DEPARTMENT OF BIOTECHNOLOGY

COURSE STRUCTURE & SYLLABI

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

Programme : POST GRADUATE DIPLOMA IN FERMENTATION TECHNOLOGY (P.G.D.F.T) (COURSE DURATION: ONE YEAR)

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TIRUCHIRAPPALLI – 620 020

POST GRADUATE DIPLOMA IN FERMENTATION TECHNOLOGY (P.G.D.F.T)
(COURSE DURATION: ONE YEAR)

Sem	Course Code	Course Category	Course Title	Ins. Hrs/ Week	Credit	Marks		Total
						CIA	ESE	
I	23PDFT1CC1	Core - I	Biomolecules and Microbial Biochemistry	6	4	25	75	100
	23PDFT1CC2	Core - II	Biocatalysis and Biotransformations	6	4	25	75	100
	23PDFT1CC3	Core - III	Microbiology of Industrial Fermentation	6	4	25	75	100
	23PDFT1CC4	Core - IV	Principles of Fermentation Technology	6	4	25	75	100
	23PDFT1CC5P	Core - V	Microbiology, Enzymology and Fermentation - Practical	6	4	20	80	100
Total				**30**	**20**	**120**	**380**	**500**
II	23PDFT2CC6	Core - VI	Bioseparations and Biological Techniques	6	4	25	75	100
	23PDFT2CC7	Core - VII	Animal and Plant Cell Bioprocesses	6	4	25	75	100
	23PDFT2CC8	Core - VIII	Downstream Processes and Fermentation Economics	6	4	25	75	100
	23PDFT2CC9	Core - IX	Industrial Fermentation Processes	6	4	25	75	100
	23PDFT2CC10P	Core - X	Bioprocess - Practical	6	4	20	80	100
Total				**30**	**20**	**120**	**380**	**500**
Grand Total				**60**	**40**	**240**	**760**	**1000**

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PDFT1CC1	Core - I	6	4	25	75	100

Course Title	Biomolecules and Microbial Biochemistry

SYLLABUS		
Unit	**Contents**	**Hours**
I	**Carbohydrates**: Classification, structure, general properties and functions of polysaccharides and complex carbohydrates; amino sugars, proteoglycans and glycoproteins. *Lipids: Classification, structure, properties and functions of fatty acids, essential fatty acids, fats, phospholipids, sphingolipids, cerebrocides, steroids, bile acids, prostaglandins*, lipo-amino acids, lipoproteins, proteolipids, phosphatido-peptides, lipopolysaccharides.	**18**
II	**Proteins:** Primary (peptide conformation, N- and C- terminal, peptide cleavage), Secondary (α-helix, sheet, random coil, Ramachandran plot), Tertiary and Quaternary structures of proteins. *Nucleic acids: Nucleic acids as genetic information carriers, experimental evidence e.g., genetic transformation, Hershey-Chase experiments, action spectrum, etc*. Structure and function of nucleotides. Primary, secondary and tertiary structure of nucleic acids, DNA forms and conformations, Denaturation of DNA.	**18**
III	**Microbial Metabolism:** Glycolysis, Alernative pathways to Glycolysis-: Pentose phosphate pathway, Entner-Doundroff pathway, Aerobic respiration-Tricarboxylic acid cycle, *The Electron Transport chain*, The Chemiosmosis.	**18**
IV	**Vitamins and Amino acid: A**nerobic respiration, Fermentation -lactic acid Alcohol, Mixed Acid, 2,3 butanediol, Propionic acid, Butyric acid., *Metabolic pathways of Energy Use: Gluconeogenesis, Biosynthesis of Lipid, Aminoacid – Arginine, valine, tryptophan*, histidine and methionine, catabolism of threonine, cysteine, tyrosine, tryptophan methionine, biosynthesis of Purine and Pyrimidine, Vitamins- water-soluble and lipid-soluble vitamins.	**18**
V	**Microbial photosynthesis:** Prokaryotic and eukaryotic photosynthetic apparatus, photophosphorylation, light and dark, reaction, photorespiration, *Biological nitrogen fixation*, Biochemistry of nitrogen fixation.	**18**
VI	**Current Trends (For CIA only) –** Bio-molecular spectrum that drives microbial biology and functions.	

