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

P.G and Research Department of Biotechnology

Jamal Mohamed College

(Autonomous)

(Accredited at Five Star Level by NAAC)

Tiruchirappalli – 620 020.

JAMAL MOHAMED COLLEGE (AUTONOMOUS),
TIRUCHIRAPPALLI – 620 020.

P.G. Diploma in Fermentation Technology (P.G.D.F.T)
Course Structure from 2010 onwards
Department of Biotechnology

COURSE DURATION: I YEAR

SEM	Subject Code	Course	Title of the Paper	Hrs / Week	Credit	Int. Mark	Ext. Mark	Max. Mark
I	10 PDFT 1401	Core I	Biomolecules and Microbial Biochemistry	6	4	25	75	100
	10 PDFT 1402	Core II	Biocatalysis and Biotransformations	6	4	25	75	100
	10 PDFT 1403	Core III	Microbiology of Industrial Fermentation	6	4	25	75	100
	10 PDFT 1404	Core IV	Principles of Fermentation Technology	6	4	25	75	100
	10 PDFT 1405: P	Core V	Microbiology, Enzymology and Fermentation - Practical	6	4	40	60	100
TOTAL				**30**	**20**	**140**	**360**	**500**
II	10 PDFT 2406	Core VI	Bioseparations and Biological Techniques	6	4	25	75	100
	10 PDFT 2407	Core VII	Animal and Plant Cell Bioprocesses	6	4	25	75	100
	10 PDFT 2408	Core VIII	Downstream Processes and Fermentation Economics	6	4	25	75	100
	10 PDFT 2409	Core IX	Industrial Fermentation Processes	6	4	25	75	100
	10PDFT2410: P	Core X	Bioprocesses - Practical	6	4	40	60	100
TOTAL				**30**	**20**	**140**	**360**	**500**
GRAND TOTAL				**60**	**40**	**280**	**720**	**1000**

SEMESTER I **10 PDFT1401**

CORE COURSE I – BIOMOLECULES AND MICROBIAL BIOCHEMISTRY

Hours: 6 **Credits: 4**

Unit 1 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 2 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 3 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 4 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 5 Microbial photosynthesis: prokaryotic and eukaryotic photosynthetic apparatus, photophosphorylation, light and dark, reaction, photorespiration, Biological nitrogen fixation, Biochemistry of nitrogen fixation.

References

1. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000) Maxmillan/ Worth publishers.

2. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999). John Wiley & Sons, NY

3. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999). Saunders College Publishing, NY.

4. Biochemistry, 4th edition, by L. Stryer (1995). W.H. Freeman & Co.,NY.
5. Outlines of Biochemistry by E.E.Conn, P.K.Stumpf, G. Bruenimg and Ray H.Doi (1987), John Wiley and sons.

6. Harper's Biochemistry, 25th edition, by R.K.Murray, P.A.Hayes, D.K.Granner, P.A. Mayes and V.W.Rodwell (2000) Prentice Hall International.

7. Biochemistry, 2nd edition, by Laurence A. Moran, K.G. Scrimgeour, H. R. Horton, R.S. Ochs and J. David Rawn (1994), Neil Patterson Publishers Prentice Hall.

8. Introductory Biochemistry by S.K.Singla and O.P.Chauhan (1995) Kalyani Publishers, New Delhi.

SEMESTER I **10PDFT1402**

CORE COURSE II – BIOCATALAYSIS AND BIOTRANSFORMATIONS

Hours: 6 **Credits: 4**

Unit 1 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 2 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 3 Enzyme assays – methods, isolated enzymes and cell – free preparations, Immobilization of enzymes, industrial applications.

Unit 4 Microbial biodegradation – aerobic and Anaerobic biodegradation of organic pollutants, Bioremediation using extracellular electron transfer, Bacterial degradation of xenobiotics,

Unit 5 Oil biodegradation in marine systems – analysis of waste biotreatment in confined environments, metabolic engineering and biocatalytic applications of the pollutant degradation machinery.

