SCHEME OF TEACHING AND EXAMINATION
III SEMESTER

2022-23 Batch

Sl. No	Category	Subject Code	Subject Title	Credits	HOURS/ WEEK			EXAMINATION MARKS		
					L	T	P	CIE	SEE	TOTAL
1.	BSC	22UMA302C	Numerical Techniques and Fourier Series	03	3	0	0	50	50	100
2.	IPCC	22UBT301C	Microbiology	04	3	0	2	50	50	100
3.	IPCC	22UBT305C	Unit Operations	04	3	0	2	50	50	100
4.	PCC	22UBT303C	Biochemistry	03	3	0	0	50	50	100
5.	PCC	22UBT307L	Biochemistry lab	01	0	0	2	50	50	100
6.	INT	22UBT308I	Internship	02	0	0	2	100	-	100
7.	UHV	22UHS324C	Universal Human Values –II	01	2	0	0	50	50	100
8.	HSMC	22UHS322C 22UHS323C	Samskruthika Kannada- Balake Kannada	01	2	0	0	50	50	100
9.	AEC	22UBT306C	Cell Culture Techniques	02	2	0	0	50	50	100
			Total	**21**	**17**	**2**	**8**	**500**	**400**	**900**

22UMA302C	NUMERICAL TECHNIQUES AND FOURIER SERIES	03 - Credits (3 : 0 : 0)
Hours / Week : 03		CIE Marks : 50
Total Hours : 40		SEE Marks : 50

UNIT – 1	10 Hrs.

Numerical Methods-I:

Introduction to root finding problems, Newton-Raphson method. Finite differences, forward and backward difference operators (no derivations on relations between operators) Newton-Gregory forward and backward interpolation formulae. (Without proof), Lagrange's and Newton's divided difference interpolation formulae (without proof) Numerical differentiation using Newton's forward and backward formulae-problems.

UNIT – 2	10 Hrs.

Numerical Methods -II:

Numerical Integration: Simpson's one third rule, Simpson's three eighth rule waddles' (no derivation of any formulae)-problems. Numerical solution of ODE: Taylors, Euler's and Modified Euler's method, Runge-Kutta 4^{th} order method, miles Predictor corrector method.

UNIT – 3	10 Hrs.

Fourier series:

Periodic functions, Conditions for Fourier series expansions, Fourier series expansion of continuous and functions having finite number of discontinuities, even and odd functions. Half-range series, practical harmonic analysis.

UNIT – 4	10 Hrs.

Fourier transforms:

Infinite Fourier transforms and inverse Fourier transforms- simple properties, Fourier sine and Fourier cosine transforms. Inverse Fourier sine and cosine transforms.

REFERENCES

1. Numerical Methods for Engineers by Steven C Chapra &Raymond P Canale.
2. Higher Engineering Mathematics by Dr. B.S. Grewal, Khanna Publishers, New Delhi.
3. Advanced Engineering Mathematics By H. K. Das, S. Chand & company Ltd. Ram Nagar, New Delhi
4. Advanced Engineering Mathematics by E Kreyszig ,John Wiley & Sons**.**

LEARNING OBJECTIVES

1. To understand the numerical methods of solving algebraic and transcendental equations.
2. To acquire the knowledge of interpolation techniques.
3. To understand the basic concepts of numerical differentiation, numerical integration and numerical solution of ordinary differential equations.
4. To understand concepts of Fourier series, and Fourier transforms.

COURSE OUTCOMES
After completion of the course the students shall be able to, 1. Solve engineering problems using non-linear equations and interpolation techniques. 2. Solve problems using numerical differentiation and numerical integration. 3. Solve ordinary differential equations using numerical methods. 4. Solve Problems using the Fourier series. 5. Solve problems using the basic concept of Fourier transforms.

Course Articulation Matrix: Mapping of Course Outcomes (CO) with Programme Outcomes (PO) and Programme Specific Outcomes (PSO)

		PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
No	**Programme Outcomes / Course Outcomes**															
The students will be able to:																
1	Solve engineering problems using non-linear equations and interpolation techniques.	✓	✓													
2	Solve problems using numerical differentiation and numerical integration.	✓	✓													
3	Solve ordinary differential equations using numerical methods.	✓	✓													
4	Solve Problems using the Fourier series.	✓	✓													

5	Solve problems using the basic concept of Fourier transforms.	✓	✓													

22UBT301C	MICROBIOLOGY	Credits: 04 (3: 0: 2)
L: T: P - 3: 0: 2		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction:

Scope of microbiology, History of microbiology-Evolution of microbes. Contributions of Scientist for the development of microbiology. Microbial diversity & taxonomy, Prokaryotes & Eukaryotes. Microscopy: Principles and applications of Bright field microscopy, Dark-Field Microscopy, Phase contrast microscopy, Fluorescence Microscopy and Electron microscopy (SEM & TEM).

UNIT–II	10Hrs.

Microorganisms:

Bacteria- Morphology and ultra structure of Bacteria, Culturing of bacteria, reproduction and growth (continuous and batch).Viruses, fungi, algae, protozoa, actinomycetes- structure and modes of reproduction. Fastidious microorganisms. Microbial toxins. Microbial Techniques: Pure culture techniques- Aerobic and Anaerobic culture techniques. Fermentation (acid & alcohol).

UNIT–III	10 Hrs.

Control of Microorganisms:

Control of microorganisms by Physical methods and chemical methods, antibiotics, chemotherapeutic agents and Phage biotics. Medical Microbiology: Normal microflora, common diseases caused by microbes-pathogenesis, symptoms, diagnosis, treatment, prevention.

UNIT–IV	10 Hrs.

Agricultural and Environmental Microbiology:

Microbiology of soil, Air and Aquatic Microbiology, Bio-fertilizer, Plant endophytes, Microbes in bioremediation and bio-control agents.

Industrial Microbiology: Microbial processes using yeasts and bacteria (production of alcohol, vinegar, cheese), Microbes as source of protein (SCP), gelatin agents (alginate, xanthin, agar agar) Microbial insecticides, Enzymes from Microbes (amylase, protease), Useful products from microorganisms using recombinant DNA technology (vaccines and antibiotics).

REFERENCE BOOKS

1. Pelczar, Chan and Noel Kreig, “Microbiology”- 5th Edition Tata Macgraw Hill, 2010.
2. Tortora, Funke and Case, “Microbiology an Introduction” -8th Edition, Pearson Education, 2006.
3. Stainer R.Y., Ingraham J.L., “General Microbiology”- 5th Edition Mc.Millan Press, 2010.
4. Madigan, Martinko, Parker, Brock’s, “Biology of Microorganisms” - 10th Edition, Prentice Hall, Pearson Education, 2003.
5. Prescot and Dunn, “Industrial Microbiology”-Agribios India, 2002.
6. J. Salle, “Fundamental Principles of Bacteriology” – 7th Edition, Tata Macgraw Hill, 2007.
7. E Alcamo I “Fundamentals of Microbiology”6th Ed, Jones &Bartlet, Pub. 2001.
8. Prescott, Harley & Klein, “Microbiology” -7th Edition, WCB/McGraw Hill, Int. Edition, 2008.

LEARNING OBJECTIVES

- To know the basic concepts of Microbiology, scope and organization of organisms in the taxonomy.
- Ability to understand the techniques to study microorganisms through microscopy.
- Capable to analyse the structure of different microbes and their applications.
- To know the metabolic reactions within the organisms for fermentation process.

COURSE OUTCOMES**

- Ability to know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy
- Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes
- Ability to discuss the causative organisms of the disease and their effect on society
- Ability to analyse the applied techniques in the environment and create awareness to society

LIST OF EXPERIMENTS

1. Study of microscopes: Types, working principle, parts of the microscope, handling (operating) & caring.
2. Media preparation: NA, Peptone broth, PDA, Macconkeys agar.
3. Isolation of bacteria by serial dilution, pour plate ,spread plate and streak plate techniques
4. Isolation and identification of bacteria and fungi from different sources.
5. Study of colony characteristics and Morphology of bacteria, yeasts and fungi.
6. Study of different staining techniques. (Simple staining differential staining)
7. Enumeration of microorganisms using colony counter
8. Fermentation of Carbohydrates (gas production)
9. Growth curve of bacteria and yeast.
10. Antibiotic susceptibility testing of bacteria & Observation of motility by hanging drop technique.

COURSE OUTCOMES

1. Ability to know the basic concepts of Microbiology, scope ,organization and understand the techniques to study microorganisms through microscopy
2. Ability to analyze the structure of different microbes and interpret the techniques used to grow and identify the microbes
3. Ability to discuss the causative organisms of the disease and their effect on society
4. Ability to analyse the applied techniques in the environment and create awareness to society

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	2			2		2					1	1	1
CO 2	2	2	2		2	3		1					2	1	2
CO 3	3	3	2		2	2		1				1	1	1	2
CO 4	3	3	3		2	3		2				1	2	1	3

22UBT305C	UNIT OPERATIONS	Credits: 04
L:T:P – 3:0:2		CIE Marks: 50
Total Hours/Week: 05		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to Fluid Mechanics:

Units and Dimensions, Basic and Derived units, Dimensional homogeneity, Dimensionless numbers, Rayleigh method, Buckingham's pi theorem, Similitude. Fluid definition and classification (Types of fluids – Newtonian and Non Newtonian); Rheological behaviour of fluids. Fluid statics and its applications Hydrostatic equilibrium, Pressure measurement - Manometers.

UNIT–II	10 Hrs.

Flow past Immersed Bodies:

Types of flow - laminar and Turbulent; Reynolds number; Basic equations of fluid flow - Continuity equation and Bernoulli equation; Correction for Bernoulli's equation, Pump work in Bernoulli's equation; Flow through circular and non-circular conduits – Friction factor relations for smooth and commercial pipes.

UNIT–III	10 Hrs.

Flow measurements:

Orifice meter, Venturimeter, Rota meter. Pumps, principle, construction numerical. Major and minor losses, Centrifugal & Reciprocating pumps, Characteristics of centrifugal pumps. Pipes, fittings and valves. Dimensional Analysis.

UNIT–IV	10 Hrs.

Mechanical Operations:

Types of filtration, Filter media and filter aids, calculation of resistances and rate of filtration, filtration equipment. Settling, Free and Hindered, Stoke's law, Newton's law, Terminal settling velocity, Batch sedimentation, Agitation: Theory of mixing, Power number calculations, mixing equipment. Flow patterns in agitated tanks, mechanism of mixing, scale up of mixing systems. Size Separation: Particle shape, size, screen analysis, screening equipment. Size Reduction: Characteristics of comminute products, crushing laws and work index; Size reduction equipment.

LIST OF EXPERIMENTS IN UNIT OPERATIONS LABORATORY

1. Friction in circular and non-circular pipes
2. Flow rate measurement using Orifice meter

3. Flow rate measurement using Venture meter
4. Batch sedimentation test
5. Constant pressure /constant filtration using leaf filter
6. Verification of Stoke's law in Free / Hindered settling
7. Determination of screen effectiveness and sieve analysis
8. Verification of Bernoulli's theorem
9. Unsteady state flow
10. Study of packed bed characteristics
11. Distillation

Reference Books *

1. McCabe WL, Smith JC and Harriott (2005) Unit operations of Chemical Engineering, 7th Edn., McGraw-Hill Publications, USA.
2. Gavhane K. A (2012) Unit Operations I & II, 22nd Edn. Nirali Prakashan, India.
3. Alan S Foust, Wenzel LA, Clump CW, Maus L, and Anderson LB (2008) Principles of Unit Operations. 3rd Edn. John Wiley & Sons, USA.
4. R. P. Chhabra V. Shankar (2017) Coulson and Richardson's Chemical Engineering Volume 1A: Fluid Flow: Fundamentals and Applications. 7th Edition, Elsevier, USA.
5. R.P. Chhabra Basavaraj Gurappa (2019) Coulson and Richardson's Chemical Engineering Volume 2A: Particulate Systems and Particle Technology. 6th Edition, Elsevier, USA.

Course Outcomes**

After completion of the course student will be able to

1. Understand the application of dimensional analysis and can state and describe the nature and properties of the fluids.
2. Apply the knowledge of fluid mechanics in Engineering applications
3. Determine the flow rate, discharge of transportation fluids
4. Apply the knowledge of mechanical operations in Engineering applications

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

** **Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	2	2	2	1	1	-	-	-	-	-	-	-	3		
CO2	3	2	3	2	1	-	-	-	-	-	-	-	3		
CO3	3	2	1	1	1	-	-	-	-	-	-	-	3		
CO4	2	3	3	1	1	-	-	-	-	-	-	-	2		

22UBT303C	BIOCHEMISTRY	Credits: 03
L: T: P - 3: 0: 0		CIE Marks: 50
Total Hours/Week: 42		SEE Marks: 50

UNIT – 1	12 Hrs.
Principles of Bioenergetics: Energy Flow cycle, energy conversion. Structure and properties of ATP, Bioenergetics of metabolic pathway **Carbohydrate Metabolism:** Glycolysis, TCA cycle, Electron transport chain and oxidative phosphorylation and respiration energetics. Calvin Cycle, Glyoxylate cycle, Pentose Phosphate Pathway, Gluconeogenesis and regulation of gluconeogenesis. Disorders of carbohydrate metabolism- Galactosemia, Lactose intolerance, Glycogen storage disorder etc. (Defective enzyme lead to disorder during metabolism). Osazone formation to identify the carbohydrates.	
UNIT – 2	**10 Hrs.**
Lipid Metabolism: Biosynthesis of fatty acids. cholesterol, phospholipids and glycolipids, Regulation of fatty acid biosynthesis, biodegradation of fatty acid, ketone bodies production during starving and diabetes. Disorders of lipid metabolism- Sphingolipidoses etc.	
UNIT – 3	**10 Hrs.**
Nucleic acid Metabolism: Biosynthesis of purines - origin of ring atoms, formation of IMP, conversion of IMP to AMP and GMP.De novo synthesis of pyrimidine nucleotides - biosynthesis of UTP & CTP. Biodegradation of purines&pyrimidines. Recycling of Purine and Pyrimidine nucleotides by salvage pathways.Disorders of nucleic acid metabolism-Lesch-Nyhan Syndrome and Gout	
UNIT – 4	**10 Hrs.**
Amino Acid Metabolism: Biosynthesis of amino acids starting from acetyl CoA (with reference to oxaloacetate family)-Aspartate, Asparagine, Methionine, Lysine, Threonine.Biodegradation of amino acids-deamination, transamination and urea cycle.Disorders of amino acid metabolism-Phenylketonuria, Albinism, Maple Syrup Urine Disease, Tyrosinemia.	

REFERENCES

1. David L. Nelson and Michael Cox, "Lehninger Principles of Biochemistry" –6th Edition LubertStryer, "Biochemistry" -Freeman & Co., Pub, 2010.
2. Voet&Voet, "Biochemistry"- 3rd Edition, John Wiley,New York Pub., 2004.
3. Thomas M. Davlins" Biochemistry with clinical correlations" Wiley-Liss; 5 edition, 2001.
4. Mathews, Vanholde&Arhen "Biochemistry" -3rd Edition, Pearson Education Pub., 3 edition 2010.
5. K. Trehan, "Biochemistry" -New Age International Pub, 2nd edition, 2003
6. Elliot & William H, "Biochemistry & Molecular Biology" Oxford Pub., 2005.
7. Helmreich JEM, "Biochemistry of cell signaling" –Oxford Pub. 2005.
8. U. Sathyanarayana, "Biochemistry" -Books and Allied Pub, 2007
9. Berg J.M., Stryer, Tymoczko J.L. "Biochemistry" Freeman & co 2010.
10. Freifelder D. "Molecular Biology" -Narosa Publications, 2nd Edition 2003.

LEARNING OBJECTIVES

- To understand the principles of bioenergetics.
- To study metabolic pathway reactions and analysis of metabolic disorders.
- To study the experimental identification of biomolecules.

LIST OF EXPERIMENTS

COURSE OUTCOMES

1. Ability to understand the principles of high energy compounds & interpret the metabolic pathways in the carbohydrates and their disorders
2. Ability to recognize the regulation of lipid metabolism along with the in born errors.
3. Ability to understand the origin of atoms in purine and pyrimidine & also interpret the pathways in the nucleic acid metabolism disorders
4. Ability to comprehend pathways involved in amino acid metabolism and its disorders

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	2	3	2			3	3				3	2	3	
CO 2	2	3	3	3		3	2	3				3	2	1	2
CO 3	2	2	3	3		3	2	2				3	3	2	
CO 4	2	2	2	2		2	2	2				2	2	2	

SUBJECT CODE:22UBT307L	BIOCHEMISTRY LABORATORY	Credits: 02
L: T: P - 0: 0:2		CIE Marks: 50
Total Hours/Week: 42		SEE Marks: 50

LIST OF EXPERIMENTS **12 Hrs.**

1. pH measurements, volume / weight measurements, concentration units, Specificity, precision, Accuracy.
2. Classes of carbohydrates, lipids and proteins.
3. Reagent preparation and preparation of buffers of constant strength.
4. Qualitative tests for carbohydrate and lipids.
5. Qualitative tests for amino acids and proteins.
6. Estimation of sugar by Folin and O-toluene method.
7. Estimation of amino acid and protein by ninhydrin method
8. Determination of Saponification value of lipids.
9. Determination of Iodine value of lipid.
10. Determination of acetyl value of a lipid.
11. Estimation of urea by diacetylmonooxime method.