…… Self Study

Text Book(s):

1. E Conn P.K. Stumpf, G. Bruenimg and Ray H. Doi, Outlines of Biochemistry, John Wiley & sons. 5th Edition, 2009.
2. Donald Voet and Judith G Voet. Biochemistry, John Wiley & Sons, 4th Edition, 2021.
3. Jeremy Mark Berg, John L. Tymoczko, Lubert Stryer, Gregory Joseph Gatto (Jr.) Biochemistry, 4th Edition, W.H. Freeman/MacMillan Learning, 2019.

Reference Book(s):

1. R.H. Garrett and C.M. Grisham. Biochemistry,by Cengage Learning, 6th edition, 2016.
2. David L. Nelson and M.M. Cox. Lehninger Principles of Biochemistry, 3rd edition, Macmillan Learning, 2021.
3. Victor W. Rodwell, David Bender, Kathleen M. Botham. Harper's Illustrated Biochemistry, 31stedition, McGraw Hill International. 2018.

Web Resource(s):

1. https://toxtutor.nlm.nih.gov/12-001.html
2. https://en.wikipedia.org/wiki/Biocatalysis_%26_Biotransformation
3. https://onlinecourses.nptel.ac.in/noc23_cy03/preview

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 knowledge about classification, structure and properties of carbohydrates and lipids.	**K3**
CO2	Describe the structure and functions of proteins and nucleic acids.	**K3**
CO3	Illustrate the microbial metabolism related to carbohydrates.	**K4**
CO4	Analyze and relate the biosynthesis of amino acids and fermentation processes.	**K4**
CO5	Assess about prokaryotic and eukaryotic photosynthesis.	**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	2	2	2	2	2	2	2	2	3	3	2.2
CO2	2	2	2	2	2	2	2	2	3	3	2.2
CO3	2	2	2	2	2	2	2	2	3	3	2.2
CO4	2	2	2	2	2	2	1	2	3	3	2.1
CO5	2	2	2	2	2	2	2	2	3	3	2.2
Mean Overall Score											**2.18**
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
I	23PDFT1CC2	Core - II	6	4	25	75	100

Course Title	Biocatalysis and Biotransformations

SYLLABUS

Unit	Contents	Hours
I	Catalysis, Biocatalysis, chemical nature of enzymes, characteristics - Enzyme Classification and nomenclature. General properties of enzymes like effect of pH, Temperature, Ions etc., *Extraction, assay and purification of enzymes*.	18
II	Mechanism of enzyme action – Energy mechanics.Enzyme Kinetics – MM hypothesis, Significance of Km and Vm values, Modifiers of Enzyme activity – *Reversible and Irreversible modifications*.	18
III	Enzyme assays – methods, isolated enzymes and cell – free preparations, Immobilization of enzymes, *industrial applications*.	18
IV	Microbial biodegradation – aerobic & Anaerobic biodegradation of organic pollutants, Bioremediation using extracellular electron transfer, *Bacterial degradation of xenobiotics*.	18
V	Oil biodegradation in marine systems – analysis of waste biotreatment in confined environments, *metabolic engineering and bio catalytic applications of the pollutant degradation machinery*.	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. Dagmar Klostermeier, Markus G. Rudolph Biophysical Chemistry, CRC Press, 2018
2. David Freifelder., Physical Biochemistry, Applications to Biochemistry and Molecular Biology by W.H. Freeman Publishing Inc. 2021.
3. Glick and Pasternack, Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology, ASM Press, 2010.

