SYLLABUS

P.G Diploma in Fermentation Technology
(P.G.D.F.T)

2017-18

Since 1951

PG & Research Department of Biotechnology
JAMAL MOHAMED COLLEGE (Autonomous)
College with Potential for Excellence
Reaccredited (3rd Cycle) with ‘A’ Grade by NAAC
(Affiliated to Bharathidasan University)
Tiruchirappalli – 620 020.
Post Graduate Diploma in Fermentation Technology (PGDFT)
Course Pattern from 2017 - 2018

(COURSE DURATION: 1 YEAR)

<table>
<thead>
<tr>
<th>SEM</th>
<th>Course Code</th>
<th>Course</th>
<th>Course Title</th>
<th>Hrs / Week</th>
<th>Credit</th>
<th>CIA Mark</th>
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<tr>
<td>I</td>
<td>17PDFT1C1</td>
<td>Core I</td>
<td>Biomolecules and Microbial Biochemistry</td>
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<td>Core II</td>
<td>Biocatalysis and Biotransformations</td>
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<td>17PDFT1C5/P</td>
<td>Core V</td>
<td>Microbiology, Enzymology &amp; Fermentation - Practical</td>
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<td>Bioseparations and Biological Techniques</td>
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<td>Core VIII</td>
<td>Downstream Processes and Fermentation Economics</td>
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Objective: The course aims to provide students with a basic understanding of the molecular architecture of eukaryotic cells and organelles, including macromolecules.

Unit 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, cerebrosides, steroids, bile acids, prostaglandins#, lipoamino acids, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides.

Unit 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.


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

Text Books
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
Objective: To identify enzymes of interest for target biotransformations by genome.

Unit 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 Hours

Unit 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 Hours

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

18 Hours

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

18 Hours

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

18 Hours

Self-study portion

Text Books:

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:
Objective: To introduce the students to the concept of microbial fermentation and the importance of microbes in the production of industrially important products.

Unit 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 Hours

Unit II Microbial Nutrition - Nutritional requirements, nutritional types of microorganisms. Effect of environment on microbial growth. 18 Hours

Unit 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 Hours

Unit IV Primary and secondary metabolites – Organic feed stocks, organic acids, amino acids, enzymes, nucleosides, nucleotides and related compounds, vitamins and antibiotics. 18 Hours

Unit V Cell immobilization, microbial transformation, single cell protein, sewage treatment, biosensor, bioleaching and effluent treatment, GMO’s. 18 Hours

Text Books:


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:
Objective: To introduce the students to fermenter and its operation in fermentation. The knowledge on fermentation process enable the students to manipulate microbes for improvement.

Unit I Major types of organisms used in fermentation, Microbial growth kinetics, #Batch culture, Continuous Culture, Fed – Batch – Types#, applications, fermentation kinetics. 18 Hours

Unit II Isolation, preservation and improvement of industrially important microorganisms, Media for industrial fermentations – media formulation, #Development of inoculum for industrial fermentations#. 18 Hours

Unit 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 Hours

Unit IV Control of fermentation – requirements for control, design of a fermentation control systems, sensors and controllers, control of incubation, #aeration and agitation#. 18 Hours

Unit V Computers in fermentation, modeling, software sensors, control and supervision of fermentation processes – #off-line / online measurements – PID#. 18 Hours

#self-study portion

Text Books:


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:


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

Subject Code: 17PDFT1C5/P
Max Marks: 100
Hrs / Week: 6
Internal Marks: 25
Credit: 4
External Marks: 75

Objective: To train the students to understand the concepts of fermenter, microbial fermentation and microbial enzymes.

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.
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.
12. Aseptic sampling from fermenters.
13. Techniques to determine microbial contaminations.
14. Trouble shooting and diagnostics.

Text Books:
SEMESTER II: CORE VI

BIOSEPARATIONS AND BIOLOGICAL TECHNIQUES

Subject Code: 17PDFT2C1
Max Marks: 100
Hrs / Week: 6
Internal Marks: 25
Credit: 4
External Marks: 75

Objective: To empower the students with the concepts and principles of Biological techniques.

Unit 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 Hours

Unit II
Electrophoretic techniques - Principle and technique of gel, SDS, high voltage and discontinuous electrophoresis, Isoelectric focussing. Pulsed field gel electrophoresis and capillary electrophoresis. 18 Hours

Unit III
Spectrophotometry- Basic principles, instrumentation and applications of UV, Visible, IR spectrophotometers and Mass Spectrometry. Flame Photometry - Principles and applications. 18 Hours

Unit IV
Solid removal operations Centrifugation techniques – Principle, methodology and application of analytical centrifugation, differential centrifugation, density gradient centrifugation, ultra-centrifuge. 18 Hours

Unit 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 Hours

#self-study portion

Text Books:

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:
**SEMESTER II: CORE VII**  
**ANIMAL AND PLANT CELL BIOPROCESSES**

**Subject Code:** 17PDFT2C2  
**Max Marks:** 100  
**Hrs / Week:** 6  
**Credit:** 4  
**Internal Marks:** 25  
**External Marks:** 75

**Objective:** To understand the critical relationship among animal and plant cell culture.

### Unit 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 CO2 and supplements, serum and protein free defined media.  
**18 Hours**

### Unit II

**18 Hours**

### Unit 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 Hours**

### Unit IV

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

### Unit 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 Hours**

*Self-study portion*

**Text Books:**

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:
Objective: To learn about the structural features of the components of downstream process.

Unit I Introduction to recovery and purification of fermentation products, removal of microbial cells and other solid matters. *Foam separation*. 18 Hours


Unit III Techniques in Chromatography for downstream processing – adsorption, affinity, ion-exchange, gel permeation, reverse phase chromatography, HPLC, *ultrafiltration, reverse osmosis, drying, crystallization, whole broth processing*. 18 Hours

Unit IV Effluent Treatment - dissolved oxygen concentration, strengths of fermentation effluents, *treatment and disposal of effluents, by-products*. 18 Hours

Unit 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 Hours

_textBooks:

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 References:

Objective: To understand the potential scientific consequences of industrial fermentation products.

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

Unit 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 Hours

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

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

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

Text Books:

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 Refernces:

Objective: To understand the concepts, principles and design of a fermenter.

1. Introduction to bioprocess technology parts and designs of bioreactors.
2. Production of biomass; batch and continuous fed batch fermentation.
4. Laboratory scale fermentation of antibiotics, immobilization of cells and enzymes.
5. Down Stream Processing with an extra cellular enzyme.
7. Citric Acid Production and Quantification.

Text Books:


Books for References: