SYLLABUS

POST GRADUATE DIPLOMA IN FERMENTATION TECHNOLOGY

(PGDFT)

2020-21 onwards

Since 1951

PG & Research Department of Biotechnology
JAMAL MOHAMED COLLEGE (Autonomous)
College with Potential for Excellence
Accredited (3rd Cycle) with 'A' Grade by NAAC
DBT Star Scheme & DST-FIST Funded
(Affiliated to Bharathidasan University)
Tiruchirappalli – 620 020.

Post Graduate Diploma in Fermentation Technology (PGDFT)
Course Pattern from 2020 - 2021

(COURSE DURATION: I YEAR)

SEM	Course Code	Course	Course Title	Hrs / Week	Credit	CIA Mark	SE Mark	Total Marks
I	20PDFT1C1	Core I	Biomolecules and Microbial Biochemistry	6	4	25	75	100
	20PDFT1C2	Core II	Biocatalysis and Biotransformations	6	4	25	75	100
	20PDFT1C3	Core III	Microbiology of Industrial Fermentation	6	4	25	75	100
	20PDFT1C4	Core IV	Principles of Fermentation Technology	6	4	25	75	100
	20PDFT1C5/P	Core V	Microbiology, Enzymology & Fermentation - Practical	6	4	25	75	100
TOTAL				**30**	**20**	**125**	**375**	**500**
II	20PDFT2C1	Core VI	Bioseparations and Biological Techniques	6	4	25	75	100
	20PDFT2C2	Core VII	Animal and Plant Cell Bioprocesses	6	4	25	75	100
	20PDFT2C3	Core VIII	Downstream Processes and Fermentation Economics	6	4	25	75	100
	20PDFT2C4	Core IX	Industrial Fermentation Processes	6	4	25	75	100
	20PDFT2C5/P	Core X	Bioprocess - Practical	6	4	25	75	100
TOTAL				**30**	**20**	**125**	**375**	**500**
GRAND TOTAL				**60**	**40**	**250**	**750**	**1000**

Programme Specific Outcome

At the end of the programme, students will be able to:

- Describe the basic concepts in biomolecules and microbial biochemistry.
- Explain the principles of fermentation technology, use of biocatalysts and biotransformation involved in the bioprocess.
- Illustrate the process of industrial fermentation, bio process of animal and plant cell and the role of enzymes in fermentation.
- Summarize the steps in downstream processing.
- Evaluate the cost-effective fermentation process and bioprocess in compliance with market demand.

SEMESTER I: CORE I
BIOMOLECULES AND MICROBIAL BIOCHEMISTRY

Subject Code: 20PDFT1C1 **Max Marks: 100**
Hours / Week: 6 **Internal Mark: 25**
Credit: 4 **External Mark: 75**

Unit I Carbohydrates: **18 Hours**

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#, lipoamino acids, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides.

Unit II Proteins: **18 Hours**

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.

Unit III Microbial Metabolism: **18 Hours**

Glycolysis, Alernative pathways to Glycolysis-: Pentose phosphate pathway, #Entner-Doundroff pathway, Aerobic respiration- Tricarboxylic acid cycle, The Electron Transport chain#, The Chemiosmosis.

Unit IV Vitamins and Amino acid **18 Hours**

Anerobic 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.

Unit V Microbial photosynthesis: **18 Hours**

prokaryotic and eukaryotic photosynthetic apparatus, photophosphorylation, light and dark, reaction, photorespiration, #Biological nitrogen fixation#, Biochemistry of nitrogen fixation.

#.....#self-study portion

Text Books

T.B. 1. E.E Conn,P.K. Stumpf, G. Bruenimg and Ray H. Doi, Outlines of Biochemistry, John Wiley & sons. 1987.

T.B. 2. Donald Voet and Judith G Voet. Fundamentals of Biochemistry, John Wiley & Sons, NY. 1999.

Unit I Chapter II, T.B.1

Unit II Chapter VII, T.B. 1

Unit III Chapter X, T.B.1

Unit IV Chapter XIV, T.B. 2

Unit V Chapter XIV, T.B. 2

Books for References

1. R.H. Garrett and C.M. Grisham. Biochemistry, 2nd edition, by Saunders College Publishing, NY. 1999.
2. David L. Nelson and M.M. Cox. Lehninger Principles of Biochemistry, 3rd edition, Maxmillan and Worth Publishers. 2000.
3. R.K.Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V.W. Rodwell. Harper's Biochemistry, 25th edition, Prentice Hall International. 2000.
4. L. Stryer. Biochemistry, 4th edition, W.H. Freeman & Co., NY.1995.

