KRISHNA VISHWA VIDYAPEETH (DEEMED TO BE UNIVERSITY), KARAD

Revised Syllabus (CBCS)

For

PG DIPLOMA IN FERMENTATION TECHNOLOGY

DURATION : One Year

PATTERN OF EXAMINATION: Semester System

- **Theory Examination**– At the end of each semester as per the rules and regulations of KVV DU, Karad

- **Practical Examination**– At the end of each semester as per the rules and regulations of KVV DU, Karad

MEDIUM OF INSTRUCTION : English

STRUCTURE OF COURSE : PG Diploma

Year of Revision : 2023-24

Scheme of Examination

Theory/ paper	80 marks/ paper
Internal Assessment	20 marks/ paper
Total	100 marks

Practical Examination

Practicals	80 marks/ practical course
Internal Assessment	20 marks/ practical course
Total	100 marks

In case of Industrial training

Industrial training report	80 marks
Internal Assessment	20 marks
Total	100 marks

* Grand Total 600 marks (4 Theory Papers & 2 *Practicals courses) Per *semester

* In semester II there is either practical course III and IV or Industrial training of minimum 02 months

Eligibility:

i) Applicants must have passed B.Sc. with minimum 50% marks with Biotechnology/Microbiology/Industrial Microbiology/ Zoology/ Botany/ Chemistry as principal subject.

ii) No person shall be admitted for the Post Graduate diploma program unless such a person is in a position to work as a full-time student for the period applicable in the case.

iii) The academic merit, for admission to degree courses shall be on the basis of merit as determined by the competitive test conducted by the University on all India basis.

Provided further that minimum percentage of marks for eligibility for admission to Post Graduate Course shall be 50% at the entrance test.

Mode of Admission: On the basis of merit in the all India level competitive entrance test Krishna All India Entrance Test (KAIET) **to be conducted by the university.**

PG Diploma in Fermentation Technology
(Programme Code:)
Course Structure
Semester I

		PG Diploma in Fermentation Technology (CBCS) w. e. f. 2021-22										
	Sr. No.	**Course Code**	**Course Title**	**Teaching Hours/ Week**			**Marks (Total 100)**				**Credits**
				T	**P**	**Total**	**Internal**		**External**		
							T	**P**	**T**	**P**	
CGPA		**Theory**									
	1		Foundation of Biochemistry for Fermentation Technology	4	--	4	20	--	80	--	4
	2		Bioseparation and Biological Techniques in Fermentation	4	**-**	4	20	--	80	--	4
	3		Principles of Fermentation Technology	4	--	4	20	--	80	--	4
	4		Industrial Fermentation Microbiology	4	--	4	20	--	80	--	4
		Practicals									
	5		Practical Course I	---	4+4	8	-	20	--	80	4
	6		Practical Course II and Industrial Visit	---	4+4	8	--	20	--	80	4
	Total Credit for Semester I: 24 (T = Theory : 16, P = Practical : 8;) **CC: Core Course, CCS : Core course specialization DSE: Discipline Specific Elective** **Total Credits for Semester I CGPA course = 24 credits**										

PG Diploma in Fermentation Technology
(Programme Code:)
Course Structure
Semester II

		PG Diploma in Fermentation Technology (CBCS) w. e. f. 2021-22									
	Sr. No.	Course Code	Course Title	Teaching Hours/ Week			Marks (Total 100)				Credits
				T	P	Total	Internal		External		
CGPA							T	P	T	P	
		Theory									
	1		Industrial Fermentation Processes	4	--	4	20	--	80	--	4
	2		Enzymology and Biotransformation	4	-	4	20	--	80	--	4
	3		Downstream Processing	4	--	4	20	--	80	--	4
	4		Animal and Plant cell Bioprocesses	4	--	4	20	--	80	--	4
		Practicals									
	5 A		Practical Course III & Practical Course IV	---	4+4	8	-	20	--	80	4
	5 B		**OR** Industrial Training of Minimum 2 month	---	4+4	8	--	20	--	80	8
	Total Credit for Semester I: 24 (T = Theory : 16, P = Practical : 8;) **CC: Core Course, CCS : Core course specialization DSE: Discipline Specific Elective** **Total Credits for Semester I CGPA course = 24 credits**										

SEMESTER I

PAPER I FOUNDATION OF BIOCHEMISTRY FOR FERMENTATION TECHNOLOGY

Course Objectives:

1) To give students the knowledge about the important biomolecules like Protein, Carbohydrates, Lipids,

Nucleic acids, Porphyrins.

2) To make students familiar with the vitamins and their structures & functions.