REFERENCES

1. Rodney Boyer, “Modern Experimental Biochemistry”-Pearson Education Pub, (2000).
2. Keith Wilson, “Practical Biochemistry” Cambridge University Pub, (2003).
3. Pattabhiraman, “Practical Biochemistry”
4. BeeduSashidharRao and Vijay Deshpande, “Experimental Biochemistry” -I.K.Intl
5. Plummer D. T “Practical Biochemistry” -TMH Pub., 1988

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Ability to understand the basic aspects of standard reagent & buffer preparations.
2. Ability to identify various biomolecules qualitatively.
3. Ability to estimate the concentration of carbohydrates in a given sample
4. Ability to evaluate the concentration of amino acid quantitatively.
5. Ability to analyze the types of lipids.
6. Ability to apply knowledge of acid & iodine value to determine the quality of lipids.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	2	3	2			3	3				3	2	3	1
CO 2	2	3	3	2			2	3				3	2	3	1
CO 3	2	3	3	3		3	2	2				2	2	1	2
CO 4	3	3	3	2		2	2	2				2	3	1	1
CO 5	2	2	2	2		1	2	2				3	3	2	1
CO 6	2	2	3	3		3		3				2	3	2	1

SUBJECT CODE:22UBT306C	CELL CULTURE TECHNIQUES	Credits: 02
L: T: P - 2: 0: 0		CIE Marks: 50
Total Hours/Week: 26		SEE Marks: 50

UNIT – 1	8 Hrs.
Plant cell culture: History and introduction, requirements, lab organisation, media constituents, choice of media sterilization of media, explant selection, sterilisation and preparation for inoculation, role of growth hormones in cell culture.Cellular totipotency, cytodifferentition, organogenic differentiation, somatic embryogenesis. Plant growth hormones - auxins, gibberlins, cytokinins. Stoichometry of cell growth and product formation.	
UNIT – 2	**6 Hrs.**
Culture techniques and applications: Protoplast culture, somatic hybridization, haploid production, micro propagation,somaclonal variation, crop improvement, hairy root culture, synthetic seeds. Regeneration of plantlets-shooting, rooting and hardening.	
UNIT – 3	**6 Hrs.**
Animal cell culture Techniques History and development of mammalian cell culture. lab layout and equipments, cell culture media (Natural and Artificial) - components of the medium, functions of media components. Role of antibiotics in media. Types of primary culture, establishment of primary culture, cell lines – mechanical and enzymatic mode of desegregation. Subculture - passage number, split ratio, seeding efficiency, criteria for subculture.	
UNIT – 4	**6 Hrs.**
Cell line Characterization and Maintenance Measurement of Cell viability and Cytotoxicity assay –MTT, LDH dehydrogenase, . Dye exclusion and inclusion tests, clonogenic assay. Characterization. Cell line contaminations, detection and control. Stem cells & their applications	

REFERENCES

1. Culture of Animal cells-3rdEdition-R.IanFreshney.Wiley Less, 2010
2. Introduction to Plant biotechnology by H. S. Chawla, 2nd Edition, Oxford and IBH Publishers, 2010
3. Biotech Expanding Horizons-B. D. Singh, Kalyani Publishers,2010.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts and Peter Walter Molecular biology of The Cell, GS publishers,2002

LEARNING OBJECTIVES

1. To use the plant cells to produce in vitro cultures
2. To comprehend the applications of plant tissue culture techniques in various fields
3. To acquire working knowledge of culture of animal cells in *in vitro* conditions.
4. To identify, describe and classify the contaminants of cell culture and preservation techniques

COURSE OUTCOMES
1. To use the plant cells to produce in vitro cultures 2. To comprehend the applications of plant tissue culture techniques in various fields 3. To acquire working knowledge of culture of animal cells in *in vitro* conditions. 4. To identify, and classify the cell culture techniques

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**PSO1**	**PSO2**	**PSO3**
CO 1	3												1	1	1
CO 2	1				3									2	2
CO 3	1				3			1			1		3	3	
CO 4	3				3									3	

V-Semester-2022-23

SI No	Subject Code	Subject Name	Credits	Hours			Examination Marks		
				L	T	P	CIE	SEE	Total
1	22UBT516C	Bioprocess & Reaction Engineering	3	3	0	0	50	50	100
2	22UBT519C	Genetic Engineering & Applications	3	3	0	0	50	50	100
3	22UBT520C	Fundamentals of Bioinformatics	3	2	2	0	50	50	100
4	22UBT52XE	Elective-I	3	3	0	0	50	50	100
5	22UBT506H	Industrial Safety and Bioethics	3	3	0	0	50	50	100
6	22UBT514L	Bioinformatics Lab	1	0	0	2	50	50	100
7	22UBT515L	Genetic Engineering Lab	1	0	0	2	50	50	100
8	22UCS559L	Advanced C Programming Lab	2	0	0	2	50	50	100
9	22UHS002N	Advance Quantitative Aptitude and Soft Skills	1	2	0	0	50	50	100
10	22UXX5XXN	Open Elective-I	3	3	0	0	50	50	100
		Total	**23**	**19**	**2**	**6**	**500**	**500**	**1000**

Elective-I

UBT521E: Environmental BT

UBT522E: Biomedical Instrumentation

UBT525E: Stem cell technology

UBT527E: Nutraceuticals

Subject Code: 22UBT516C	BIOPROCESS & REACTION ENGINEERING	Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.
Kinetics of Homogeneous reactions Basic Concepts of Bioreactor and bioprocess engineering, Concentration dependent term of a rate equation. Rate Constant. Representation of elementary reaction and Non elementary reactions, Kinetic Models of Non elementary Reactions, Testing Kinetic Models. Temperature-dependent term of a rate equation: Temperature dependency from Arrhenius law, Collision theory, Transition state theory, Thermodynamic approach, Activation Energy.	
UNIT–II	**10Hrs.**
Interpretation of Batch Bioreactor Data Constant volume batch reactor, Integral method of analysis of data -first order, second order, zero order reactions, fractional life, homogenous catalyzed reactions, irreversible reaction in series, irreversible reactions in parallel, reactions of shifting order, autocatalytic reactions, reversible reactions, differential method of analysis of data and numerical.	
UNIT–III	**10 Hrs.**
Introduction to Reaction Design Introduction. Factors to be consider for designing a reactor, Types of reactors, Basic design equation, relation between Concentration and conversion, Performance equation for ideal batch reactor, MFR/CSTR and PFR, space time and space velocity for flow reactors, design of flow reactors and numerical.	
UNIT–IV	**10 Hrs.**
Design for single reactions Introduction .Size comparison of single reactors, multiple reactors CSTR in series /MFR in series, CSTR in parallel .PFR in series, in parallel, Reactors of different types in series, and numerical.	

REFERENCE BOOKS

1. Scott Fogler, H (2016) Elements of Chemical Reaction Engineering, 6th edn., Prentice Hall India Pvt. Ltd.
2. Levenspiel O (2006) Chemical Reaction Engineering, Wiley Eastern, 3rd edn, New Delhi.
3. Kargi and Shuler (2015) Bioprocess Engineering. 3nd edn., Prentice Hall PTR.
4. BaileyJE and Ollis DF (2010) Biochemical Engineering Fundamentals, 2nd edn. Mc Graw- Hill.
5. Charles D. Holland (1990) Fundamentals of Chemical Reaction Engineering, John Wiley and Sons.
6. Pauline M Doran., Bioprocess Engineering Principles, 2nd Edition, Academic Press, USA, 2013.
7. Tapobrata Panda., Bioreactors: Analysis and Design, 1st Edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.

LEARNING OBJECTIVES

1	To Understand the basic concept of reaction engineering
2	To calculate the order and rate of reaction
3	To categorize the batch reactor data for different reactions
4	To decide the suitable bioreactor for different reactor
5	To Demonstrate the RTD to calculate the conversion
6	To Evaluate the bioreactor for various purposes

COURSE OUTCOMES

1. Understand the basic concept of reaction engineering.
2. Predict the order and rate of the different reactions.
3. Analyze the batch bioreactor data for different reactions.
4. Design the suitable bioreactor for different biochemical reactions.
5. Predict the residence time distribution to determine the conversion in non ideal flow reactors
6. Analyze bioreactors for various cell cultures.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	3	2	2	2							1	2		
CO 2	3	2	2	2	1							1	2		
CO 3	2	3	2	1	2							1	2		
CO 4	2	3	3	2	1							1	2		
CO 5	3	1	2	1	2							1	2		
CO 6	2	2	2	2	1							1	2		

Subject Code:22UBT519C	GENETIC ENGINEERING & APPLICATIONS	Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction

Tools of genetic engineering- vectors in recombinant DNA technology, biology and salient features of vectors, Types of vectors - plasmids, cosmids, bacteriophage lambda vectors.