Reference Book(s):

1. Malcolm Webb and Edwin C. Dixon, Enzymes, Academic Press, 2012.
2. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry (Textbook) Trevor Palmer, Albion Press 2nd edition, (2008).
3. Allan Fersht, Structure and Mechanism in Protein Science: A Guide to Enzyme Catalysis and Protein Folding: Vol 9, 2017.

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	Acquire knowledge of the fundamentals and applications of biocatalysis and enzymology.	K3
CO2	Comprehend and apply advanced techniques involved in the extraction and utilization of enzymes in biotransformation.	K4
CO3	Analyze and relate the performance of biocatalysts (evolutionary methods, Pathway engineering) such as catalytic antibodies, nucleic acids as catalysts.	K4
CO4	Identify enzymes of interest for target biotransformation by genome.	K5
CO5	Understand enzymes and their catalytic action, mechanism & kinetics with examples.	K3

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: Dr.T. Nargis Begum

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PDFT1CC3	Core - III	6	4	25	75	100

Course Title	Microbiology of Industrial Fermentation

SYLLABUS		
Unit	**Contents**	**Hours**
I	Introduction to microbiology, Microscopy, General structural organization, function and reproduction of bacteria, algae and fungus. Isolation, cultivation and identification of bacteria. *Microbial growth, culture media, pure culture techniques*. Measurement of microbial growth.	**18**
II	Microbial Nutrition - Nutritional requirements, nutritional types of microorganisms. *Effect of environment on microbial growth*.	**18**
III	Principles of sterilization and disinfection. Physical and chemical methods of microbial control. Maintenance and preservation of microorganism, Antimicrobial agent and resistant mechanisms. *Bacterial spores*.	**18**
IV	Primary and secondary metabolites – Organic feed stocks, organic acids, amino acids, enzymes, *nucleosides, nucleotides and related compounds*, vitamins and antibiotics.	**18**
V	Cell immobilization, microbial transformation, single cell protein, sewage treatment, biosensor, bioleaching and effluent treatment, *GMO's*.	**18**
VI	**Current Trends (For CIA only) –** Novel xenobiotic degrading microbes	

…… Self Study

Text Book(s):

1. J.G. Black. Microbiology Principles and Explorations, 6th edition, John Wiley and Sons Inc., 2005.
2. M. Pelczar, J.Jr. Chan E.C.S., Kreig, Microbiology, 5th edition, Tata McGraw Hill, 2006.
3. J.J. Perry, J.T. Staley, S.Lory. Microbial life, 1St edition, Sinauer Associates Publishers, 2002.

Reference Book(s):

1. Joanne M. Willey, Linda Sherwood, Christopher J. Woolverton, McGraw Hill, 2017.
2. Tortora, Funke, Case. Microbiology – An Introduction, 3rdedition,Benjamin-Cummings Publications, 2004.

Web Resource(s):

1. http://www.biologydiscussion.com/industrial-microbiology-2/industrial-fermentation-processes-microbiology/55742
2. https://www.generalmicroscience.com/industrial-microbiology/types-of-fermentation-processes/
3. https://nptel.ac.in/courses/102/105/102105058/

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Understand the general structural organisation of microbes and its complexity	**K3**
CO2	Comprehend the nutritional requirements for microbial propagation	**K3**
CO3	Apply the various methods of sterilization to prevent microbial growth	**K3**
CO4	Analyse and isolate the various primary and secondary metabolites from different sources and appraise their applications	**K4**
CO5	Evaluate the different industrial applications of microbes and their significance	**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	2	2	2	2	2	2	3	2	3	3	2.3
CO2	2	2	2	2	2	2	3	2	3	3	2.3
CO3	2	2	2	2	2	2	3	2	3	3	2.3
CO4	2	2	2	2	2	2	2	2	3	3	2.2
CO5	2	2	2	2	2	2	2	2	3	3	2.2
Mean Overall Score											**2.26**
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	23PDFT1CC4	Core - IV	6	4	25	75	100