3) To give students the knowledge of chemistry of cell walls of Bacteria, Actinomycetes & Yeasts.

Course Outcomes:

1) Students would be well versed on the fundamental principles of Biochemistry.

2) Students will have through knowledge of structures and functions of Bio-macromolecules like proteins, carbohydrates, lipids, Nucleic acids (DNA and RNA).

2) Students will be well versed with structure and functions of vitamins, and chemistry of cell walls of bacteria, actinomycetes & yeasts.

UNIT I **15 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, lipoaminoacids, lipoproteins, proteolipids, phosphatidopeptides, lipopolysaccharides.

UNIT II **15 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, Protein folding: Anfinsen's Dogma, Levinthal paradox, cooperativity in protein folding, free energy landscape of protein folding, and pathways of protein folding, molten globule state, chaperons, diseases associated with protein folding, introduction to molecular dynamic simulation**.**

UNIT III **15hours**

Microbial Metabolism: Glycolysis, Alernative pathways to Glycolysis-: Pentose phosphate pathway, Entner-Doundroff pathway, Aerobic respiration- Tricarboxylic acid cycle, Electron transport chain – components (carriers), their organization into large functional complexes, the path of electron flow through them, Proton gradient, Proton motive force. ATP synthesis – Mechanisms: chemiosmotic model proposed by Peter Mitchell, ATP synthase complex of mitochondria, Binding change mechanism (rotational catalysis mechanism) proposed by Paul Boyer, Shuttle systems to convey cytosolic NADH into mitochondria for oxidation – malate aspartate shuttle, glycerol – 3 – phosphate shuttle Regulation of oxidative phosphorylation. Mitochondrial genes: their origin and the effects of mutations. Role of mitochondria in Apoptosis and oxidative stress. The Chemiosmosis.

UNIT IV **15 hours**

Isolation, screening and strain improvement of industrially important microorganisms .Introduction to fermentation processes- media for industrial fermentation, sterilization, inoculum preparation. 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.

Reference Books

1. Conn,E.E.,P.K.Stumpf,G.BruenimgandRayH.Doi,OutlinesofBiochemistry,JohnWiley &sons.(1987).
2. DonaldVoetandJudithGVoet.FundamentalsofBiochemistry,JohnWiley&Sons,NY.(1999).
3. Garrett,R.H.andC.M.Grisham.Biochemistry,2nd edition,bySaundersCollegePublishing,

NY.(1999)

4. Lehninger:byDavidL.NelsonandM.M.Cox.PrinciplesofBiochemistry,3rdedition,Maxmillan andWorthPublishers.(2000)
5. Murray,R.K.,P.A.Hayes,D.K.Granner,P.A.MayesandV.W.Rodwell,.Harper'sBiochemistry,25thedition,PrenticeHallInternational.(2000)
6. Stryer,L.Biochemistry,4thedition,W.H.Freeman &Co.,NY.(1995).

PAPER II BIOSEPARATIONS AND BIOLOGICALTECHNIQUES

Course Objectives:

1) To give students the knowledge about the principles various Microbiological, Physicochemical and Biochemical techniques used in research laboratories, industries and diagnostics.

2) To make students know the operative procedures and applications of the techniques in diagnostics, research laboratories and industries.

Course Outcomes:

1) Student would be able to understand the difference between UV visible and fluorescence spectroscopy & colorimetry.

2) Student will be able to describe the basic principle, technique and applications of different types of chromatographic techniques like paper, ion exchange and affinity chromatography.

3) Student will gain knowledge regarding fundamental principles of centrifugation and electrophoresis.

4) Student will be able to get the thorough knowledge of ESR, NMR and various principles and instrumentation behind them.

5) Student would be well versed with the knowledge of x- ray and radioisotopes, radiography and the dangers, safety precautions associated with them

6) Student will understand the principles and applications of SDS- PAGE, Southern blotting.

UNIT I **15 hours**

Bio separation 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 **15hours**

Electrophoretic techniques-Principle and technique of gel, SDS, high voltage and discontinuous electrophoresis, Isoelectric focusing. Pulsed field gel electrophoresis and capillary electrophoresis. Principle, Classification of chromatographic methods – Thin layer, Paper and Column – Principle and its applications (New topics included)

UNIT III **15hours**

General principles of electromagnetic radiation spectroscopy, principles, procedures and applications UV – visible spectrometry, turbidometry and nephalometry, fluorimetry, luminometry, atomic absorption and mass spectroscopy, Spectrophotometry-Basic principles, instrumentation and applications of IR spectrophotometers. Flame Photometry-Principles and applications. Solid removal operations Centrifugation techniques –Principle, methodology and application of analytical centrifugation, differential centrifugation, density gradient centrifugation, ultra-centrifuge.

UNIT IV **15hours**

X-Rays - X-Ray diffraction, crystals and detectors, quantitative analysis and applications. Radiochemical methods -Basic concepts, counting methods and applications. Auto radiography Tracer techniques- radioactive decay, units of radioactivity, detection and measurement of radioactivity, Geiger-Muller counter, Scintillation counter. Applications of radioisotopes in biology, Biophysical Techniques: Raman spectroscopy. Electron spin and nuclear magnetic resonance spectroscopy.

Reference Books:

1. Boyer,R..ModernExperimental Biochemistry,3rdedition,Addison-WesleyLongman.(2002).
2. DavidPlummer.PracticalBiochemistry,TataMc-GrawHill.(1990)
3. Jayaraman,J..ALab.Manualin BiochemistryNewAgeInternational(P)Ltd.(1996).
4. Sadasivam&Manickam.BiochemicalMethodsNewAgeInternational(P)Ltd.(1996).
5. Sawhney,S.K.,&R.Singh. IntroductoryPracticalBiochemistry,NarosaPublishers.(2000).
6. "Biotechnology – Foundation course", by Anant N. Rao, 2007, Jaypee Brothers Medical Publishers (p) Ltd, New Delhi.
7. "Biophysical Chemistry – Principles and Techniques", by A. Upadhya and K. Upadhya and N. Nath, 4th revised edition,

2007, Himalaya Publishing House, Delhi.

PAPER III PRINCIPLES OF FERMENTATION TECHNOLOGY

Course Objectives:

1) To make the students well versed with the screening techniques, Microbial assays, Primary & secondary metabolites.

2) To give the students knowledge of design of fermentors, types of fermentors, equipments & instruments used in fermentation and sterilization processers.

3) To acquaint the students with fermentation media, innoculum preparation, Scale up processes &. various downstream processes used in fermentation industries.

Course Outcomes:

1) Students will be well versed with the screening techniques, Microbial assays, Primary & secondary metabolites.

2) Students will gain the knowledge of design of fermentors, types of fermentors , equipments, instruments used, sterilization processers.

3) Students will be well versed with fermentation media, inoculum preparation, Scale up Processes and with the various downstream processes of fermentation industries.

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UNIT I **15 hours**

Major types of organisms used in fermentation .Microbial growth kinetics, Batch culture, Continuous Culture, Fed –Batch–Types, applications, fermentation kinetics. Isolation, preservation and improvement of industrially important microorganisms, media for industrial fermentations–media formulation], Development of inoculums for industrial fermentations.

UNIT II **15 hours**

Fermentor design and types-basic functions of a Fermentor for microbial and animal cell culture - alternative vessel design,

common measurements and control systems. Bioreactors configurations-Stirred tanks, Bubble column, Airlift, fluidized bed, packed bed, hollow fiber, Novel seesaw bioreactor. Bioreactor design features: Principal features of a typical (conventional) bioreactor. Bioreactor design for sterile operation – sterilization in place, Clean in place considerations. Photo bioreactors: Configurations – continuous run tubular loop, multiple parallel tube, helical wound tubular loop, flat panel Heat Transfer. Shear effects in culture. Sensors – solutions to common problems in fermentation, anaerobic fermentation.

(The highlighted portion Can be removed)

UNIT III **15 hours**

Selection & Preservation of Industrial microorganisms - Primary and Secondary Screening Strain Improvement (New topics included) - Control of fermentation–Preservation of Industrially important microorganisms requirements for control, design of a fermentation control systems, sensors and controllers, control of incubation, aeration and agitation.

UNIT IV **15 hours**

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

Reference Books:

1. ArnoldL.Demain&JulianE.Davis.IndustrialMicrobiology&Biotechnology,ASMPress.(2004).
2. Coulson,J.M.andJ.F.Richardson;6thEdition,ChemicalEngineeringElsevier.McGrawHillPublication.(1999).
3. Emt.elMansi&CFA.BryceFermentationMicrobiology&Biotechnology,Taylor&FrancisLtd.(2004).
4. Stanbury,P.F.,A.Whitaker&S.J.Hall.PrinciplesoffermentationtechnologyOxfordPress.(199).
5. “Prescott and Dunn’s Industrial microbiology”, edited by Reed, G., 4th edition, 1982.
6. “Industrial microbiology”, by Miller B. M., and W. Litsky, 1976 Mc Graw-hill, New York.
7. “Pharmaceutical microbiology”, edited by Hugo, W.B. and A.D. Russell 1977, Blackwell scientific, oxford.
8. “Biotechnology: A textbook of industrial microbiology”, by Crueger, W. and A. Crueger, 1982, Sinauer

Associates, Inc., Sunderland, Mass

PAPER IV INDUSTRIAL FERMENTATION MICROBIOLOGY

Course Objectives:

1) To give the students deep theoretical knowledge about the industrial production of yeast, yeast products, mushrooms , polysaccharides, pigments, bioinsecticides etc.