Course outcomes:

CO1 Acquire the knowledge about classification,structure and properties of carbohydrates and lipids.
CO2 Describe the structure and functions of proteins and nucleic acids.
CO3 Illustrate the microbial metabolism related to carbohydrates.
CO4 Intellectual about the Biosynthesis of amino acids and fermentation processes.
CO5 Asses about prokaryotic and eukaryotic photosynthesis.

Mapping withProgramme outcome and Programme Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓			✓	✓	✓	✓	✓		
CO2	✓		✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓	✓	✓	✓	✓	✓			✓
CO4	✓			✓			✓	✓		✓
CO5	✓	✓	✓	✓	✓		✓	✓		

Number of matches (✓) - 36
Mapping Score - 72 %
If number of matches (✓) ≥35 (ie.) 70% and above - High

Prepared by:
1. Dr. T. Nargis Begum

Checked by:
1. Dr. J. Sebastin Raj
2. Dr. A. Khaleel Ahamed

SEMESTER I: CORE II
BIOCATALAYSIS AND BIOTRANSFORMATIONS

Subject Code: 20PDFT1C2 **Max Marks:100**
Hours/Week:6 **Internal Marks: 25**
Credit: 4 **External Marks: 75**

Unit I **18 Hours**

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#.

Unit II **18 Hours**

Mechanism of enzyme action – Energy mechanics.Enzyme Kinetics – MM hypothesis, Significance of Km and Vm values, Modifiers of Enzyme activity – #Reversible and Irreversible modifications#.

Unit III **18 Hours**

Enzyme assays – methods, isolated enzymes and cell – free preparations, #Immobilization of enzymes, industrial applications#.

Unit IV **18 Hours**

Microbial biodegradation – aerobic & Anaerobic biodegradation of organic pollutants, #Bioremediation using extracellular electron transfer, Bacterial degradation of xenobiotics#.

Unit V **18 Hours**

Oil biodegradation in marine systems – analysis of waste biotreatment in confined environments, #metabolic engineering and biocatalytic applications of the pollutant degradation machinery#.

#.....#**Self-study portion**

Text Books:

1. Charles R. Canter & Paul R. Schimmel; 1st Edition. Biophysical Chemistry: Part I: The conformation of biological macromolecules by W.H. Freeman Publishers.1980.
2. David Freifelder. 2nd Edition. Biophysical Biochemistry: Applications to Biochemistry and Molecular Biology by W.H. Freeman Publishing Inc.1982
3. Glick and Pasternack; 4th Edition, Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology, ASM Press.2009.

Unit I Chapter I, T.B.1

Unit II Chapter VII, T.B. 1

Unit III Chapter VII, T.B.1

Unit IV Chapter X, T.B. 2

Unit V Chapter XV, T.B. 3

Books for References:

1. Malcolm Webb, and Edwin C. Dixon, 2nd Edition; Enzymes, Academic Press.1984.
2. Puri and Sharma, Principles of Physical chemistry Vishal Publishing Co.2008.
3. Trevor Palmer; 4th Edition; Understanding Enzymes,Prentice Hall.1995.

Web References:

1. https://toxtutor.nlm.nih.gov/12-001.html
2. https://en.wikipedia.org/wiki/Biocatalysis_%26_Biotransformation

Course Outcomes:

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

CO1. Knowledge of the fundamentals and applications of biocatalysis andenzymology.
CO2. Briefly introduce some advanced techniques involved in the extraction and utilization of enzymes in biotransformation.
CO3. Improving the performance of biocatalysts (evolutionary methods, pathway engineering) such as catalytic antibodies, nucleic acids as catalysts.
CO4. Identify enzymes of interest for target *biotransformations*by genome.
CO5. Define enzymes and its catalytic action, mechanism & kinetics with examples.

Mapping with Programme Outcomes and Programme Specific Outcomes.