Enzymes in genetic engineering:

Introduction- Restriction Endonucleases-classification, mode of action, applications. Enzymes used in nucleic acid modification – Alkaline phosphatase, polynucleotide Kinase, Ligases, terminal deoxy nucleotidyl transferase

UNIT–II	10Hrs.

Nucleic acid hybridization and amplification

Methods of nucleic acid detection, Fluorescent In situ hybridization (FISH), colony hybridization, polymerase chain reaction (PCR), its types and applications, methods of nucleic acid hybridization, Southern, Western and Northern hybridization techniques.

Construction of cDNA libraries:

Construction of Complementary DNA (cDNA), genomic DNA libraries and cDNA libraries.

UNIT–III	10 Hrs.

Gene transfer techniques

Gene transfer techniques in plants, animals and microbes –Transformation, microinjection, electroporation, microprojectile system, and liposome mediated transfer, embryonic stem cell method. Agrobacterium-mediated gene transfer in plants – Ti & Ri Plasmid: structure and functions, Ti based vectors- Binary vectors and Cointegrate vectors.

Transgenic science and genetic improvement:

Transgenic science in plant improvement, Antisense RNA technology (Flavr savr tomatoes). Application of plant transformation for productivity and performance – Herbicide resistance - glyphosate. insect resistance - Bt genes(*Bacillus thuringiensis* and its mode of action), Cry proteins – mechanism of action.

UNIT–IV	10 Hrs.

Gene therapy

Introduction, Methods of Gene therapy-gene targeting, gene augmentation, assisted killing, prodrug therapy and gene silencing. Gene therapy in the treatment of cancer, SCID, muscular dystrophy. Use of thrombolytic agents in blood clotting. Challenges in gene therapy.

Applications:

Engineering microbes for the production of Insulin, growth hormones, monoclonal antibodies.

REFERENCE BOOKS

1. Molecular Biotechnology, Principles and applications of Recombinant DNA by Bernard R Glick and Jack J Pasternak, second edition, CBS Publishers, 2012.
2. Recombinant DNA by Watson, et al., second edition, Freeman Publishers 2010.
3. Principles of gene manipulation, Primrose S.B., Blackwell Scientific Publications, 2010.

4. From Genetics to Gene Therapy – the molecular pathology of human disease by David S Latchman, BIOS scientific publishers, 2010.
5. Biotechnology Expanding Horizon, B.D.Singh, 3rd revised edition, Kalyani Publishers,2010
6. NPTEL Source material

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Emphasize on the basic aspects of genetic engineering; the key areas and apply the knowledge in vectors used in genetic engineering experiments.
2. Apply the properties of various enzymes and vectors in gene and genome manipulation.
3. Acquire working knowledge on the mechanism of methods of nucleic acid detection, hybridization and amplification and their applications in the research.
4. Acquire working knowledge on the construction of genomic and cDNA libraries their applications in the research and biology of *Bacillus thuringiensis*.
5. Identify the various gene transfer techniques in plants, animals and microbes that are essential for controlled protein production in the industry and acquire knowledge on various strategies of Gene therapy and its application in therapeutics.
6. Identify and apply the current applications and advances of biotechnology and describe the steps involved in the production of biopharmaceuticals in microbial systems and industrial utilization.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	1	1	1	2						1		2	1	2	3
CO 2	1			2	3							2	1	2	3
CO 3		1		2								2	1	2	1
CO 4		1		2								2	1	2	1
CO 5		1	1	2	3	3		3				2	1	2	1
CO 6		1	1	2	3	2	2	3				2	1	2	1

Subject Code:22UBT520C	FUNDAMENTALS OF BIOINFORMATICS	Credits: (2: 2: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	12 Hrs.
Introduction to Bioinformatics and Biological Database Introduction to bioinformatics, Components of bioinformatics and interdisciplinary nature of bioinformatics, Classification of biological databases; Primary database: NCBI, GenBank, DDBJ and EMBL, PIR, Uniprot; Secondary databases: PROSITE, PRINTS, BLOCKS and Pfam; Structure databases: Protein Data Bank (PDB), MMDB, CATH, SCOP; Specialized databases: PubMed, OMIM, Metabolic Pathway-KEGG;ExPasy and PubChem databases, File format: GenBank flat file, PDB flat file. Tutorials: Practices on other primary and secondary databases	
UNIT–II	**10 Hrs.**
Sequence alignment and database searches: Introduction, Types of sequence alignment, Comparison between global and local alignment, Pairwise sequence alignment: Dot matrix analysis, Dynamic programming, Global alignment-Needleman-Wunch algorithm, Local Alignment-Smith & Waterman algorithm, Substitution matrix- BLOSUM and PAM; GAP Penalty; Low complexity regions;Word/k-tuple method- BLAST, FASTA. Multiple Sequence Alignment:Introduction, applications of MSA; Types of MSA: Progressive method of MSA-Clustal W; Iterative method of MSA; Motifs and Patterns; Statistical models of MSA-Position Specific Scoring Matrix (PSSM) and Profiles. Tutorials: Solving problems on pairwise sequence alignment	
UNIT–III	**10 Hrs.**
Phylogenetic analysis and predictive methods using sequences Introduction, concepts of trees, types of evolutionary trees, Rooted and unrooted trees, Steps in constructing phylogenetic trees,Tree building methods - Distance based methods: Neighbor Joining (NJ) method, Fitch-Margoliash (FM) method; Character based method: Maximum parsimony; Tree Evaluation methods, Phylogenetic Softwares. Predictive Methods using sequences: Structure of Prokaryote and Eukaryote genes; Algorithms for Prokaryotic and Eukaryotic gene prediction, Web based tools for gene prediction (ORF finder, GenScan).Protein Secondary Structure Prediction, Tertiary Structure Predictions: Homology modelling. Tutorials: Practices on prediction of phylogenetic trees	

UNIT–IV	10 Hrs.

Plasmid mapping and primer designing &molecular modelling techniques

Restriction mapping, Web based tools: Restriction Mapper and REBASE. Utilities of Mac Vector and Vector NTI; Basics of Primer designing, Primer design softwares (PRIME3). Rational Approaches in Drug Design, molecular docking, deriving the Pharmacophoric Pattern, quantitative structure-activity relationship (QSAR), deriving bioactive conformations, Calculation of Molecular Properties,Dockingsoftwares (AUTODOCK, HEX)

Tutorials: Solving problems related to Restriction mapping and Primer designing

Reference Books *

1. Introduction to Bioinformatics – Arthur Lesk, Oxford, 2nd Edition,2006.
2. Bioinformatics – Stuart M Brown, NYU Medical Center, NY USA. 2000.
3. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006.
4. Computational methods for macromolecular sequence analysis – R F Doolittle. Academic Press, 1996.

Course Outcomes**

After completion of the course student will be able to

1. Importance of databases involved in bioinformatics along with their file formats
2. Will have idea on searching similar sequences in databases and find similarity between given set of sequences
3. Derive evolutionary relationship between genes and proteins by phylo-genetic analysis
4. Explain various statistical tools involved in predicting the structure of genes and proteins
5. The principle behind restriction mapping and primer designing
6. Different approaches involved in silico drug design

* **Books to be listed as per the format with decreasing level of coverage of syllabus**

** **Each CO to be written with proper action word and should be assessable and quantifiable**

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	1	2	2				3	2	2	3
CO 2	3	2	2	2	2	1	2	-				3	2	2	3
CO 3	3	2	-	1	-	-	2	-				3	2	2	3
CO 4	2	2	-	1	-	2	-	-				3	1	-	2

CO 5	2	2	2	1	-	2	-	2				1	2	-	2
CO 6	2	1	2	2	2	2	1	1				1	1	1	1

Subject Code:UBT527E	NUTRACEUTICALS	3 Credits: (3-0-0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to Nutraceutical and dietetics

Organizational elements, classification of nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutraceuticals. Scope involved in the industry, Indian and global scenario. Recommended dietary intake (RDA), acceptable dietary intake, nitrogen balance, protein efficiency ratio, net protein utilisation. Basics of energy balance - Basal Metabolic Rate (BMR), Body Mass Index (BMI) and Standard Dynamic Action (SDA) with special reference to nutraceutical industry.

UNIT–II	10Hrs.