References

1. Biophysical Chemistry: Part I: The conformation of biological macromolecules by Charles R. Canter & Paul R. Schimmel; 1st Edition, (1980); W.H. Freeman Publishers.
2. Enzymes by Malcolm Webb, and Edwin C. Dixon, 2nd Edition (1984); Academic Press.
3. Molecular Biotechnology: Principles and Applications of Recombinant DNA Technology by Glick and Pasternack; 4th Edition, (2009) ASM Press.
4. Understanding Enzymes, (Trevor Palmer; 4th Edition; (1995); Prentice Hall.
5. Principles of Physical chemistry by Puri & Sharma, (2008); Vishal Publishing Co.
6. Biophysical Biochemistry: Applications to Biochemistry and Molecular Biology by David Freifelder; 2nd Edition, (1982), W.H. Freeman Publishing Inc.

SEMESTER I

10PDFT1403

CORE COURSE III -MICROBIOLOGY OF INDUSTRIAL FERMENTATION

Hours: 6 **Credits: 4**

Unit 1 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 2 Microbial Nutrition - Nutritional requirements, nutritional types of microorganisms. Effect of environment on microbial growth.

Unit 3 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 4 Primary and secondary metabolites – Organic feed stocks, organic acids, amino acids, enzymes, nucleosides, nucleotides and related compounds, vitamins and antibiotics.

Unit 5 Cell immobilization, microbial transformation, single cell protein, sewage treatment, biosensor, bioleaching and effluent treatment, GMO's

References

1. Microbiology by Prescott LM, Harley JP, Klein DA.; 1st Edition (2007); McGraw Hill.
2. Microbiology by Pelczar M.J.Jr. Chan E.C.S., Kreig (2006) 5th edition Tata McGraw Hill.
3. Microbiology – An Introduction (Brief Edition) by Tortora, Funke, Case; (2004); Benjamin-Cummings Publications.
4. Microbiology Principles and Explorations by Black, J.G. (2005) 6th edition John Wiley and Sons Inc.
5. Microbial life by Perry, J.J., Staley, J.T., Lory, S., (2002) Sinauer Associates Publishers.

SEMESTER I **10 PDFT1404**

CORE COURSE IV - PRINCIPLES OF FERMENTATION TECHNOLOGY

Hours: 6 Credits: 4

Unit 1 Major types of organisms used in fermentation. Microbial growth kinetics, Batch culture, Continuous Culture, Fed – Batch – Types, applications, fermentation kinetics

Unit 2 Isolation, preservation and improvement of industrially important microorganisms, media for industrial fermentations – media formulation, Development of inoculum for industrial fermentations.

Unit 3 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 4 Control of fermentation – requirements for control, design of a fermentation control systems, sensors and controllers, control of incubation, aeration and agitation.

Unit 5 Computers in fermentation, modeling, software sensors, control and supervision of fermentation processes. – off-line / online measurements – PID

References:

1. Industrial Microbiology & Biotechnology by Arnold L. demain & Julian E. Davis. (2004) ASM Press.
2. Fermentation Microbiology & Biotechnology by Emt.el-Mansi & CFA. Bryce (2004). Taylor & Francis Ltd.
3. Principles of fermentation technology by P.F. Stanbury, A. Whitaker & S.J. Hall (1997). Oxford.
4. The Bacterial Vol. Ill by Gungalus, I.C. and stainer. RY. (Eds.) Academic press. New York.
5. Bacterial physiology and metabolism by Sala Teh JR - Academic press, New York.
6. Chemical Engineering by J.M. Coulson and J.F. Richardson; 6th Edition, (1999) Elsevier.