2) To make the students well versed with the instrumentation used in fermentation industry.

Students should also know applications of computers in fermentation industry.

3) To introduce the students with economics of fermentation processes, IPR, Patent office,

Patent filling process etc.

Course Outcomes:

1) Students will gain deep theoretical knowledge about the industrial production of yeast, yeast products, mushrooms , polysaccharides, pigments, bioinsecticides etc.

2) Students will be well versed with the instrumentation used in fermentation industry.

3) Students will learn about the applications of computer in fermentation industry which will be increasing his skills for working in industry.

UNIT I **15 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 **15 hours**

Microbial Nutrition - Nutritional requirements, nutritional types of microorganisms. Autotrophs, myxotrophs, Heterotrophs – Uptake of nutrients by cell -Effect of environment on microbial growth – growth curve (Newly included topics)

UNITIII **15 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.

UNITIV **15 hours**

Primary and secondary metabolites– Organic feed stocks, organic acids, aminoacids, enzymes, nucleosides, nucleotides and related compounds, vitamins and antibiotics. Cell immobilization, microbial transformation, single cell protein, sewage treatment, biosensor, bioleaching and effluent treatment, GMO's.-Introduction, Production of β – carotene, Production of Lycopene, Production of Xanthophylls and Other pigments, Marketing Prospects for Carotenoids.-Introduction , Classification of methods for Production of 5′ IMP and 5′ GMP, Production 5′-IMP and 5′- GMP by hydrolysis of RNA, Production of 5′IMP and 5′GMP by fermentation, Production of Nucleic acid- related substances by fermentation -Introduction, Nature of Microbial Polysaccharides, Mechanism of synthesis, Bacterial Polysaccharides, Fungal Polysaccharides, Yeast Polysaccharides, commercially produced Polysaccharides.

Reference Books:

1. Black,J.G.MicrobiologyPrinciplesandExplorations6theditionJohnWileyandSonsInc.(2005).
2. PelczarM.J.Jr.ChanE.C.S.,Kreig.Microbiology5th editionTataMcGrawHill.(2006)
3. Perry, J.J., Staley, J.T., Lory, S., Microbial life Sinauer Associates Publishers. (2002).
4. Prescott,L.M,Harley, J.P, Klein, D.A.;1st Edition. Microbiology McGrawHill. (2007).
5. Tortora, Funke,Case;.Microbiology–AnIntroduction (BriefEdition)Benjamin-Cummings Publications.(2004).
6. "Microbial Technology", 2nd edition, volume I& II, edited by Peppler, H. J. and Perlman, D. 1979 Academic Press, New York.
7. "Basic Biotechnology", 2nd edition, by Colin Ratledge and Bjorn Kristiansen, 2001,Cambridge University Press, New York.
8. "Prescott and Dunn's Industrial Microbiology", edited by Reed, G., 4th edition, 1982.

PRACTICAL COURSE I

Course Objective:

1) To make the students able to perform to prepare the various nutrient media, sugar media and media for biochemical tests.

2) To make the students able to perform the endospores staining, nuclear material staining and capsule staining.

3) To make the students able to perform the various techniques of isolation, biochemical characterization and enumeration of microorganisms.

Course Outcomes:

1) Students would be able to prepare the various nutrient media, sugar media and media for Biochemical tests.

2) Students would be able to perform the staining of endospores, nuclear material and capsule of bacteria.

3) Students will be able to perform the various techniques of isolation , biochemical characterization and enumeration of microorganisms.

4) Students will get insight of industrial work culture by visiting industry.

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. Detection of microbial enzyme production-amylase, gelatinase,lipase,caseinase
8. Qualitative study of enzyme activity
9. Anatomy of Fermentor, cleaning of Fermentor, Assembling and final presterilization of Fermentor,

Anatomy and calibration of fermentor electrodes/probes, Post–sterilization procedures, Aseptic techniques in inoculation of fermentors

10. Aseptic sampling from fermentors
11. Techniques to determine microbial contaminations
12. Screening of industrially important organisms (Protease producers & Lipase producers).
13. Visit to industry/ Science Institute/ Research laboratory.