Nutrition related diseases and disorders

Carbohydrates, Protein, amino acids, Fat, vitamins and minerals - Excess and deficiency, symptoms, prevention and management.Role of nutraceuticals with special reference to diabetes mellitus, hypertension, hypercholesterolemia, cancer, glands in the prevention and treatment. Concept of antioxidants - use of antioxidants as dietary supplements in prevention and treatment of cancer, obesity and stress.Role of nutraceuticals and functional foods in pediatrics, geriatrics, sports, pregnancy and lactation.

UNIT–III	10 Hrs.

Nutraceuticals of microbial, plant and animal origin

Concept of prebiotics and probiotics - principle, mechanism, production and technology involved, applications - examples of bacteria used as probiotics, use of prebiotics in maintaining the useful microflora - extraction from plant sources. Synbiotics for maintaining good health.Algae as source of omega - 3 fatty acids, antioxidants and minerals - extraction and enrichment. Plant secondary metabolites, classification and sub-classification - Alkaloids, phenols, Terpenoids. Animal metabolites - Sources and extraction of nutraceuticals of animal origin. Examples: chitin, chitosan, glucosamine, chondroitin sulphate and other polysaccharides

UNIT–IV	10 Hrs.

Biotechnology in Phytonutraceuticals

Role of medicinal and aromatic plants in nutraceutical industry – propagation - conventional and tissue culture, cultivation, post harvest technology and strategies for crop improvement, development of high yielding lines and yield enhancement, plant genomics and metabolomics. Biofortification and nutritional enhancement.GM foods with enhanced nutraceutical properties.Golden rice, GM Tomatoes

REFERENCE BOOKS

6. Israel Goldberg (Ed.) (1999) Functional foods, designer foods, pharma foods, Nutraceuticals, Aspen publishers Inc., USA.
7. L. Rapport and B. Lockwood,Nutraceuticals, Pharmaceutical Press.,2nd Edition,2002.
8. M. Maffei ,Dietary Supplements of Plant Origin, Taylor & Francis,1 st Edition,2003.

9. Shahidi and Weerasinghe, Nutraceutical beverages Chemistry, Nutrition and health Effects, American Chemical Society,1 st Edition, 2004.
10. Richard Neeser& J. Bruce German (2004) Bioprocesses and Biotechnology for Functional Foods and Nutraceuticals, Jean, Marcel Dekker, Inc.
11. TimothtS. Tracy, Richard L. Kingston, Herbal Products 2nd Edition, 2007.

LEARNING OBJECTIVES

COURSE OUTCOMES

1. To be aware of basic concepts of nutraceuticals and nutrition.
2. To have a general idea of scope of nutraceuticals and functional foods.
3. To have brief idea about nutrition related health disorders and the role of Nutraceuticals.
4. To classify nutraceuticals and the role of nutraceuticals among different age groups.
5. To learn about the basic aspects of nutraceuticals derived from microbial, plant and animal origin.
6. To know about the role of biotechnology in production of plant secondary metabolites

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3	2	-	-	2	1	2	2				3	2	2	3
CO 2	3	2	2	2	2	1	2	-				3	2	2	3
CO 3	3	2	-	1	-	-	2	-				3	2	2	3
CO 4	2	2	-	1	-	2	-	-				3	1	-	2
CO 5	2	2	2	1	-	2	-	2				1	2	-	2
CO 6	2	1	2	2	2	2	1	1				1	1	1	1

Subject Code:22UBT506H	INDUSTRIAL SAFETY & BIOETHICS	Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction to Bioethics & Biosafety:

Definition and scope of bioethics and biosafety, Ethical implications and need for biosafety, Legal and Socio-Economic impacts of Biotechnology. Convention on biological weapons. Bioterrorism-classification of biological agents with examples.

Biosafety regulation guidelines

Recombinant DNA Advisory Committee (RDAC) ,Institutional Biosafety committee(IBC),Review Committee on Genetic Modification (RCGM),Genetic Engineering Approval Committee(GEAC), Biosafety guidelines- national guidelines, Cartagena Protocol on Biosafety.

UNIT–II	10Hrs.

Biosafety Regulation:

Genetically modified organisms and their release in environment, Laboratory associated infections and other hazards, Good Lab Practices and Good Manufacturing Process (GLP &GMP). Biosafety levels for microorganismBL1,BL2,BL3,BL4) plants (BL1-P,BL2-P,BL3-P,BL4-P) animals (BL1-N,BL2-N,BL3-N,BL4-N).

Risk assessment during laboratory research and risk groups. Recombinant organisms and transgenic crops. Guideline for labeling GM crops. Containments; Physical, Biological. Field trial methods using transgenic plants.

UNIT–III	10 Hrs.

Food and Pharma safety:

Biosafety assessment procedures for biotech foods and Pharma products. Procedure to apply patent, Copy right, Plant Breeder's Right, Environmental aspects of biotech applications. Special application of patent laws in biotechnology and case studies. Flavr Savr Tomato as model case, case studies of relevance (Eg. Bt cotton, Bt brinjal). Licensing and cross licensing.

UNIT–IV	10 Hrs.

Industrial safety

Need for safety, importance of occupational safety, Health and safety programs, Safe and unsafe conditions.

Accidents: Accident preventive measure, Measurement and control of safety performance, 5E's for accident prevention Safety policy

Fire: Fire extinguishers and fire exits, extinguishing agents.

Importance of safety in food and Pharma industry. Food safety, Biological, chemical and Physical Hazards-HAACP system, Pharma safety. Food and safety act. Injuries by industrial sector

REFERENCE BOOKS

1. Sateesh M.K.(2012),Bioethics and Biosafety, I.K.International Publication
2. Singh B.D.(2010), Biotechnology Expanding Horizon (3rd revised edition), Kalyani Publishers.
3. Goel D and Parashar S (2010), IPR-Biosafety and Bioethics (2nd edition), Pearson Education India

Publishers..

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Interpret ethical issues connected with BT and biosafety guidelines.
2. Use GLP and GMP at work place.
3. Identify biosafety assessment procedures and patent laws.
1. Use the safety measures at work place.

Course Outcomes	Programme Outcomes (POs)												Program Specific Outcomes (PSOs)		
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO1	-	2	1	-	-	3	-	3	-	-	-	-	-	-	3
CO2	-	-	-	1	2	3	-	-	-	-	-	1	-	2	-
CO3	1	-	2	-	-	3	-	-	-	-	-	1	-	2	3
CO4	-	1	-	2	-	3	-	-	1	-	-	-	-	-	2

Subject Code:22UBT521E	ENVIRONMENTAL BT	Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.
Microorganisms Issues and scope of Environmental BT. Characteristics of soil, microbial flora of soil, interactions among soil microorganisms, biogeochemical role of soil microorganisms. **Bioaccumulation of Toxicants** Characteristics of Xenobiotics, Relationship of Bioaccumulation with Chemical Structure, Ecophysiology of Bioaccumulation, Process of toxicants uptake, Factors affecting bioaccumulation, measurement of bioaccumulation.	
UNIT–II	**12Hrs.**
Biological Treatment of Wastewater Waste water characteristics BOD, COD, Primary & Secondary treatment, nano-filtration, ulta-filration and microfiltration. Microbial removal of phosphorous and Nitrogen, Nutrient removal by Biomass production Wastewater treatment of food processing industries like sugar factories, vegetable oil industries, potato processing industries, dairy industries, beverages industries, and distilleries. **Solid Waste Management** Basic aspects, general composition of urban solid wastes, aerobic treatment, anaerobic treatment, biogas generation; Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, MoEF rules	
UNIT–III	**10 Hrs.**
Bioleaching & Biomining Microbes in Bioleaching- types, methods of bioleaching, Microbial recovery of metal, phosphate, petroleum. **Bioremediation** Major contaminants of air, water and soil, Biomonitors of environment (Bioindicators), Bioremediation using microbes, Phytoremediation, Biofilms its applications. Bio-stimulation of Naturally occurring microbial activities, Bio-augmentation.	
UNIT–IV	**10 Hrs.**
Biotechnology in Biodiversity Conservation Value of biodiversity, threats to biodiversity, Biosphere reserves and Ecosystem Conservation, Approaches to Bioresource conservation programme, Biotechnological processes for bioresource assessment, BT in ex situ conservation of Biodiversity, BT and its role in utilization of Biodiversity, International initiatives for biodiversity management.	
REFERENCE BOOKS	

1. Environmental Biotechnology by Pradipta Kumar Mahopatra.
2. Text book of microbiology by R C Dubey and D K Maheshwari
3. Environmental Biotechnology by Foster C.F., John ware D.A., Ellis Horwood Limited,1987.
4. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom (1992), RIT,.
5. Comprehensive Biotechnology Vol. 1- 4 : M.Y. Young (Eds.), Pergamon Press.
6. Industrial Microbiology : L.E. Casida, Willey Eastern Ltd., 1989.
7. Industrial Microbiology : Prescott & Dunn, CBS Publishers, 1987.
8. Biotechnology, Economic & Social Aspects : E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge.

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Understand issues and scope of Environmental BT and concepts of Bioaccumulation.
2. Develop different treatment methods for waste water by using BT approach.
3. Develop different treatment methods for solid waste by using BT approach.
4. Apply the knowledge of bioleaching for metal recovery and bioremediation processes to remove environmental contaminants.
5. Understand the Value of biodiversity and threats to biodiversity.
6. Apply the knowledge of BT in biodiversity conservation.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	3	2	2				2		3		1	2	3	1
CO 2	2	3	2	1				1	2				3	3	1
CO 3	2	3	2	1				1	2				3	3	1
CO 4	1	3	2	3				2	2	3			2	3	
CO 5								2		3		3			
CO 6	1	3	2	2					2	2			1	3	

22UBT514L	**BIOINFORMATICS LABORATORY**	**Credits: (0: 0: 2)**
L: T: P – 0-0- 1		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

LIST OF EXPERIMENTS

1. Bibliographic search from PUBMED, SCIRUS and MEDMINER
2. Sequence retrieval from Nucleic acid and Protein databases.
3. Sequence searches using BLAST – Retrieval of homologs, paralogs, orthologs, and Xenologs
4. Pair wise comparison of sequences – Analysis of parameters affecting alignment.
5. Multiple alignments of sequences and pattern determination using PROSITE
6. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees.
7. Identification of functional sites in Genes / Genomes.
8. Secondary structure prediction of proteins and comparison with PDB.
9. Restriction mapping: Analysis of maps for suitable molecular biology experiment.
10. Primer Design: Factors affecting primer design.
11. PDB structure retrieval and visualization: Analysis of homologous structures.
12. Determination of ligand-protein interactions using SPDBV/ LIGPLOT
13. Superposition of structures – Calculation of RMSD.
14. Docking studies – Analysis of substrate / ligand binding using homologous structures.

REFERENCE BOOKS

1. Bioinformatics – Andreas D Boxevanis. Wiley Interscience, 1998.
2. Bioinformatics – David W Mount, cold spring harbor, 2001.
3. Bioinformatics – A biologists guide to biocomputing and the internet. Stuart M brown,
4. Fundamental Concepts of Bioinformatics – D E Krane & M L Raymer, Pearson, 2006.
5. Computational methods in Molecular Biology – S.L.Salzberg, D B Searls, S Kasif, Elsevier, 1998.
6. Bioinformatics – methods and applications: Genomics, proteomics and drug Discovery – s c Rastogi, N. mendiratta & prastogi, phi, 2006.

COURSE OUTCOMES

1. Ability to Search literature and sequence databases
2. Ability to retrieve and search sequences from databases
3. Ability to align pair wise and multiple sequences
4. Ability to identify evolutionary and relationships and functional sites in genomes
5. Ability to evaluate primer designing and restriction mapping
6. Ability to docking and superimpose the structures

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	PSO1	PSO2	PSO3
CO 1	**3**	**3**	**3**	**-**	**3**	**1**	**-**	**3**				**3**	3	**3**	**1**
CO 2	**3**	**3**	**3**	**-**	**3**	**1**	**-**	**-**				**3**	2	3	1

CO 3	**3**	**3**	**2**	**2**	**3**	**1**	**1**	**-**				**3**	**3**	**3**	1
CO 4	**3**	**3**	**2**	**-**	**3**	**-**	**1**	**-**				**3**	**2**	**3**	**2**
CO 5	**3**	**3**	**2**	**1**	**3**	**1**	**-**	**2**				**3**	**3**	**3**	**2**
CO 6	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**1**				**3**	**2**	**3**	**1**

22UBT515L	**GENETIC ENGINEERING LABORATORY**	**Credits: (0: 0: 2)**
L: T: P – 0-0- 1		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

LIST OF EXPERIMENTS

1. Transformation.-
2. Blue white colony screening.
3. Thermal denaturation of DNA.
4. Restriction Digestion.
5. Ligation Experiment.
6. Southern Blotting – Agarose Gel Electrophoresis
7. Electroblotting and analysis.
8. SOP for PCR
9. SOP for Gel Documentation
10. SOP for UV-Spectrophotometer
11. SOP for Lyophilizer
12. PCR (Amplification with specific primers)

REFERENCE BOOKS

1. Sadashiva and Manickam, “Biochemical Methods”, 2nd Edition, New age international Publishers,2017.
2. Sambrook & Russell, “Molecular Cloning”, Cold Spring Harber Lab, 3rd Edition, 2002.
3. Current protocols in molecular biology-Greena Publishing Associates, NY, 1988

COURSE OUTCOMES

1. To demonstrate proficiency in Transformation and screening of transformants.
2. To apply the knowledge of thermal denaturation to calculate Tm value.
3. To evaluate the functions of restriction digestion and Ligation on DNA.
4. To demonstrate proficiency in Electro-blotting and detection.
5. To demonstrate understanding of SOP and PCR.
6. To gain knowledge in common and advanced laboratory practices in Genetic engineering lab.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	PSO1	PSO2	PSO3
CO 1	**3**	**3**	**3**	**-**	**3**	**1**	**-**	**3**				**3**	3	**3**	**1**
CO 2	**3**	**3**	**3**	**-**	**3**	**1**	**-**	**-**				**3**	2	3	1

CO 3	**3**	**3**	**2**	**2**	**3**	**1**	**1**	**-**				**3**	**3**	**3**	1
CO 4	**3**	**3**	**2**	**-**	**3**	**-**	**1**	**-**				**3**	**2**	**3**	**2**
CO 5	**3**	**3**	**2**	**1**	**3**	**1**	**-**	**2**				**3**	**3**	**3**	**2**
CO 6	**3**	**3**	**3**	**2**	**3**	**1**	**-**	**1**				**3**	**2**	**3**	**1**

VII-Semester -2022-23

Sl. No	Subject Code	Subject Name	Credits	Hours			Examination Marks		
				L	T	P	CIE	SEE	Total
1	UBT704C	Economics and Plant Design	3	3	0	0	50	50	100
2	UBT715C	Downstream Processing Technology	3	2	2	0	50	50	100
3	UBT72XE	Elective- 4	3	3	0	0	50	50	100
4	UBT73XE	Elective-5	3	3	0	0	50	50	100
5	UBT716H	Industrial Management and Entrepreneurship	3	3	0	0	50	50	100
6	UXX7XXN	Open Elective-3	3	3	0	0	50	50	100
7	UBT711I	Industrial Internship	2	0	0	4	50	50	100
8	UBT710L	Bioseparation Techniques Lab	1	0	0	2	50	50	100
9	UBT701T	Technical Seminar	1	2	0	0	50	50	100
		Total	**22**	**19**	**2**	**6**	**450**	**450**	**900**

Elective- 4

UBT722E: Aquaculture & Marine biotechnology UBT723E: Dairy Biotechnology
UBT724E: Food processing technology UBT725E:Protein Engineering and Drug design

Elective- 5

UBT731E: Nanobiotechnology & biomaterials UBT732E: Computational biology
UBT733E: Bioconjugative technology UBT734E: Food Biotechnology

Subject Code: 22 UBT704C	ECONOMICS & PLANT DESIGN	3 Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week:		SEE Marks: 50

UNIT-I	10 Hrs.
Process design development Design project procedure, design information from the literature and other sources of information, flow diagrams, preliminary design and equipment design and specialization, safety factors specifications, and materials of construction. **General design considerations:** Marketability of the product, availability of technology, raw materials, human resources, land and utilities, site characteristics, plant location, plant layout, plant operation and control, utilities, storage, materials handling, materials and fabrication selection,. Waste disposal community factors. Safety and hazard control measures.	
UNIT–II	**12Hrs.**
Capital investments Fixed capital investments including land, building, equipment and utilities, installation costs,(including equipment, instrumentation, piping, electrical installation and other utilities),working capital investments. **Manufacturing costs and plant overheads:** Manufacturing Costs: Direct Production costs (including raw materials, human resources, maintenance and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges Plant Overheads: Administration, safety and other auxiliary services, Conceptual numerical.	
UNIT–III	**10 Hrs.**
Cost analysis Cost Analysis: Factors involved in project cost estimation, methods employed for the estimation of the capital investment. Estimation of working capital Depreciation: different type of depreciation methods of and calculations, Conceptual numerical.	
UNIT–IV	**10 Hrs.**
Profitability analysis Methods for the evaluation of profitability. Return on original investment, interest rate of return, Cash flow diagrams. Break-even analysis. Conceptual numericals.	
REFERENCE BOOKS	
1. Peters and Timmerhaus (1989) Plant Design and Economics for Chemical Engineers, 4th edn.McGraw Hill. 2. Rudd and Watson (1987) Strategy of Process Engineering, Wiley. 3. Poornima M C (2006) Entrepreneurship Development and Small Business Enterprises", Pearson education. 4. Vasanth Desai (2007) Dynamics of Entrepreneurial Development & Management",H imalaya	