Course Title	Principles of Fermentation Technology

SYLLABUS		
Unit	**Contents**	**Hours**
I	Major types of organisms used in fermentation, Microbial growth kinetics, *Batch culture, Continuous Culture, Fed – Batch – Types*, applications, fermentation kinetics.	**18**
II	Isolation, preservation and improvement of industrially important microorganisms, Media for industrial fermentations – media formulation, *Development of inoculum for industrial fermentations*.	**18**
III	Fermenter design and types-basic functions of a fermenter for microbial and animal cell culture – alternative vessel design, common measurements and control systems. *Sensors – solutions to common problems in fermentation*, anaerobic fermentation.	**18**
IV	Control of fermentation – requirements for control, design of a fermentation control systems, sensors and controllers, control of incubation, *aeration and agitation*.	**18**
V	Computers in fermentation, modelling, software sensors, control and supervision of fermentation processes – *off-line / online measurements – PID*.	**18**
VI	**Current Trends (For CIA only) –** Interpretation of fermentation data from modern fermenters.	

…… Self Study

Text Book(s):

1. Arnold L. Demain and Julian E. Davis, Industrial Microbiology & Biotechnology,2nd edition, ASM Press, 2004.
2. J.M. Coulson, and J.F. Richardson, Chemical Engineering, 6th Edition, Mc Graw Hill Publication,1999.

Reference Book(s):

1. Emt.el-Mansi and Bryce, Fermentation Microbiology & Biotechnology, 2nd edition, Taylor & Francis Ltd, 2004.
2. P.F.Stanbury, A. Whitaker & S.J. Hall, Principles of fermentation technology, Oxford Press, 2014.

Web Resource(s):

1. https://nptel.ac.in/courses/102/105/102105058/
2. https://swayam.gov.in/nd1_noc19_bt20/preview

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 concept of microbial growth kinetics and mode of operation of fermentors.	**K5**
CO2	Design a suitable Industrial medium for growing various microbes and strain improvement strategies.	**K6**
CO3	Adapt knowledge on Fermenter design and its types.	**K6**
CO4	Formulate the control parameters in a fermentor.	**K6**
CO5	Discuss the role of computers in a fermentation industry.	**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	3	3	2.2
CO2	2	2	2	2	2	2	2	2	3	3	2.2
CO3	2	2	2	2	2	2	2	2	3	3	2.2
CO4	2	2	2	2	2	2	2	2	3	3	2.2
CO5	2	2	2	2	2	2	2	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. S. Deborah

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
I	23PDFT1CC5P	Core - V	6	4	20	80	100

Course Title	Microbiology, Enzymology and Fermentation - Practical

SYLLABUS		
S.No	**Contents**	**Hours**
1	Media preparation, Sterilization.	**90**
2	Culture transfer techniques, Isolation of pure cultures.	
3	Microbial isolation and screening.	
4	Bacterial staining.	
5	Bacterial growth curve studies.	
6	Isolation of Antibiotic producing organism.	
7	Extracellular activities of microorganisms- amylase, gelatinase, lipase, caseinase.	
8	Qualitative study of enzyme activity.	
9	Effect of pH, Temperature, Substrates, Inhibitor on enzyme activity	
10	Enzyme kinetics – Km, Vmax, Specific activity and activity determination.	
11	Structure of Fermenter, cleaning of Fermenter, Assembling and final pre-sterilization of Fermenter, Anatomy and calibration of fermenter electrodes / probes, Post – sterilization procedures, Aseptic techniques in inoculation of fermentors.	
11	Aseptic sampling from fermenters.	
12	Techniques to determine microbial contaminations.	
13	Trouble shooting and diagnostics.	

Text Book(s):

1. Peter F. Stanbury, Allan Whitaker, Stephen J. Hall Principles of Fermentation Technology, Elsevier Science, 2nd Edition,2013
2. J. G. Cappuccino, and N. Sherman, Microbiology-A laboratory manual, Pearson Education,2nd Edition, 2004.
3. S. Ignacimuthu, Applied Plant Biotechnology, Mc Graw Hill publications Co. Ltd, 1stEdition, 1996.