Referenc

e Books:

1. Cappuccino,J.G.andN.Sherman(2004).Microbiology.Alaboratorym anualPearsonEducation.
2. Ignacimuthu,S.(1996).AppliedPlantBiotechnology..- McGrawHillpublicationsCo.Ltd., NewDelhi.
3. RodneyBoyer(2003).AnIntroductiontoPracticalBiochemistryPearso nEducation.

PRACTICAL COURSE II

Course Objectives:

1) To train the students properly to be able to perform the qualitative and quantitative estimation of proteins, lipids, carbohydrates, DNA, RNA.

2) To make the students able to statistically analyze biological data and interpret the results

3) To give the students enough demonstration and practices so as to enable them to perform the electrophoresis and chromatographic techniques

Course Outcomes:

1) Students will know and able to perform the techniques of qualitative and quantitative estimation of proteins, lipids, carbohydrates, DNA, RNA and shall be able to carry out the estimations independently.

2) Students will learn to apply the statistical methods on biological data and interpret the results.

3) Students will be able to perform the electrophoresis and chromatographic techniques

1. Determination of Carbohydrate content of bacteria.
2. Determination of Protein content of bacteria / yeast.
3. Determination of Lipid content of bacteria.
4. Separation of dyes, plant pigments by column chromatography.
5. Separation of amino acids by paper chromatography.
6. Separation of amino acids by thin layer chromatography.
7. Electrophoretic separation of serum proteins by Agarose and Polyacrylamide gel electrophoresis (PAGE).
8. Determination of acid value of fat
9. Determination of saponification value of fat
10. Determination of iodine number of fat

11.Determination of carbohydrates by Anthrone method

12.Preparation of Buffers

13.Preparation of Normal and Molar solutions

14. Determination of BOD

15. Determination of COD

Reference Books for Practical course I and Practical course II

1. "Laboratory manual in Biochemistry", by Jayraman, J., 1998, New age International Publishers, New Delhi.

2. "Experiments in Microbiology, Plant Pathology and Tissue Culture", by Aneja, K. R., 1993, Wishwa Prakashan.

3. "Practical Biotechnology", by P. Ramadass and A. Wilson Aruni, 2007, Jaypee Brothers Medical Publishers(p) Ltd. New Delhi.

4. "Medical Microbiology", Vol. 2, 12th edition, 1975 by Cruickshank, R. Duguid, J. P. Marriman, B. P. and R. A. Swan, Churchill Livingstone, London.

5. "Hand book of microbiological media", by Atlas, R. M., 1993, CRC Press, Inc. Florida.

6. "Manual of laboratory techniques", by Rghumulla, N., Nair, K. M., and Kalyansundaram, S., 2nd edition, 2003, National Institute of Nutrition Press, Hyderabad.

7. "Illustrated genera of imperfect fungi", by Barnett, H. L., and Hunter, B. B., 3rd edition, 1972, Burgess Publishing Company, Minneapolis, Minnesota.

8. "Compendium of soil fungi", by Domsch, K. H., Gams, W. and Anderson, T. H., 1980, Academic Press, London.

9. "Standard methods for the examination of water and waste water", 20th edition, edited by Greenberg, et al., 1998, APHA, AWWA, Washington, DC.

10. "Methods in Microbiology", Vol.3A and Vol.3B edited by Norris and Ribbons, Academic Press, London.

11."Methods in Microbiology", Vol.4 edited by Booth, C., Academic Press, London.

12. "Methods in Microbiology", Vol.5 edited by Norris and Ribbons, Academic Press, London.

13. "Microbiological applications", by Benson, H. J., 6th edition, 1994, Wm. C. Brown Publishers, Dubuque, Iowa.

14. "Identification methods for Microbiologists", edited by Gibbs, G. M. and Shapton, D. A., 1968, Academic Press, London.

SEMESTER II

PAPER I INDUSTRIAL FERMENTATION PROCESSES

Course Objectives:

1) To make the students to understand the Drug discovery and drug development

2) To impart the knowledge to the students about the production of various types of enzymes, amino acids, vitamins, and organic acids and probiotics to the students.

3) To give the students deep insight into the antibiotics, antimicrobial agents and their mode of action.

4) To give the students knowledge about good manufacturing practices.

Course Outcomes:

1) Students will gain the knowledge regarding Drug discovery and drug development

2) Students will get knowledge about production of various types of enzymes, amino acids, vitamins, and organic acids.

3) Students will have a deep insight into the antimicrobial agents and their mode of action.