Publishing House.
5. Khanka SS (2004) Entrepreneurship Development, S Chand & Co.
Thomas W. Zimmer, Norman M. Scarborough.(2007), Essentials of Entrepreneurship and small Business Management

LEARNING OBJECTIVES

COURSE OUTCOMES

At the end of the course the student should be able to:

1. Acquire knowledge in the design of a plant.
2. Conduct preliminary feasibility study of the plant design assigned.
3. Estimate the cost analysis involved in the design of a chemical plant.
4. Analyze the project profitability and alternative investments for the selection of good investment projects
5. Develop entrepreneurs with substantial knowledge in engineering concepts.
6. Apply the knowledge of plant design and cost estimation in actual engineering problems.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2	1	1			1	1	1		2		2		
CO 2	2	1	2	1			1	1	1		3		2		
CO 3	1	2	1	2			1	1	1		2		1		
CO 4	2	1	2	2			1	1	1		3		2		
CO 5	1	1	2	1			1	1	1		2		1		
CO 6	2	2	2	1			1	1	1		2		2		

Subject Code: 22 UBT715C	DOWNSTREAM PROCESSING TECHNOLOGY	3 Credits: (3: 0: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction Role and importance of downstream processing in biotechnological processes. Range and characteristics of bioproducts. Purification process of bio-product. Cell disruption methods for intracellular products; physical, chemical and mechanical methods. Basic principles of distillation,crystallization, centrifugation, ultracentrifugation (preparative and analytical).Types of centrifuges and rotors,centrifugation-differential,density gradient (zonal and isopycnic).	
UNIT–II	**12Hrs.**
Primary Recovery Operations Process involved in liquid-liquid extraction, solid-liquid extraction, ammonium sulphate precipitation, Precipitation of proteins and nucleic acids by solvents and polyethylene glycol, dialysis, electrodialysis, ultrafiltration (Removal of insolubles by filtration), reverse osmosis, drying and lyophilization. Membrane based separations theory, design and configuration of membrane separation equipment.	
UNIT–III	**10 Hrs.**
Chromatography Principles of chromatographic seperations, Classification of chromatography- plain and column chromatography, Paper chromatography - Single dimensional (Ascending and Descending, radial and two dimensional) chromatography, partition coefficient, retention factor, Thin layer chromatography, Gas liquid Chromatography, Adsorption Chromatography: Adsorption column chromatography, Ion Exchange Chromatography: cation Exchange and anion Exchange chromatography. Gel Filtration Chromatography, Affinity Chromatography, High Performance liquid chromatography, NP-HPLC and RP-HPLC.	
UNIT–IV	**10 Hrs.**
Electrophoresis Electrophoresis principles, factors affecting electrophoresis mobility, Moving boundary electrophoresis, Zone Electrophoresis, Gel Electrophoresis, Continuous Gel electrophoresis, Disc Gel electrophoresis, Agarose Gel Electrophoresis, Capillary Electrophoresis,Cellulose Acetate, Starch Gel , Native and SDS-PAGE, High voltage electrophoresis, Isoelectric focusing, Immunoelectrophoresis, ELISA, Flow cytometry. **Downstream Processes** Case studies (production)-DSP flowsheets for penicillin, insulin, amino acid, monoclonal antibody.	

REFERENCE BOOKS

1. BioseparationsPrinciples and techniques, by B.Sivasankar, Kindle edition,PHI Publishers, 2010
2. Biophysical chemistry principles and Techniques by Upadhay and Nath,Himalaya Publishing House, 3rd edition, 2010
3. NPTEL Source material.
4. Bioseparations - Downstream processing for biotechnology by Belter P.A., Cussier E. and Wei Shan Hu., Wiley Interscience Pub, 1988
5. Separation Processes in Biotechnology by Asenjo J. and Dekker M, 1993.
6. Product Recovery in Bioprocess Technology – BIOTOL Series, VCH, 1990
7. Rate controlled separations by Wankat P.c., Elsevier, 1990
8. Fermentation & Enzyme Technology by D.I.C. Wang, Wiley Eastern 1979

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Identify the basic separation unit operation in DSP like membrane separation, enrichment operation, product recovery and various resolutions and fractionation techniques.
2. Interpret and analyze the industrial fermentation processes.
3. Apply the knowledge in identifying various pharma and R&D sections.
4. Analyse the details of experimentation pertaining to chromatography and electrophoresis.
5. Understand analyse and apply the techniques in various tests involved in finding out purity of biological components.
6. Apply the knowledge in identifying various biochemicals using advanced purifications like HPLC and to demonstrate DSP flowsheets.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1			2			3	2	2				1	2	1	1
CO 2			2			3	2	3				1	2	1	1
CO 3			1			3	2	2				1	2	1	1
CO 4			2			3	2	2				1	2	1	1
CO 5			1			3	3	3				1	2	1	1
CO 6			1			3	2	2				2	2	1	1

Subject Code: 22 UBT724E	FOOD PROCESSING TECHNOLOGY	3 Credits: (3: 0: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.

Introduction

Constituents of food, soluble fibres, protein rich foods, popular fats and oils in foods, Food flavours, Browning reactions and its effects . Intrinsic and extrinsic parameters of foods, effect of inhibitors, pH and temperature. Minerals in foods. Aroma compounds in foods .Food additives, Vitamins, amino acids, Sweeteners, Food colours. Toxic-trace elements in food.

UNIT–II	12Hrs.

Detection of Microorganisms

Culture, Microscopic and Sampling Methods, Conventional; SPC, Membrane Filters, Microscope colony Counts, Agar Droplets, Dry Films, Most probable Numbers (MPN), Dyereduction, Roll Tubes, Direct, Microscopic Count (DMC), Microbiological Examination of surfaces, Air Sampling, Metabolically Injured Organisms, Enumeration and Detection of Food-borne Organisms. Dairy products: Composition of milk, Sterilization of milk (Pasteurization and UHT), Cheese production, Acidophilus milk Yoghurt, Kumiss and Kefir. Marketing scope of dairy & food products Fruit and vegetable processing: Jam, jelly, Juice, squash, wine, pickles and sauerkraut

UNIT–III	10 Hrs.

Food Spoilage & Preservation

The Role and Significance of Microorganisms, Primary Sources of Microorganisms found in Foods Synopsis of common borne bacteria, Molds& Yeasts. Microbial Spoilage of Vegetables, Fruits, Fresh and Processed Meats, Poultry, and Seafood. Spoilage of Miscellaneous Foods, Food Preservation: Principles Underlying in spoilage and preservation, Application, Effect and Legal Status of Food Irradiation, Food Preservation with Low Temperatures, High Temperatures and Drying. Food Industry: Characteristics of Food Industry.:, nutritional food supplements. Food packaging, New trends in packing, edible films. Factors influencing food product development, marketing, and promotional strategies, risks and benefits of food industry.

UNIT–IV	10 Hrs.

Food Engineering

Properties of fluid foods, Measurement of rheological parameters .Thermal properties of frozen foods. Food freezing equipment, storage of frozen foods. Food dehydration: Freeze Dehydration Calculation of drying times. Food waste management.

REFERENCE BOOKS

1. Food Science & Nutrition, by Sunetra Roady, Oxford University Press,2007.
2. Food microbiology by William Frazier and Westhoff D.C, 4thEdn,TATA McGraw Hill

Pub(2005)
3. Modern Food Micro-Biology by James M.Jay, CBS Publishers.2005.
4. Food Microbiology by K.Vijay RameshMJP Publishers, 2007.
5. Plant biotechnology In Agriculture by K. Lindsey and M.G.K. Jones, Prentice Hall, USA. 1990.
6. Food Science By Potter N.N. and Joseph Hotchkiss, 5th Edn, CBSPub,1996.

