution of Upstream and Downstream Processes.	**K4**
CO3	Interpret the different Bioprocess Parameters for monitoring the fermentation unit.	**K5**
CO4	Outline the application of Recombinant Microbes use in fermentation.	**K5**
CO5	Gain expertise in Emerging Trends in Bioprocessing.	**K6**

Relationship Matrix:

Course Outcomes (COs)	Programme Outcomes (POs)					Programme Specific Outcomes (PSOs)					Mean Score of COs
	PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	
CO1	2	2	2	2	2	2	2	3	3	2	2.2
CO2	2	2	2	2	2	2	2	2	2	2	2.0
CO3	2	2	2	2	2	2	2	2	2	2	2.0
CO4	2	2	2	3	3	2	2	3	3	2	2.4
CO5	3	2	3	3	3	3	3	3	3	3	2.9
										Mean Overall Score	2.3
										Correlation	Medium

Mean Overall Score	Correlation
< 1.5	Low
≥ 1.5 and < 2.5	Medium
≥ 2.5	High

Course Coordinator: Dr. S. Deborah