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓		✓	✓	✓	✓	✓		
CO2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
CO3	✓	✓		✓	✓	✓	✓			✓
CO4	✓	✓	✓	✓			✓	✓		✓
CO5	✓	✓	✓	✓	✓		✓	✓		

No of matches	36
Mapping Score	72%
If number of matches ≥ 35 (ie) 70% and above	High

Prepared by:
1.H.F.SeyedMafiyaHaniff

Checked by:
1.Dr.A.Nishanthini
2.Dr.A.Khaleel Ahamed

SEMESTER I: CORE III
MICROBIOLOGY OF INDUSTRIAL FERMENTATION

Subject Code: 20PDFT1C3 **Max Marks: 100**
Hrs / Week: 6 **Internal Marks: 25**
Credit: 4 **External Marks: 75**

Unit I **18 Hours**

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.

Unit II **18 Hours**

Microbial Nutrition - Nutritional requirements, nutritional types of microorganisms. #Effect of environment on microbial growth#.

Unit III **18 Hours**

Principles of sterilization and disinfection. Physical and chemical methods of microbial control. #Maintenance and preservation of microorganism, Antimicrobial agent and resistant mechanisms. #Bacterial spores#.

Unit IV **18 Hours**

Primary and secondary metabolites – Organic feed stocks, organic acids, amino acids, enzymes, #nucleosides, nucleotides and related compounds#, vitamins and antibiotics.

Unit V **18 Hours**

Cell immobilization, microbial transformation, single cell protein, sewage treatment, biosensor, bioleaching and effluent treatment, #GMO's#.

#.....# **Self-study portion**

Text Books:

T.B.1 J.G. Black. Microbiology Principles and Explorations, 6th edition, John Wiley and Sons Inc., 2005.

T.B. 2 M.Pelczar, J.Jr. Chan E.C.S., Kreig, Microbiology,5th edition ,Tata McGraw Hill, 2006.

T.B. 3 J.J. Perry, J.T. Staley, S.Lory. Microbial life, 1St edition, Sinauer Associates Publishers, 2002.

Unit I Chapter III, T.B.1

Unit II Chapter IV, T.B. 1

Unit III Chapter VI, T.B.1

Unit IV Chapter VII, T.B. 2

Unit V Chapter XI, T.B. 3

Books for References:

1. L.M.Prescott, J.P.Harley, D.A. Klein, Microbiology, 1st edition, McGraw Hill,2007.
2. Tortora, Funke, Case. Microbiology – An Introduction, 3rdedition,Benjamin-Cummings Publications, 2004.

Web reference:

- http://www.biologydiscussion.com/industrial-microbiology-2/industrial-fermentation-processes-microbiology/55742

- https://www.generalmicroscience.com/industrial-microbiology/types-of-fermentation-processes/
- https://nptel.ac.in/courses/102/105/102105058/

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

CO 1. Understand the concept of microbial fermentation and the importance of microbes in the production of industrially important products.
CO 2. Design a suitable nutrition medium for growing various industrially important microbes
CO 3. Gain knowledge on principles of sterilization and microbial control.
CO 4. Get expertise in Primary and secondary metabolite production.
CO 5. Understand the concept of cell immobilization and effluent treatment in industry

Mapping with programme outcomes and programme specific outcomes:

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO2	✓	✓	✓	✓				✓	✓	✓
CO3	✓	✓	✓	✓				✓	✓	✓
CO4	✓	✓	✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓	✓			✓	✓	✓

No. of matches 39
Mapping Score 78%
If number of matches ≥35 (i.e.) 70% and above High

Prepared by:
Dr.B.Nazeema Banu

Checked by:
1. Dr.A.Nishanthini

2. Dr.A.Khaleel Ahamed.

SEMESTER I: CORE IV
PRINCIPLES OF FERMENTATION TECHNOLOGY

Subject Code: 20PDFT1C4 **Max Marks: 100**
Hours/Week: 6 **Internal Marks: 25**
Credit: 4 **External Marks: 75**

Unit I **18 Hours**

Major types of organisms used in fermentation, Microbial growth kinetics, #Batch culture, Continuous Culture, Fed – Batch – Types#, applications, fermentation kinetics.

Unit II **18 Hours**

Isolation, preservation and improvement of industrially important microorganisms, Media for industrial fermentations – media formulation, #Development of inoculum for industrial fermentations#.

Unit III **18 Hours**

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.

Unit IV **18 Hours**

Control of fermentation – requirements for control, design of a fermentation control systems, sensors and controllers, control of incubation, #aeration and agitation#.

Unit V **18 Hours**

Computers in fermentation, modeling, software sensors, control and supervision of fermentation processes – #off-line / online measurements – PID#.

#.....# Self-study portion

Text Books:

T.B-1 Arnold L. Demain& Julian E. Davis, Industrial Microbiology & Biotechnology,2nd edition, ASM Press, 2004.

T.B-2J.M. Coulson, and J.F. Richardson, Chemical Engineering, 6th Edition, Mc Graw Hill Publication,1999.

Unit I Chapter III, T.B.1

Unit II Chapter IV, T.B. 1

Unit III Chapter V, T.B.1

Unit IV Chapter IV, T.B. 2

Unit V Chapter V, T.B. 2

Books for References:

1. Emt.el-Mansi & Bryce, Fermentation Microbiology & Biotechnology, 2nd edition, Taylor & Francis Ltd, 2004.
2. P.F.Stanbury, A. Whitaker & S.J. Hall, Principles of fermentation technology, 3rd edition, Oxford Press, 1997.

Web reference:

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

Course outcome:

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

CO 1. Understand the concept of microbial growth kinetics and mode of operation of fermentors.
CO 2. Design a suitable Industrial medium for growing various microbes and strain improvement strategies.
CO 3. Gain knowledge on Fermenter design and its types.
CO 4. Get expertise in control parameters in a fermentor.
CO 5. Understand the role of computers in a fermentation industry.

Mapping with programme outcomes and programme specific outcomes:

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓				✓	✓	✓
CO2	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO3	✓	✓	✓	✓				✓	✓	✓
CO4	✓	✓	✓	✓				✓	✓	✓
CO5	✓	✓	✓	✓				✓	✓	✓

No. of matches **37**
Mapping Score **74%**
If number of matches ≥35 (i.e.) 70% and above **High**

Prepared by:
Dr.B.Nazeema Banu

Checked by:

1. Dr.A.Nishanthini

2. Dr.A.Khaleel Ahamed.

SEMESTER I: CORE V
MICROBIOLOGY, ENZYMOLGY AND FERMENTATION - PRACTICAL

Subject Code: 20PDFT1C5/P **Max Marks: 100**
Hours/Week: 6 **Internal Marks: 25**
Credit: 4 **External Marks: 75**

1. Media preparation, Sterilization.
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.
12. Aseptic sampling from fermentors.
13. Techniques to determine microbial contaminations.
14. Trouble shooting and diagnostics.

Text Books:

T.B-1J. G. Cappuccino, and N. Sherman, Microbiology-A laboratory manual, 2nd edition, Pearson Education, 2004

T.B-2 Ignacimuthu, Applied Plant Biotechnology,1stedition,Mc Graw Hill publications Co. Ltd, 1996.

Books for References:

1. Rodney Boyer, An Introduction to Practical Biochemistry, 2nd edition, Pearson Education, 2003.

Course outcome:

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

CO 1. Design a suitable nutrition medium for growing various industrially important microbes

CO 2. Understand the concept of microbial fermentation and the importance of microbes in the production of industrially important products.

CO 3. Gain knowledge on principles of sterilization and microbial control.

CO 4. Get expertise in Primary and secondary metabolite production.

CO 5. Understand the concept of cell immobilization and effluent treatment in industry

Mapping with programme outcomes and programme specific outcomes:

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✓	✓	✓	✓	✓	✓		✓	✓	✓
CO2	✓	✓	✓	✓		✓		✓	✓	✓
CO3	✓	✓	✓	✓		✓		✓	✓	✓
CO4	✓	✓	✓	✓		✓		✓	✓	✓
CO5	✓	✓	✓	✓	✓	✓		✓	✓	✓

No. of matches	42
Mapping Score	84%
If number of matches ≥35 (i.e.) 70% and above	High

Prepared by:
1. Dr.B.Nazeema Banu

Checked by:

1. Dr. A. Nishanthini

2. Dr. A. Khaleel Ahamed.

SEMESTER II: CORE VI
BIOSEPARATIONS AND BIOLOGICAL TECHNIQUES

Subject Code: 20PDFT2C1 **Max Marks :100**
Hrs / Week: 6 **Internal Marks :25**
Credit: 4 **External Marks :75**

Unit I **18 Hours**

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.

Unit II **18 Hours**

Electrophoretic techniques - Principle and technique of gel, SDS, high voltage and discontinuous electrophoresis, Isoelectric focussing. #Pulsed field gel electrophoresis and capillary electrophoresis#.

Unit III **18 Hours**

Spectrophotometry- Basic principles, instrumentation and applications of UV, Visible, IR spectrophotometers and Mass Spectrometry. #Flame Photometry - Principles and applications#.

Unit IV **18 Hours**

Solid removal operationsCentrifugation techniques – #Principle, methodology and application of analytical centrifugation#, differential centrifugation, density gradient centrifugation, ultra-centrifuge.

Unit V **18 Hours**

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.

#.....# Self-study portion

Text Books:

1. R.Boyer, Modern Experimental Biochemistry, 3rd edition, Addison-Wesley Longman.2002.
2. David Plummer. Practical Biochemistry, Tata Mc-Graw Hill.1990.
3. J. Jayaraman, A Lab. Manual in Biochemistry New Age International (P) Ltd.1996.

Unit I Chapter I, T.B.1

Unit II Chapter II, T.B. 1

Unit III Chapter III, T.B.1

Unit IV Chapter IV, T.B. 2

Unit V Chapter X, T.B. 3

Books for References:

1. Sadasivam& Manickam. Biochemical Methods New Age International (P) Ltd.(1996).
2. Sawhney, S.K., & R. Singh. Introductory Practical Biochemistry, Narosa Publishers. (2000).

Web Reference:

1.https://www.chromatographytoday.com/news/ -bioseparations/34425
2. https://www.sciencedirect.com/topics/medicine-and-dentistry/bioseparation

Course Outcomes:

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

CO1. Define advanced downstream processing methods for product recovery.
CO2. Describe the components of downstream equipment and to understand the requirements for successful operations.
CO3. Enhance problem solving techniques required in multi-factorial manufacturing environment in a structured and logical fashion.
CO4. Understand the methods to obtain pure proteins, enzymes and in general about product development R & D
CO5. Have depth knowledge and hands on experience on Downstream processes to commercial therapeuticaly important proteins.

Mapping with Programme Outcomes and Programme Specific Outcomes.

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✔			✔	✔	✔	✔	✔	✔	✔
CO2	✔	✔	✔	✔	✔	✔		✔	✔	
CO3		✔	✔	✔	✔					✔
CO4		✔	✔	✔		✔		✔		✔
CO5	✔	✔	✔	✔	✔	✔			✔	✔

No of matches	35
Mapping Score	70%
If number of matches ≥ 35 (ie) 70% and above	High

Prepared by:
1. H.F.SeyedMafiyaHaniff

Checked by:
1. Dr.A.Nishanthini
2. Dr.A.Khaleel Ahamed

SEMESTER II: CORE VII
ANIMAL AND PLANT CELL BIOPROCESSES

Subject Code: 20PDFT2C2 **Max Marks :100**
Hours / Week: 6 **Internal Marks :25**
Credit: 4 **External Marks: 75**

Unit I **18 Hours**

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.

Unit II **18 Hours**

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 cultureintiation, 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#.

Unit III **18 Hours**

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#.

Unit IV **18 Hours**

Plant secondary metabolites production: cell culture, hairy root culture, Ri plasmid, #control mechanism and maintenance of phenyl propanoid pathway, alkaloids, flavonoids, phenols#.

Unit V **18 Hours**

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#.

#.....# Self-study portion

Text Books

T.B. 1. Bernard R. Glick and Jack J. Pasternak, Molecular Biotechnology, Panima Publishing House, New Delhi.2002.

T.B. 2. S.S. Bhojwani and M.K. Razdan., Plant Tissue culture: theory and practice a revised edition, Elsevier science.2004.

T.B. 3. J.W. Goding. Monoclonal Antibodies: Principles and Practice, Academic Press.1983.