Reference Book(s):

1. Rodney Boyer, An Introduction to Practical Biochemistry, 2nd edition, Pearson Education, 2003.
2. Aydin Berenjian, Essentials in Fermentation Technology, Springer International Publishing, 2020.
3. Brian McNeil, Linda Harvey, Practical Fermentation Technology, John Wiley and Sons, Ltd, 2008.

Web Resource(s):

1. https://archive.nptel.ac.in/courses/102/105/102105058/
2.https://www.classcentral.com/course/swayam-industrial-biotechnology-14122
3.https://www.mitconbiopharma.com/training/bio-tech-training/certificate-course-in-fermentation

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Develop a clear understanding of techniques used for culturing microbes	**K3**
CO2	Comprehend the mechanism of microbial growth and factors affecting them	**K4**
CO3	Determine the mechanism of enzyme action and study their optimum activity under different conditions	**K5**
CO4	Scrutinize and analyse the design, working and maintenanceof reactors	**K5**
CO5	Evaluate the various methods to determine microbial contamination and troubleshooting techniques for efficient functioning of bioreactors	**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	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											**2.48**
Correlation											**Medium**

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

Course Coordinator: Ms. Geet Andrea .S

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PDFT2CC6	Core - VI	6	4	25	75	100

Course Title:	Bioseparations and Biological Techniques

SYLLABUS		
Unit	**Contents**	**Hours**
I	Bioseparation and Scope - General laboratory procedures: lab safety, note books and reports, cleaning of glasswares, preparation and storage of solutions. pH, Buffers, Electrodes and Biosensors, Measurement of Protein, Nucleic acid solutions. *Chromatography – Principle, operative technique and applications of paper, TLC, adsorption chromatography, GLC, and HPLC*. Ion-Exchange, molecular sieve.	**18**
II	Electrophoretic techniques - Principle and technique of gel, SDS, high voltage and discontinuous electrophoresis, Isoelectric focussing. *Pulsed field gel electrophoresis and capillary electrophoresis*.	**18**
III	Spectrophotometry- Basic principles, instrumentation and applications of UV, Visible, IR spectrophotometers and Mass Spectrometry. *Flame Photometry - Principles and applications*.	**18**
IV	Solid removal operations Centrifugation techniques – *Principle, methodology and application of analytical centrifugation*, differential centrifugation, density gradient centrifugation, ultra- centrifuge.	**18**
V	X-Rays - X-Ray diffraction, crystals and detectors, quantitative analysis and applications. Radio chemical methods - Basic concepts, counting methods and applications. Autoradiography. *Tracer techniques- radioactive decay, units of radioactivity, detection and measurement of radio activity, Geiger-Muller counter, Scintillation counter*. Applications of radioisotopes in biology.	**18**
VI	**Current Trends (For CIA only) – Nano-enabled bioseparation**	

…… Self Study

Text Book(s):

1. Roger G. Harrison, ,Paul W. Todd .Scott R. RudgeBioseparations Science and Engineering Oxford University Press, 2nd Edition, 2015.
2. Sivasankar, B. “Bioseparations: Principles and Techniques”. PHI, 2005.
3. Asenjo, Juan A. “Separation Processes in Biotechnology”. CRC / Taylor & Francis, 1990.

Reference Book(s):

1. Ghosh, Raja “Principles of Bioseparations Engineering”. World Scientific, 2006.
2. “Product Recovery in Bioprocess Technology”. (BIOTOL – Biotechnology by Open Learning Series) Butterworth – Heinmann / Elsevier, 2004.
3. Abhinav A Shukla, Mark R Etzel, Shishir Gadam, Process Scale Bioseparations for the Biopharmaceutical Industry, CRC Press, 2020.