CORE COURSE V - MICROBIOLOGY, ENZYMOLOGY AND FERMENTATION - Practical

Hours: 6 Credits: 4

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

References:

1. An Introduction to Practical Biochemistry by Rodney Boyer (2003). Pearson Education.
2. Microbiology. A laboratory manual by J. G. Cappuccino and N. Sherman (2004). Pearson Education.
3. Molecular Cloning by J. Sambrook and D. W. Russell (2001). Cold Spring Harbour Lab. Press.
4. Laboratory Manual of Biochemistry by J. Jayaraman (1988) Wiley Eastern
5. Practical Biochemsitry by Wilson and Walker (1994). Cambridge University Press
6. A short course in Bacterial Genetics by J.H. Miller (1992) Cold Spring Harbor Laboratory.
7. Methods for Genetics and molecular Bacteriology by Ed. RGF Murray, WA. Wood & NB krieg (1994) American society for Microbiology.
8. Handbook of Laboratory culture media, Reagents, Stains and Buffers by N. Kannan (2003), Panima Publishers, New Delhi.
9. A short course in Bacterial Genetics by J.H. Miller (1992) Cold Spring Harbor Laboratory.
10. Plant Molecular Biology by Grierson and S.N. Covey (1988) Blackie
11. Applied Plant Biotechnology. . S.Ignacimuthu S.J. (1996) - Me Graw Hill publications Co. Ltd., New Delhi.

SEMESTER II **10 PDFT2406**

CORE COURSE VI – BIOSEPARATIONS AND BIOLOGICAL TECHNIQUES

Hours: 6 Credits: 4

Unit 1 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 2 Electrophoretic techniques - Principle and technique of gel, SDS, high voltage and discontinuous electrophoresis, Isoelectric focussing. Pulsed field gel electrophoresis and capillary electrophoresis.

Unit 3 Spectrophotometry- Basic principles, instrumentation and applications of UV, Visible, IR spectrophotometers and Mass Spectrometry. Flame Photometry - Principles and applications.

Unit 4 Solid removal operations Centrifugation techniques – Principle, methodology and application of analytical centrifugation, differential centrifugation, density gradient centrifugation, ultra- centrifuge.

Unit 5 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.

References:

1. Introductory Practical Biochemistry by S.K.Sawhney and R. Singh (2000). Narosa Publishers
2. Practical Biochemistry by David Plummer (1990). Tata Mc-Graw Hill
3. Biochemical Methods by Sadasivam & Manickam (1996) New Age International (P) Ltd.
4. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.
5. A Lab. Manual in Biochemistry by J. Jayaraman (1996) New Age International (P) Ltd.

SEMESTER II **10 PDFT2407**

CORE COURSE VII - ANIMAL AND PLANT CELL BIOPROCESSES

Hours: 6 Credits: 4

Unit 1 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 2 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 3 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 4 Plant secondary metabolites production: cell culture, hairy root culture, Ri plasmid, control mechanism and maintenance of phenyl propanoid pathway, alkaloids, flavonoids, phenols.

Unit 5 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 and adult stem cells, and potent uses of human stem cells.

References:

1. Animal Cell culture by J.R.W. Masters (2000) Oxford University Press.
2. Animal Biotechnology by M.M. Ranga (2003) Student Edition, Jodhpur.
3. Molecular Biotechnology by Bernard R. Glick and Jack J. Pasternak (2002). Panima Publishing House, New Delhi.
4. Monoclonal Antibodies: Principles and Practice by J.W. Goding (1983) Academic Press.
5. Hybridoma Technology in Biosciences and Medicine by T. A. Springer (1985) Plenum Press, New York.
6. Plant cell culture by R.A Dixon And R.A. Gonzales (2004) IRL press
7. Genetic Engineering of crop plants-by (Eds) G.W. Lycett and D. grierson (1990)
8. Plant Tissue culture: theory and practice a revised edition by S.S. Bhojwani and M.K. Razdan (2004) Elsevier science.
9. Manual of industrial Microbiology and Biotechnology by Arnold L., Demain and Julian E., Davies, ASM Press.