Unit I Chapter III, T.B.1
Unit II Chapter IV, T.B. 1
Unit III Chapter VI, T.B.1
Unit IV Chapter VII, T.B. 2
Unit V Chapter X, T.B. 3

Books for References

1. J.R.W. Masters. Animal Cell culture, Oxford University Press,2000.
2. M.M. Ranga. Animal Biotechnology, Student Edition, Jodhpur,2003.
3. T. A. Springer. Hybridoma Technology in Biosciences and Medicine, Plenum Press, New York.1985.

Web Reference

https://link.springer.com/chapter/10.1007%2F978-3-540-68182

Course Outcome

CO 1. Explain the basic concepts in mammalian bioprocess.
CO 2. Describe the principles and techniques involved in plant cell culture
CO 3. Illustrate the process of fermentation technology.
CO 4. Demonstrate the applications of fermentation technology.
CO 5. Summarize the bioprocess of plant, animal and insects and their application in various fields.

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✔		✔			✔	✔	✔		
CO2	✔	✔	✔	✔	✔	✔		✔		
CO3	✔	✔	✔	✔		✔	✔	✔	✔	
CO4		✔	✔	✔	✔	✔	✔	✔	✔	✔
CO5	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

No. of matches	39
Mapping Score	78%
Number of matches ≥ 35 (ie) 70% and above	High

Prepared by:
1.Dr. A. Nishanthini.

Checked by:
1. H.F. Seyed Mafia Haniff
2. Dr.A.Khaleel Ahamed

SEMESTER II: CORE VIII
DOWNSTREAM PROCESSES AND FERMENTATION ECONOMICS

Subject Code: 20PDFT2C3 **Max Marks: 100**
Hours/Week: 6 **Internal Marks: 25**
Credit: 4 **External Marks: 75**

Unit I **18 Hours**

Introduction to recovery and purification of fermentation products, removal of microbial cells and other solid matters. #Foam separation#.

Unit II **18 Hours**

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#.

Unit III **18 Hours**

Techniques inChromatography for downstream processing – adsorption, affinity, ion-exchange, gel permeation, reverse phase chromatography, HPLC, #ultrafiltration, reverse osmosis, dyring, crystallization, whole broth processing#.

Unit IV **18 Hours**

Effluent Treatment - dissolved oxygen concentration, strengths of fermentation effluents, #treatment and disposal of effluents, by-products#.

Unit V **18 Hours**

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#.

#.....# Self-study portion

Text Books:

T.B. 1. Arnold L. demain& Julian E. Davis. Industrial Microbiology & Biotechnology, ASM Press.2004.

T.B. 2. J.M. Coulson and J.F. Richardson. Chemical Engineering, Pergamon Press.1984.

Unit I Chapter III, T.B.1

Unit II Chapter IV, T.B. 1

Unit III Chapter VI, T.B.1

Unit IV Chapter VIII, T.B. 2

Unit V Chapter XI, T.B. 2

Books for Reference

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.

Web Reference:

https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/downstream-processing

Course Outcomes:

On Completion of this course the students will be able to

CO 1.Demonstrate the basics of biochemistry.
CO 2. Analyse the principle and mechanism of fermentation technology.
CO 3. Discuss the techniques and tools in the process of fermentation.
CO 4.Explain the steps involved in downstream processing.
CO 5.Employ the economical fermentation process in compliance with market demand.

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✔		✔	✔	✔	✔	✔			
CO2		✔	✔		✔	✔	✔	✔	✔	
CO3		✔	✔	✔	✔	✔	✔	✔	✔	✔
CO4		✔				✔		✔	✔	
CO5	✔	✔	✔	✔	✔		✔	✔	✔	✔

No. of matches	35
Mapping Score	70%
Number of matches ≥ 35 (ie) 70% and above	High

Prepared by:
1. Dr. A. Nishanthini

Checked by:
1. H,F.Seyed Mafiya Haniff.
2. Dr. A. Khaleel Ahamed

SEMESTER II: CORE IX
INDUSTRIAL FERMENTATION PROCESSES

Subject Code:20PDFT2C4 **Max Marks: 100**
Hours / Week: 6 **Internal Marks: 25**
Credit: 4 **External Marks :75**

Unit I **18 Hours**
Enzyme production – amylase, glucose isomerases, asparaginase, proteases, rennin, pectinases, lipases, penicillin acylase. #Enzyme & cell immobilization.

Unit II **18 Hours**
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.