Web Resource(s):

1. https://onlinecourses.nptel.ac.in/noc22_bt48/preview
2. https://onlinecourses.swayam2.ac.in/cec20_bt22/preview
3. https://www.classcentral.com/course/swayam-downstream-processing-7972

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Determine the advanced downstream processing methods for product recovery.	**K3**
CO2	Describe the components of downstream equipment and to understand the requirements for successful operations.	**K3**
CO3	Enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.	**K4**
CO4	Understand the methods to obtain pure proteins, enzymes and in general about product development research and development.	**K4**
CO5	Have depth knowledge and hands on experience on Downstream processes to commercial therapeutically important proteins.	**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	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	**2.48**
										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
II	23PDFT2CC7	Core - VII	6	4	25	75	100

Course Title:	Animal and Plant Cell Bioprocesses

SYLLABUS		
Unit	**Contents**	**Hours**
I	Introduction to mammalian cell culture – mammalian cell characteristics, growth kinetics, metabolism, bioreactors for mammalian cell culture, process monitoring and control. *Equipments and requirements for animal cell culture technology, Introduction to balanced salt solution, and simple growth medium, chemical, physical and metabolic functions of different constituents of culture medium*. Role of CO_2 and supplements, serum and protein free defined media.	**18**
II	Plant cell culture – Introduction, culture media – micronutrients, carbon sources, vitamins, pH, plant growth regulators. medium preparation, Facilities – sterile transfer facilities, temperature, light, aeration. culture initiation, - sterile explants, callus culture initiation, suspension culture, bioreactors and scale – up. *Growth quantitation – fresh weight, dry weight, packed cell volume, indirect measurement, viabilitiy assays, secondary metabolite production, Regeneration, micropropagation, and transformation*.	**18**
III	Insect cell culture, culture techniques – media preparation, Flasks and roller bottles, shakers and spinner flasks, stirred tank reactors, airlift fermenters, fed batch culture, MOI and infectivity, recovery of insect cells, protein expression using stable cell lines. *Process issues in large – scale mammalian and insect cell culture, tissue engineering and cell therapy*.	**18**
IV	Plant secondary metabolites production: cell culture, hairy root culture, Ri plasmid, *control mechanism and maintenance of phenyl propanoid pathway, alkaloids, flavonoids, phenols*	**18**
V	Nuclear transplantation, therapeutic transplantation, transfection methods-lipofection, electroporation, microinjection, embryonic stem cell transfer, targeted gene transfer, *hybridoma technology and production of monoclonal antibodies, stem cells – embryonic & adult stem cells, and potent uses of human stem cells*.	**18**
VI	**Current Trends (For CIA only) – 3D cell culture**	

***…….* Self Study**

Text Book(s):

1. Bernard R. Glick and Jack J. Pasternak, Molecular Biotechnology, Panima Publishing House, New Delhi, 2002.
2. S.S. Bhojwani and M.K. Razdan., Plant Tissue culture: theory and practice a revised edition, Elsevier science, 2004.
3. J.W. Goding. Monoclonal Antibodies: Principles and Practice, Academic Press, 1983.

Reference Book(s):

1. J.R.W. Masters. Animal Cell culture, Oxford University Press,2015.
2. M.M. Ranga. Animal Biotechnology, Student Edition, Jodhpur,2013.
3. T. A. Springer. Hybridoma Technology in Biosciences and Medicine, Plenum Press, New York, 2016.

