POST GRADUATE DIPLOMA IN FERMENTATION TECHNOLOGY (PGDFT)

SEM	COURSE CODE	COURSE	COURSE TITLE	HRS / WEEK	CREDIT	CIA MARKS	SE MARKS	TOTAL MARKS
I	14PDFT1C1	CORE I	Biomolecules and Microbial Biochemistry	6	4	40	60	100
	14PDFT1C2	CORE II	Biocatalysis and Biotransformations	6	4	40	60	100
	14PDFT1C3	CORE III	Microbiology of Industrial Fermentation	6	4	40	60	100
	14PDFT1C4	CORE IV	Principles of Fermentation Technology	6	4	40	60	100
	14PDFT1C5P	CORE V	Microbiology, Enzymology & Fermentation - Practical	6	4	40	60	100
TOTAL				**30**	**20**	**200**	**300**	**500**
II	14PDFT2C6	CORE VI	Bioseparations and Biological Techniques	6	4	40	60	100
	14PDFT2C7	CORE VII	Animal and Plant Cell Bioprocesses	6	4	40	60	100
	14PDFT2C8	CORE VIII	Downstream Processes and Fermentation Economics	6	4	40	60	100
	14PDFT2C9	CORE IX	Industrial Fermentation Processes	6	4	40	60	100
	14PDFT2C10P	CORE X	Bioprocess - Practical	6	4	40	60	100
TOTAL				**30**	**20**	**200**	**300**	**500**
GRAND TOTAL				**60**	**40**	**400**	**600**	**1000**

SEMESTER I: CORE I
BIOMOLECULES AND MICROBIAL BIOCHEMISTRY

Course Code : 14PDFT1C1 **Max Marks : 100**
Hours / Week : 6 **Internal Mark : 40**
Credit : 4 **External Mark : 60**

Objective:

The course aims to provide students with a basic understanding of the molecular architecture of eukaryotic cells and organelles, including macromolecules.

UNIT I **18 hours**

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

UNIT II **18 hours**

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 III **18 hours**

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

UNIT IV **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 **18 hours**

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

self-study portion

Text Books

1. Conn, E.E., P.K. Stumpf, G. Bruenimg and Ray H. Doi, Outlines of Biochemistry, John Wiley & sons. (1987).
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. Garrett, R.H. and C.M. Grisham. Biochemistry, 2nd edition, by Saunders College Publishing, NY. (1999)
2. Lehninger: by David L. Nelson and M.M. Cox. Principles of Biochemistry, 3rd edition, Maxmillan and Worth Publishers. (2000)
3. Murray, R.K., P.A.Hayes, D.K.Granner, P.A. Mayes and V.W. Rodwell,. Harper's Biochemistry, 25th edition, Prentice Hall International. (2000)
4. Stryer, L. Biochemistry, 4th edition, W.H. Freeman & Co., NY. (1995).

SEMESTER I: CORE II
BIOCATALYSIS AND BIOTRANSFORMATIONS

Course Code : 14PDFT1C2 **Max Marks :100**
Hours / Week :6 **Internal Marks: 40**
Credit : 4 **External Marks: 60**

Objective:

To identify enzymes of interest for target *biotransformations* by genome.

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).

SEMESTER I: CORE III
MICROBIOLOGY OF INDUSTRIAL FERMENTATION

Course Code: 14PDFT1C3 **Max Marks : 100**
Hours / Week: 6 **Internal Marks : 40**
Credit : 4 **External Marks : 60**

Objective:
To introduce the students to the various concepts of Microbial fermentation.

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:

1. Black, J.G. Microbiology Principles and Explorations 6th edition John Wiley and Sons Inc. (2005).
2. Pelczar M. J.Jr. Chan E.C.S., Kreig. Microbiology 5th edition Tata McGraw Hill. (2006)
3. Perry, J.J., Staley, J.T., Lory, S., Microbial life 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. Prescott, L.M, Harley, J.P, Klein, D.A.; 1st Edition. Microbiology McGraw Hill. (2007).
2. Tortora, Funke, Case;. Microbiology – An Introduction (Brief Edition) Benjamin-Cummings Publications. (2004).

SEMESTER I: CORE IV

PRINCIPLES OF FERMENTATION TECHNOLOGY

Course Code : 14PDFT1C4 **Max Marks: 100**
Hours / Week: 6 **Internal Marks: 40**
Credit : 4 **External Marks: 60**

Objective:

To empower the students with various designs of fermenter. The knowledge on fermentation process enable the students to manipulate microbes for improvement.