Unit III **18 Hours**
Organic acids and Feed stocks – citric acids, gluconic acids, acetic acids, lactic acids, kojic acids, #Itaconic acids – ethanol, glycerol, butanol, acetone, fermentation#.

Unit IV **18 Hours**
Amino acids – glutamic acid, lysine, tryptophan, structure and biosynthesis of nucleotides, #nucleosides and related compounds#.

Unit V **18 Hours**
Ergot alkaloids – significance and occurrence, structure, biosynthesis, strain development, production.microbial transformations – types, applications - antibiotics, #pesticides, non-steroid compounds, sterols and steroids#.

#.....# Self-study portion

Text Books

T.B. 1. Arnold L. Demainand Julian E. Davis., Industrial Microbiology & Biotechnology ASM Press. 2004.
T.B. 2. J.M. Coulson and J.F. Richardson. Chemical Engineering, Pergamon Press.1984.

Unit I Chapter III, T.B.1

Unit II Chapter III, T.B. 1

Unit III Chapter IV, T.B.1

Unit IV Chapter V, T.B. 1

Unit V Chapter XII, T.B. 2

Books for Reference

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.

Web Reference:

https://en.wikipedia.org/wiki/Industrial_fermentation
https://www.massey.ac.nz/~ychisti/FermentInd.PDF

Course Outcomes:

On Completion of this course the students will be able to

CO1. Explain the basic concepts in biomolecules and microbial biochemistry.

CO 2. Elucidate the potential scientific consequences of industrial fermentation products.

CO 3. Describe the principles and uses of fermentation technology.

CO 4. Illustrate the process and applications of industrial fermentation.

CO 5. Implicate the cost-effective fermentation process for a variety of industrial applications.

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✔		✔		✔	✔		✔		
CO2	✔	✔	✔		✔	✔	✔	✔		✔
CO3	✔		✔	✔		✔	✔	✔	✔	✔
CO4	✔	✔		✔	✔	✔	✔	✔	✔	
CO5	✔	✔	✔		✔		✔	✔		✔

No. of matches 36

Mapping Score 72%

Number of matches ≥ 35 (ie) 70% and above High

Prepared by:

1.Dr. A. Nishanthini

Checked by:

1. H.F.SeyedMafiyaHaniff.
2. Dr.A.Khaleel Ahamed

SEMESTER II: CORE X
BIOPROCESS - PRACTICAL

Subject Code: 20PDFT2C5P **Max Marks :100**
Hours/Week: 6 **Internal Marks: 25**
Credit: 4 **External Marks:75**

1. Introduction to bioprocess technology parts and designs of bioreactors.
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 Books

1. Arnold L. demainand Julian E. Davis. Industrial Microbiology & Biotechnology ASM Press.2004.
2. Coulson, J.M. and J.F. Richardson, Chemical Engineering, Pergamon Press,1984.

Books for Reference

1. Mansi & CFA. Bryce.Fermentation Microbiology andBiotechnology, Taylor& Francis Ltd.,2004.
2. P.F. A.Stanbury and Whitaker S.J. Hall. Principles of fermentation technology Oxford.1997.

Web Reference

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

Course outcomes

On Completion of this course the students will be able to

CO 1. Demonstrate the basic concepts of bioprocess technology.
CO 2. Apply skill to perform laboratory scale fermentation.
CO 3. Illustrate the process of industrial fermentation.
CO 4. Explain downstream processing with enzymes.
CO 5. Demonstrate the production of several fermentation products.

Mapping with Programme Outcomes and Programme Specific Outcomes

	PO1	PO2	PO3	PO4	PO5	PSO1	PSO2	PSO3	PSO4	PSO5
CO1	✔		✔		✔	✔	✔	✔		
CO2	✔	✔	✔	✔	✔	✔	✔	✔		✔
CO3	✔	✔	✔	✔	✔	✔	✔	✔	✔	
CO4	✔	✔	✔		✔	✔	✔		✔	
CO5	✔	✔		✔		✔	✔	✔		✔

No. of matches 38
Mapping Score 76%
Number of matches ≥ 35 (ie) 70% and above High

Prepared by:
1. Dr. A. Nishanthini

Checked by:
1. H.F.SeyedMafiyaHaniff.
2. Dr.A.Khaleel Ahamed

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