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Able to know about basic constituents of food
2. Able to know the techniques involved in detection of microbes in food industry
3. To have idea about Dairy , fruits and vegetable processed products and production
4. To be aware of different food spoilage and preservation techniques
5. To know the Characteristics of food industry and scope
6. Able to understand Basic concepts in food Engineering for preservation

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1			2			3	2	2				1	2	1	
CO 2			2			3	2	3				1	2	1	
CO 3			1			3	2	2				1	2	1	
CO 4			2			3	2	2				1	2	1	
CO 5			1			3	3	3				1	2	1	
CO 6			1			3	2	2				2	2	1	

Subject Code: 22 UBT731E	NANOBIOTECHNOLOGY AND BIOMATERIALS	3 Credits: (3: 0: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.
Introduction to nanotechnology **A Brief History of the Nano particles :** Bottom-Up versus Top-Down; What Is Nanobiotechnology.Discussions on nanofabrication, nanolithography, nanotubes, buckyballs, structure-property relationships in materials, materials characterization techniques, scanning electron, scanning tunneling and atomic force microscopy(SEM,STM & AFM), biomolecule-surface interactions, quantum dots, **Applications of nanotechnology in the life sciences:** Buckyballs and Buckytubes, Diagnostics and Sensors, Drug Delivery Revenues Health Risks and Challenge.	
UNIT–II	**12Hrs.**
Biopolymers Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli,sterilization and disinfections of polymeric materials. Biocompatibility of polymers, chemically modified glycosaminoglycans, heparin like substances from nonglycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins.	
UNIT–III	**10 Hrs.**
Synthetic polymers Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization.	
UNIT–IV	**10 Hrs.**
Biocompatibility Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Host response: Tissue response to biomaterials . Testing of implants: Methods of test for biological performance-In vitro implant tests, In vivo implant test methods. **Medical devices** Polyurethane elastomers, applications of polymers in medicine and surgery. Skin graft polymers, Properties of implant materials, metals and alloys.	

REFERENCE BOOKS

TEXT BOOKS:

1. B.Vishwanath " Nano Materials" Published by Narosa Publishing House Pvt. Ltd., New Delhi, 2011.
2. K Eric Drexler "Unbounding the future" Quill,1993.
3. Stephen Lee and Lynn M Savage "Biological molecules in Nanotechnology" 2010.
4. Mark Ratner and Daniel Ratner "Nanotechnology:A Gentle Introduction to Next Gig Idea" Pearson Ecducation Ltd, 2003.

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Ability to explain the characterization techniques of nanotechnology.
2. Ability to understand the importance of nano-particles in drug delivery system.
3. Ability to understand the importance of biopolymers.
4. Ability to differentiate biopolymer and synthetic polymer.
5. Ability to understand the importance of biocompatibility.
6. Ability to apply the methods to test the implants and use in medical devices.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	3	3			1	2					2	2	2	1
CO 2	1	2	3			1	2					3	3		
CO 3	2	2	3			2	2	3				3	2	2	1
CO 4	3	3	3			2	2	2				2	2	1	1
CO 5	3	3	3			1	2	3				1	2	3	
CO 6	2	3	3			3	3	3				3	3	3	3

Subject Code: 22 UBT716H	INDUSTRIAL MANAGEMENT AND ENTREPRENEURSHIP	3 Credits: (3: 0: 0)
L: T: P – 3-0-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

UNIT-I	10 Hrs.
DEVELOPMENT OF MANAGEMENT THOUGHTS AND ITS FUNCTIONS Concept & definition of Management, Social Responsibilities of Management, and Pioneers in Management: Contributions of Taylor, Henry Taylor, Gilberth & Mayo, Schools of Management thought: Management process school, Empirical School, Human Behavior School, Social system school, Systems approach school and decision theory school. Selection of site for the plant and plant layout, plant operation and control, utilities, structural design, storage, material handling, Sources of capital. Definition and functions of administration. Planning, organizing, staffing, directing and controlling. Concept of authority and responsibility.	
UNIT–II	**12Hrs.**
QUANTITATIVE TECHNIQUES IN MANAGERIAL DECISIONS Concept of productivity, measuring productivity, concept of budget, effective budgetary control, ABC analysis, break even analysis, product life cycle, promotion of sales, pricing, "EOQ"model. Production costs (including raw materials, and repair, operating supplies, power and other utilities, royalties, etc.), fixed charges (including depreciation, taxes, insurance, rental costs etc.).	
UNIT–III	**10 Hrs.**
PRODUCTION AND MATERIAL MANAGEMENT Types of production, types of planning, manufacturing planning, factory planning, production planning, method study, systems of wage payments, bonus, automation, organization of production, planning. Functions of purchasing & materials management, quality, quality standard & inspection, sources of supply, pricing, principles & practices, Inventory management.	
UNIT–IV	**10 Hrs.**
ENTREPRENEURSHIP & PERSONNEL MANAGEMENT Meaning of entrepreneur, evaluation of the concept, function of entrepreneur, evolution of entrepreneurship, development of entrepreneurship, stages in entrepreneurial process, role of entrepreneurs in economic development entrepreneurship- its barriers. Recruitment and selection. Training of personnel. Employer - Employee relationship. Settlement of disputes.	
REFERENCE BOOKS	
1. O.P. Khanna - "Industrial Engineering & Management", Dhanpat Rai & Sons, 1992. 2. T. R. Banga & s. C. Sharma - "Industrial Engineering & Management Science", 6th. Edn, Khanna Publications, 2003 3. C.B.Mamoria and S.V.Gankar- Personnel Management, Himalaya Pub, 21 st edn,2010 4. Veerabhadra Havinal -Management and Entrepreneurship- New Age International,2009 5. Ramesh Burbure – Management &Entrepreneurship- Rohan Pub.2008	

6. Poornima M. Charanthimath – Entrepreneurship Development, Pearson Education-2005

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Ability to recall and recollect the history theories and definition of management and its importance in society
2. To analyze and apply the basic concepts of Quantitative techniques of management
3. Ability to know the difference between production and productivity, measurement and cost analysis
4. Explore the knowledge of production costs, planning and material management
5. Able to make basic economic analysis of project
6. To be aware of making business ideas and prepare project planning
7. Ability to understand the role and importance of entrepreneurship in economic development
8. Ability to know the importance of personnel management

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	2	2		3	2		1					1	2	1	1
CO 2	2	1	2	3	2		1						2	1	2
CO 3	1	2	1	2	2		1					1	2	1	2
CO 4	2	1	2	3	1		1						2	1	3
CO 5	1	1	2		2		1					1	2	1	3
CO 6	2	3	2	1		2							2	1	3
CO 7	2	1	3	1								1	2	1	2
CO 8	1	2	1										2	1	2

Subject Code: 22 UBT710L	BIOSEPARATION TECHNIQUES LAB	3 Credits: (3: 0: 0)
L: T: P – 2-2-0		CIE Marks: 50
Total Hours/Week: 40		SEE Marks: 50

LIST OF EXPERIMENTS

1. Cell disruption techniques.
2. Solid-liquid separation methods: Filtration (Cross flow)
3. Solid-liquid separation methods: Sedimentation.
4. Solid-liquid separation methods: Centrifugation.
5. Membrane dialysis
6. Product enrichment operations: Precipitation – (NH4)2 SO4 fractionation of a protein.
7. Product enrichment operations: Two – phase aqueous extraction.
8. Product drying techniques.
9. Estimation of Amino acids / Carbohydrates by TLC.
10. Separation of ethanol from fermented broth.
11. Separation of Citric acid from fermented broth.
12. Separation of proteins by molecular sieving.
13. Analysis of biomolecules by HPLC / GC (using standard spectra).

REFERENCE BOOKS

1. Protein Purification by Scopes R.K., IRL Press,1993.
2. Rate controlled separations by Wankat P.C., Elsevier, 1990
3. Bioseparations by Belter P.A. and Cussier E., Wiley, 1985.
4. Bio-separations Science & Engineering By Roger G Harrison, Paul Todd, Scott R Rudge, Demetri.
5. Product Recovery in Bioprocess Technology - BIOTOL Series, VCH, 1990
6. Separation processes in Biotechnology by Asenjo J. and Dekker M. 1993

LEARNING OBJECTIVES

COURSE OUTCOMES

1. Able to prepare/reproduce the protocols for the experiments.
2. Able to extract the intracellular product using different cell disruption techniques.
3. Able to concentrate, purify the desired product using different chromatography/ filtration techniques.
4. Able to analyze the product both quantitative/qualitatively.
5. Able to record/observe the experimental data and interpret them in the graph/table.
6. Able to calculate the result and to write the conclusion at the end of the experiment.

Course Outcomes	Programme Outcomes												Programme Specific Outcomes		
	1	2	3	4	5	6	7	8	9	10	11	12	PSO1	PSO2	PSO3
CO 1	3												3		1
CO 2		2												3	1
CO 3			3										2	2	1
CO 4				3	3								2	2	1
CO 5		3										2	2	3	1
CO 6		3										2	3	2	1