UNIT I **15 hours**

Catalysis, Biocatalysis, chemical nature of enzymes, characteristics - Enzyme Classification and nomenclature. Enzyme production – amylase, glucose isomerases, asparaginase, proteases, rennin, pectinases, lipases, penicillin acylase. Enzyme & cell immobilization.

UNIT II **15 hours**

Vitamins & Antibiotics – vitamin B12, riboflavin, β carotene, β –lactam antibiotics, Microbial production of amino acids :Introduction, Microbial stains employed in Amino acid production – Direct production of Amino acids from carbon sources, Precursor addition methods, Enzymatic methods, Process control in Amino acid fermentation – Maintenance of pure culture conditions, Automatic control of aminoacid fermentation, Agitation –Aeration effectiveness, carbohydrate antibiotics, macro lactone antibiotics, tetracyclines and anthracyclines, nucleoside antibiotics & aromatic antibiotics, Production of Probiotics –*Lactobacillus acidophilus, Lactobacillus casei*

UNIT III **15 hours**

Organic acids & Feed stocks – citric acids, gluconic acids, acetic acids, lactic acids, kojic acids, Itaconic acids–ethanol, glycerol, butane l,acetone, fermentation. Aminoacids–glutamicacid, lysine, tryptophan, structure and biosynthesis of nucleotides, Nucleosides and related compounds.

UNIT IV **15 hours**

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

Reference Books:

1. ArnoldL.Demain&JulianE.Davis.IndustrialMicrobiology&BiotechnologyASMPress.(2004).
2. Coulson, J.M. and J.F. Richardson. Chemical Engineering, Pergamon Press. (1984).
3. Mansi&CFA.Bryce.FermentationMicrobiology&BiotechnologyTaylor&FrancisLtd. (2004).
4. Stanbury,P.F.,A.Whitaker& S.J.Hall.Principlesoffermentation technologyOxford.(1997).
5. Pharmaceutical Biotechnology", by S.S. Purohit, H.N. Kakarni and A.K. Saluja, Agrobios (India).
6. "Basic Biotechnology", edited by colin Ratledge and Bjorn Kristiansen, 2001, Cambridge University,

Press, New York.

PAPER II ENZYMOLOGY AND BIOTRANSFORMATION

Course Objectives:

1) To make the students conversant about enzymes, enzyme catalysis, rate of reactions, order of reactions, kinetics of enzyme catalysed reactions and enzyme inhibitions and their regulatory processes.

2) To give the students knowledge about the extraction, purification, immobilization and biotechnological applications of enzymes.

3) To make the students gain the knowledge of isoenzymes, multi enzymes and multi enzyme complexes.

Course Outcomes:

1) Student would able to describe structure, functions and the mechanism of action of enzymes, kinetics of enzyme catalysed reactions and enzyme inhibitions and their regulatory process.

2) Students would have the knowledge of immobilization of enzyme and exposure of wide applications of enzymes and future potential uses of enzymes.

3) Students would be well versed with kinetics of soluble and immobilized enzymes.

4) Students would gain the knowledge of enzyme catalysis, isoenzymes, multi enzymes and multi enzyme complexes.

UNITI **15 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.

UNITII **15 hours**

Introduction of chemical kinetics, Basic concept of catalysis activation energy barrier and the transition state theory. Kinetics of single substrate enzyme catalysed reactions, kinetics of multi substrate enzyme catalysed reactions, sigmoidal kinetics and allosteric enzymes, the significance of sigmoidal behavior Enzyme inhibition – Types of inhibitions : Competitive, non-competitive and uncompetitive, modes of action of inhibitors.

UNITIII **15 hours**

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

UNIT IV **15 hours**

Microbial biodegradation–aerobic & Anaerobic biodegradation of organic pollutants,

Bioremediation using extracellular electron transfer, Bacterial degradation of xenobiotics.

Oil biodegradation in marine systems–analysis of waste bio treatment in confined environments, metabolic engineering and biocatalytic applications of the pollutant degradation machinery. Enzyme Engineering: Methods, Recent advances in rationale approaches for enzyme engineering

Reference Books:

1. CharlesR.Canter&PaulR.Schimmel;1st Edition,.BiophysicalChemistry:PartI:Theconformationofbiologicalmacromoleculesby W.H.FreemanPublishers.(1980).

2. DavidFreifelder;2nd Edition,.BiophysicalBiochemistry:ApplicationstoBiochemistryandMolecularBiologybyW.H.FreemanPublishing Inc.(1982)

3. GlickandPasternack; 4thEdition,Molecular Biotechnology:PrinciplesandApplicationsofRecombinantDNATechnology,ASMPress.(2009).