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**

Fermentor design and types-basic functions of a Fermentor 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:

1. Arnold L. Demain & Julian E. Davis. Industrial Microbiology & Biotechnology, ASM Press. (2004).
2. Coulson, J.M. and J.F. Richardson; 6th Edition, Chemical Engineering Elsevier. 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 & CFA. Bryce Fermentation Microbiology & Biotechnology, Taylor & Francis Ltd. (2004).
2. Stanbury, P.F., A. Whitaker & S.J. Hall. Principles of fermentation technology Oxford Press. (1997).

SEMESTER I: CORE V

MICROBIOLOGY, ENZYMOLGY AND FERMENTATION - PRACTICAL

Course Code : 14PDFT1C5P **Max Marks : 100**
Hours / Week : 6 **Internal Marks : 40**
Credit : 4 **External Marks : 60**

Objective:

To train students to understand the concepts of fermentor 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
6. Isolation of Antibiotic producing organism
7. Extracellular activities of micro organisms- 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. Anatomy of Fermentor, cleaning of Fermentor, Assembling and final pre-sterilization of Fermentor, Anatomy and calibration of fermentator 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:

1. Cappuccino, J. G. and N. Sherman (2004). Microbiology. A laboratory manual Pearson Education.
2. Ignacimuthu, S. (1996). Applied Plant Biotechnology. . - Mc Graw Hill publications Co. Ltd., New Delhi.
3. Rodney Boyer (2003). An Introduction to Practical Biochemistry Pearson Education.

SEMESTER II: CORE VI
BIOSEPARATIONS AND BIOLOGICAL TECHNIQUES

Course Code : 14PDFT2C6 **Max Marks: 100**
Hours / Week: 6 **Internal Marks: 40**
Credit : 4 **External Marks : 60**

Objective:

To empower students with the concepts and principles Biological techniques.

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 operations Centrifugation 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. Boyer, R.. Modern Experimental Biochemistry, 3rd edition, Addison-Wesley Longman. (2002).
2. David Plummer. Practical Biochemistry, Tata Mc-Graw Hill. (1990)
3. Jayaraman, J.. 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).

SEMESTER II: CORE VII
ANIMAL AND PLANT CELL BIOPROCESSES

Course Code : 14PDFT2C7 **Max Marks : 100**
Hours / Week : 6 **Internal Marks : 40**
Credit : 4 **External Marks : 60**

Objective:

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

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 fermentors, 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:

1. Bernard R. Glick and Jack J. Pasternak. Molecular Biotechnology Panima Publishing House, New Delhi. (2002).
2. Bhojwani, S.S. and M.K. Razdan. Plant Tissue culture: theory and practice a revised edition Elsevier science. (2004).
3. Goding, J.W. 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. Masters, J.R.W. Animal Cell culture Oxford University Press. (2000).
2. Ranga, M.M. Animal Biotechnology Student Edition, Jodhpur. (2003).
3. Springer, T. A. Hybridoma Technology in Biosciences and Medicine Plenum Press, New York. (1985).

SEMESTER II CORE VIII
DOWNSTREAM PROCESSES AND FERMENTATION ECONOMICS

Course Code : 14PDFT2C8 **Max Marks : 100**
Hours / Week: 6 **Internal Marks : 40**
Credit : 4 **External Marks : 60**

Objective:

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

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 in Chromatography 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:

1. Arnold L. demain & Julian E. Davis. Industrial Microbiology & Biotechnology, ASM Press. (2004).
2. Coulson, J.M. 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 References:

1. Mansi & Bryce, C.F.A. Fermentation Microbiology & Biotechnology Taylor & Francis Ltd. (2004).
2. Stanbury, P.F., A. Whitaker & S.J. Hall Principles of fermentation technology Oxford. (1997).

SEMESTER II: CORE IX
INDUSTRIAL FERMENTATION PROCESSES

Course Code : 14PDFT2C9 **Max Marks: 100**
Hours / Week : 6 **Internal Marks: 40**
Credit : 4 **External Marks : 60**

Objective:

To understand the potential scientific consequences of industrial fermentation products.

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 & 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:

1. Arnold L. Demain & Julian E. Davis. Industrial Microbiology & Biotechnology ASM Press. (2004).
2. Coulson, J.M. 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 Refernces:

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

SEMESTER II CORE X
BIOPROCESS - PRACTICAL

Course Code : 14PDFT2C10P **Max Marks : 100**
Hours / Week : 6 **Internal Marks : 40**
Credit : 4 **External Marks : 60**

Objective:

To understand the concepts, principles and design of a fermentor.

1. Introduction to bioprocess technology parts and designs of bioreators;
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 enzyme
6. Beer or Wine Production and Quality Assessment
7. Citric Acid Production and Quantification.

Text Books:

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

Books for References:

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

****