SEMESTER II **10 PDFT2408**

CORE COURSE VIII- DOWNSTREAM PROCESSES AND FERMENTATION ECONOMICS

Hours: 6 Credits: 4

Unit 1 Introduction to recovery and purification of fermentation products, removal of microbial cells and other solid matters. Foam separation.

Unit 2 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 3 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 4 Effluent Treatment - dissolved oxygen concentration, strengths of fermentation effluents, treatment and disposal of effluents, by-products.

Unit 5 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.

References:

1. Industrial Microbiology & Biotechnology by Arnold L. demain and Julian E. Davis. (2004) ASM Press.
2. Fermentation Microbiology & Biotechnology by Emt.el-Mansi and CFA. Bryce (2004). Taylor & Francis Ltd.
3. Principles of fermentation technology by P.F. Stanbury, A. Whitaker and S.J. Hall(1997). Oxford.
4. The Bacterial Vol. Ill by Gungalus, I.C. and stainer. RY. (Eds.) Academic press. New York.
5. Bacterial physiology and metabolism by Sala Teh JR - Academic press, New York.
6. Chemical Engineering by J.M. Coulson and J.F. Richardson (1984) Pergamon Press.

SEMESTER II **10 PDFT2409**

CORE COURSE IX - INDUSTRIAL FERMENTATION PROCESSES

Hours: 6 Credits: 4

Unit 1 Enzyme production – amylase, glucose isomerases, asparaginase, proteases, rennin, pectinases, lipases, penicillin acylase. Enzyme and cell immobilization.

Unit 2 Vitamins and Antibiotics – vitamin B12, riboflavin, β carotene, β –lactam antibiotics, amino acids and peptide antibiotics, carbohydrate antibiotics, macro lactone antibiotics, tetracyclines and anthracyclines, nucleoside antibiotics and aromatic antibiotics.

Unit 3 Organic acids and Feed stocks – citric acids, gluconic acids, acetic acids, lactic acids, kojic acids, Itaconic acids – ethanol, glycerol, butanol, acetone, fermentation.

Unit 4 Amino acids – glutamic acid, lysine, tryptophan, structure and biosynthesis of nucleotides, nucleosides and related compounds.

Unit 5 Ergot alkaloids – significance and occurrence, structure, biosynthesis, strain development, production.microbial transformations – types, applications - antibiotics, pesticides, non-steroid compounds, sterols and steroids.

References:

1. Industrial Microbiology & Biotechnology by Arnold L. demain & Julian E. Davis. (2004) ASM Press.
2. Fermentation Microbiology and Biotechnology by Emt.el-Mansi & CFA. Bryce (2004). Taylor & Francis Ltd.
3. Principles of fermentation technology by P.F. Stanbury, A. Whitaker & S.J. Hall (1997). Oxford.
4. The Bacterial Vol. Ill by Gungalus, I.C. and stainer. RY. (Eds.) Academic press. New York.
5. Bacterial physiology and metabolism by Sala Teh JR - Academic press, New York..
6. Chemical Engineering by J.M. Coulson and J.F. Richardson (1984) Pergamon Press.

SEMESTER II **10 PDFT2410 P**

CORE COURSE X – BIOPROCESS - Practical

Hours: 6 Credits: 4

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.

References:

1. Industrial Microbiology and Biotechnology by Arnold L. demain and Julian E. Davis. (2004) ASM Press.
2. Fermentation Microbiology and Biotechnology by Emt.el-Mansi and CFA. Bryce (2004). Taylor and Francis Ltd.
3. Principles of fermentation technology by P.F. Stanbury, A. Whitaker and S.J. Hall (1997). Oxford.
4. The Bacterial Vol. Ill by Gungalus, I.C. and stainer. RY. (Eds.) Academic press. New York.
5. Bacterial physiology and metabolism by Sala Teh JR - Academic press, New York.
6. Chemical Engineering by J.M. Coulson and J.F. Richardson (1984) Pergamon Press.