4. MalcolmWebb,andEdwinC.Dixon,2nd Edition;Enzymes, AcademicPress.(1984).
5. PuriandSharma,PrinciplesofPhysicalchemistryVishalPublishing Co. (2008).
6. TrevorPalmer;4th Edition;UnderstandingEnzymes,PrenticeHall. (1995).
7. "Understanding Enzymes", by T. Palmer, Ellis Horwood limited.
8. Lehninger "Principles of Biochemistry", by David L. Nelson and Michel M. Cox, 4th edition, 2005 W. H. Freeman and Co. New York.

PAPER III DOWNSTREAM PROCESSESING

Course Objectives:

1) To acquaint the students with fermentation media, innoculum preparation.
2) To make the students understand Scale up processes various downstream processes used in

fermentation industries.

Course Outcomes:

1) Students will be well versed with fermentation media, inoculum preparation, Scale up Processes and with the various downstream processes of fermentation industries.

UNIT I **15 hours**

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

UNIT II **15 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 III **15 hours**

Effluent Treatment- Sewage treatment – Primary, secondary and tertiary - dissolved oxygen concentration, strengths of fermentation effluents, Treatment and disposal of effluents, by-products.

UNIT IV **15 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. Computer applications in downstream processing - Introduction, History, General specific applications, System configuration. Product formulation ,monitoring of downstream processing , process integration.

Reference Books:

1. Arnold L. demain& Julian E.Davis. Industrial Microbiology & Biotechnology,ASMPress.(2004).
2. Coulson, J.M. and J.F. Richardson. Chemical Engineering, Pergamon Press. (1984).
3. Mansi& Bryce,C.F.A.Fermentation Microbiology& BiotechnologyTaylor&FrancisLtd. (2004).
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8. "Industrial Microbiology", by A.H Patel, Mac millan India ltd,

PAPER IV ANIMAL AND PLANT CELL BIOPROCESSES

Course Objectives:

1) To make the students conversant with the basic layout and design ,equipment requirements of plant tissue culture laboratory and contamination problems in plant tissue culture and their control and make them trained in the required expertise for working in a commercial plant tissue culture laboratory.

2) To introduce the students about the basics of animal tissue culture techniques, chemically defined and serum free media, techniques of maintenance & preservation of

animal cell cultures & various types of cultures.

3) To give the students thorough knowledge about primary and secondary cell line, safety measures in laminar hood with levels of safety.

Course Outcomes:

1) students will become conversant with the basic layout and design ,equipment requirements

of plant tissue culture laboratory and contamination problems in plant tissue culture and their control

2) students will get trained in the required expertise for working in a commercial plant tissue culture laboratory

3) Students will know about different plant transformation technologies.

4) Student will get introduced to basics of animal tissue culture techniques, media used in Animal cell cultures

5) Students will get conversant with the techniques of maintenance & preservation of animal cell cultures, cell separation methods and cell quantitations.

UNITI **15 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 salts 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.

UNITII **15 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 culture intiation, suspension culture, bioreactors and scale–up. Growth quanification–fresh weight, dry weight, packed cell volume, indirect measurement, viability assays, Regeneration, micropropagation, and transformation. *Agrobacterium* mediated transformation, Virus mediated gene transfer, vectorless or direct gene transfer – Chemical gene transfer methods, Physical gene transfer methods - Transgenic research in India, Biosafety – Definition of GMOs , Advanced informed agreement Procedure (AIA), Labeling and segregation, Commodities, Transit, Pharmaceutical LMOs. The Miami group. Regulatory mechanisms in India. Categories of genetic engineering experiments on plants. Increased crop yield, Tolerance to abiotic stress, Resistance to biotic stress, Better crop characteristics. Other applications – Plant based drugs, Edible vaccines and plantibodies, therapeutic proteins. Genes for novel traits: Production of secondary metabolites, Toxin free castor oil, Low lignin wood for paper production, Transgenic plants as biosensors Introduction, Benefits and important achievements, Horizontal gene transfer, Molecular farming, Green fluorescent protein (GFP)

UNITIII **15 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. Plant secondary metabolites production: cell culture, hairy root culture, Ri plasmid, control mechanism and maintenance of phenyl propanoid pathway, alkaloids, flavonoids, phenols.

UNITIV **15 hours**

Nuclear transplantation, therapeutic transplantation, transfection methods-lipofection, electroporation, microinjection, embryonic stem cell transfer, targeted gene transfer, hybridom a technology and production of monoclonal antibodies, stem cells – embryonic & adult stem cells, and potent uses of human stem cells.