Web Resource(s):

1. https://link.springer.com/chapter/10.1007%2F978-3-540-68182
2. https://onlinecourses.nptel.ac.in/noc21_bt47/preview
3. https://www.classcentral.com/course/canvas-network-cell-culture-basics-2601

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 basic concepts in mammalian bioprocess.	**K3**
CO2	Describe the principles and techniques involved in plant cell culture	**K3**
CO3	Illustrate the process of fermentation technology.	**K4**
CO4	Demonstrate the applications of fermentation technology.	**K4**
CO5	Summarize the bioprocess of plant, animal and insect biosystems and their applications.	**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	2	2	2	2	2	2	2	3	3	3	2.3
CO2	2	2	2	2	2	2	1	3	3	3	2.2
CO3	2	2	2	2	2	2	1	3	3	3	2.2
CO4	2	2	2	2	2	2	1	2	3	3	2.1
CO5	2	2	2	2	2	2	2	2	3	3	2.1
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
II	23PDFT2CC8	Core -VIII	6	4	25	75	100

Course Title	Downstream Processes and Fermentation Economics

SYLLABUS		
Unit	**Contents**	**Hours**
I	Introduction to recovery and purification of fermentation products, removal of microbial cells and other solid matters. *Foam separation*.	18
II	Filtration – theory. Use of filter aids – batch filters, continuous filters. Centrifugation. Cell aggregation and flocculation. Cell disruptions – physical, chemical, mechanical, liquid – liquid extraction. *****Solvent recovery, two-phase aqueous extraction, super critical fluid extraction*.	18
III	Techniques in Chromatography for downstream processing – adsorption, affinity, ion-exchange, gel permeation, reverse phase chromatography, HPLC, *****Ultrafiltration, reverse osmosis, dyring, crystallization, whole broth processing*.	18
IV	Effluent Treatment - dissolved oxygen concentration, strengths of fermentation effluents, *****treatment and disposal of effluents, by-products*.	18
V	Fermentation economics – discovery and process development, strain improvement, market potential, plant and equipment, operating cost, contract manufacturing, return on investment – recovery cost. *****Water usage and recycling and effluent treatment*.	18
VI	**Current Trends (For CIA only) –** Multicolumn Counter-current Solvent Gradient Purification system	

***……..* Self Study**

Text Book(s):

1. Belter, P.A., E.L. Cussler and Wei-Houhu "Bioseparations – Downstream Processing for Biotechnology", John Wiley, 1988.
2. Arnold L. demain& Julian E. Davis. Industrial Microbiology & Biotechnology, ASM Press.2004.
3. J.M. Coulson and J.F. Richardson. Chemical Engineering, Pergamon Press.1984.

Reference Book(s):

1. Mansi & C.F.A.Bryce. Fermentation Microbiology &Biotechnology, Taylor& Francis Ltd., 2004.
2. P.F. A. Stanbury and Whitaker S.J. Hall. Principles of fermentation technology Oxford.1997.
3. Samuel S.D. Premsingh Aqueous two-phase extraction for downstream processing of biomolecules, Repro books, 2013.

Web Resource(s):

1. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular biology/downstream-processing.
2. https://www.classcentral.com/course/swayam-downstream-processing-7972
3. https://freevideolectures.com/course/3327/downstream-processing

Course Outcomes		
Upon successful completion of this course, the student will be able to:		
CO No.	**CO Statement**	**Cognitive Level (K-Level)**
CO1	Investigate the basics of biochemistry.	**K4**
CO2	Analyse the principle and mechanism of fermentation technology.	**K4**
CO3	Discuss the techniques and tools in the process of fermentation.	**K3**
CO4	Explain the steps involved in downstream processing.	**K3**
CO5	Employ the economical fermentation process in compliance with market demand.	**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	2	2	2	2	2	2	2	2	3	3	2.1
CO2	2	2	2	2	2	2	2	2	3	3	2.1
CO3	2	2	2	2	2	2	2	2	3	3	2.1
CO4	2	2	2	2	2	2	1	2	3	3	2.1
CO5	2	2	2	2	2	2	1	2	3	3	2.1
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
II	23PDFT2CC9	Core - IX	6	4	25	75	100

Course Title	Industrial Fermentation Processes

SYLLABUS		
Unit	**Contents**	**Hours**
I	Enzyme production – amylase, glucose isomerases, asparaginase, proteases, rennin, pectinases, lipases, penicillin acylase. *****Enzyme & cell immobilization*.	**18**
II	Vitamins & Antibiotics – vitamin B12, riboflavin, β carotene, β –lactam antibiotics, amino acids and peptide antibiotics, carbohydrate antibiotics, macro lactone antibiotics, *tetracyclines and anthracyclines*, nucleoside antibiotics & aromatic antibiotics.	**18**
III	Organic acids and Feed stocks – citric acids, gluconic acids, acetic acids, lactic acids, kojic acids, *****Itaconic acids – ethanol, glycerol, butanol, acetone, fermentation*.	**18**
IV	Amino acids – glutamic acid, lysine, tryptophan, structure and biosynthesis of nucleotides, *nucleosides and related compounds*.	**18**
V	Ergot alkaloids – significance and occurrence, structure, biosynthesis, strain development, production. Microbial transformations – types, applications - antibiotics, *****pesticides, non-steroid compounds, sterols and steroids*.	**18**
VI	**Current Trends *(For CIA only)** – Streptokinase from microbial sources, cold-active enzymes	

……. Self Study

Text Book(s):

1. Arnold L. Demainand Julian E. Davis., Industrial Microbiology & Biotechnology ASM Press. 2004.
2. J.M. Coulson and J.F. Richardson. Chemical Engineering, Pergamon Press, 2014.
3. Andreas Vogel, Oliver May, Industrial Enzyme applications, Wiley and sons, 2019.

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.1997.
3. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry (Textbook) Trevor Palmer, Albion Press 2nd edition, (2008).

Web Resource(s):

1. https://en.wikipedia.org/wiki/Industrial_fermentation
2. https://www.massey.ac.nz/~ychisti/FermentInd.PDF
3. https://onlinecourses.nptel.ac.in/noc19_bt20/preview

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 basic concepts in biomolecules and microbial biochemistry.	**K3**
CO2	Elucidate the potential scientific consequences of industrial fermentation products.	**K5**
CO3	Describe the principles and uses of fermentation technology.	**K4**
CO4	Illustrate the process and applications of industrial fermentation.	**K4**
CO5	Implicate the cost-effective fermentation process for a variety of industrial applications	**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	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. Geet Andrea

Semester	Course Code	Course Category	Hours/ Week	Credits	Marks for Evaluation		
					CIA	ESE	Total
II	23PDFT2CC10P	Core - X	6	4	20	80	100

Course Title	Bioprocess - Practical

SYLLABUS		
Unit	**Contents**	**Hours**
1	Introduction to Bioprocess technology parts and designs of bioreactors.	**90**
2	Production of biomass; batch and continuous fed batch fermentation.	
3	Recovery of products.	
4	Laboratory scale fermentation of antibiotics, immobilization of cells and enzymes.	
5	Down Stream Processing with an extra cellular enzyme.	
6	Beer or Wine Production and Quality Assessment.	
7	Citric Acid Production and Quantification.	

Text Book(s):

1. Arnold L. Demainand Julian E. Davis., Industrial Microbiology & Biotechnology ASM Press. 2004.
2. J.M. Coulson and J.F. Richardson. Chemical Engineering, Pergamon Press, 2014.
3. Andreas Vogel, Oliver May, Industrial Enzyme applications, Wiley and sons, 2019.

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.1997.
3. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry (Textbook) Trevor Palmer , Albion Press 2nd edition, (2008).

Web Resource(s):

1. https://en.wikipedia.org/wiki/Industrial_fermentation
2. https://www.massey.ac.nz/~ychisti/FermentInd.PDF
3. https://onlinecourses.nptel.ac.in/noc19_bt20/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 concepts of bioprocess technology.	**K3**
CO2	Apply skills to perform laboratory scale fermentation.	**K3**
CO3	Illustrate the process of industrial fermentation.	**K4**
CO4	Analyse downstream processing of enzymes.	**K4**
CO5	Demonstrate the production of several fermentation products.	**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	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: Dr. S. Deborah