Reference Books:

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2. Bhojwani,S.S.andM.K.Razdan.PlantTissueculture:theoryandpracticearevisededitionElsevierscience.(2004).
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4. Masters, J.R.W. AnimalCellcultureOxfordUniversityPress. (2000).
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6. Springer,T.A.HybridomaTechnologyinBiosciencesandMedicinePlenumPress,NewYork. (1985).
7. Plant tissue culture – Basic and Applied " by Timir Baran Jha and Biswajit Ghosh, 2005, Universities press (India) Pvt. Ltd. Hyderabad.
8. "Plant Biotechnology: Methods in tissue culture and gene transfer", Edited by

R. Keshavachandran and K.V. Peter, 2008, Universities Press, Hyderabad.

PRACTICAL COURSE III

Course Objectives:

1) To make the students perform screening out industrially important microbial strains like organic acid producers, antibiotic producers, protease producers, enzyme producers.

2) To acquaint the students with the determination of BOD and COD removal efficiency of waste water treatment plant

3) To make the students gain the knowledge of working in fermentation industry particularly in production units, micro-labs and Quality Control departments.

Course Outcomes:

1) Students will be able to screen out industrially important microbial strains like organic acid producers, antibiotic producers, protease producers, enzyme producers.

2) Students will be able to determine BOD and COD removal efficiency of waste water treatment plant

3) Students will be able to work in fermentation industry particularly in production units, micro-labs and Quality Control departments.

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. Downstream Processing with an enzyme
6. Beer or Wine Production and Quality Assessment
7. Citric Acid Production and Quantification.
8. Immobilization of cells – Yeast cells and bacterial cells.
9. Production of enzymes – Proteases.
10. Immobilization of enzymes.

Reference Books:

1. ArnoldL.demain& Julian E.Davis. Industrial Microbiology & Biotechnology ASMPress.(2004).
2. Coulson, J.M.andJ.F. RichardsonChemicalEngineering,PergamonPress.(1984).
3. Mansi&CFA.Bryce.FermentationMicrobiology&BiotechnologyTaylor&FrancisLtd. (2004).
4. Stanbury,P.F.,A.Whitaker& S.J.Hall.Principlesoffermentation technologyOxford.(1997).

PRACTICAL COURSE IV

Course Outcomes:

1) Students will be able to understand the setting up and operating a plant tissue culture laboratory.

2) Students will get acquainted with basic hands on skills for in vitro plantlet manipulation in micropropagation techniques.

3) To enable the students with the basic knowledge of safety measures to be taken in while working in ATC laboratory, cell quantification, animal cell culture techniques, establishing primary animal cell lines

Course Objectives:

1) To make the students understand the setting up and operating a plant tissue culture laboratory

2) To make the students get acquainted with basic hands on skills for in vitro plantlet manipulation in micropropagation techniques

3) Students will get basic knowledge of safety measures to be taken in while working in ATC laboratory, cell quantification, animal cell culture techniques, establishing primary animal cell lines

1. Laboratory equipments for plant tissue culture

2. Study of aseptic techniques in plant tissue culture laboratory
3. Preparation of media for plant tissue culture
4. Callus Culture
5. Suspension Culture
6. Micropropogation
7. Isolation of plant DNA using CTAB extraction method.
8. Digested slurry analysis –

i) pH

ii) Total volatile solids.

iii) Total acidity.

iv) Total alkalinity

v) Volatile acid.

vi) Organic carbon.

vii) Phosphoric acid.

Reference Books:

1. Experiment in Microbiology, Plant Pathology and Biotechnology" by K. R. Aneja, First edition, 2003 (Reprint 2008), New age International (p) Limited, Publishers, New Delhi.
2. "Practical Biotechnology" by S. Janarthanan and S. Vincent 2007, Iniversities Press (India) Pvt. Ltd., Hyderabad.
3. "Practical Biotechnology" by P. Ramadass and A. Wilson Aruni, 2007 Jaypee brothers Medical Publishers (P) Ltd., New Delhi.
4. "Plant tissue culture – Basic and Applied" by Timir Baran Jha and Biswajit Ghosh, 2005, Universities press (India) Pvt. Ltd. Hyderabad.

5. "Molecular Biotechnology – Principles and Practices" by Channarayappa, 2007, Universities Press (India) Pvt. Ltd. Hyderabad.

6. Laboratory Manual in "Industrial Biotechnology" by P. Chellapandi, 2000, Pointer Publishers, Jaipur.

7. "Practical Microbiology" by R. C. Dubey and D. K. Maheshwari, 1st edition, 2007,S. Chand and Company Pvt. Ltd., Ramnagar, New Delh