VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELGAUM
CHOICE BASED CREDIT SYSTEM (CBCS)
BIOTECHNOLOGY ENGINEERING BOARD
BE-CBCS SYLLABUS 2017-18 Scheme

B.E Biotechnology Engineering

Program Outcomes (POs)

At the end of the B.E program, students are expected to have developed the following outcomes.

1. **Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation to the solution of complex engineering problems.
2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. **Modern Tool Usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. **The Engineer and Society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. **Environment and Sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of need for sustainable development.
8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. **Individual and Team Work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary

settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. **Project Management and Finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change

Program Specific Outcomes (PSOs)

At the end of the B.E Biotechnology Engineering program, the students are expected to have developed the following program specific outcomes.

PSO1

The graduates will have the ability to plan, analyse, design, execute and contribute to the field of biotechnology and allied industries designing , developing and providing solutions for product/processes/technology development.

PSO2

The graduates of Biotechnology engineering program will have the ability to take up employment, entrepreneurship, research and development for sustainable society.

PSO3

The graduates will be able to pursue opportunities for personal and professional growth, higher studies, demonstrate leadership skills and engage in lifelong learning by active participation in the Biotechnology profession.

PSO4

The graduates will be able to demonstrate professional integrity and an appreciation of ethical, environmental, regulatory and issues related to Biotechnology.

General Notes:

1. Question Paper Pattern for Theory Courses (2017 Scheme):
   - The question paper will have TEN questions.
   - Each full question carries 20 marks.
   - There will be two full questions (with a maximum of four sub questions) from each module.
   - Each full question will have sub questions covering all the topics under a module.
   - Students will have to answer 5 full questions, selecting one full question from each module.
2. The teaching learning process should be as per the Choice Based Credit System
3. The teaching learning process may be planned to develop capabilities, competencies and skills required for career development based on course beginning and course end surveys.
4. Course objectives, course outcomes and RBT levels given under each course in the syllabus are broad and indicative/suggestive. The faculty can set them appropriately according to their lesson/ course plan.
5. The course coordinators/teachers/instructors are informed to deliberate in the faculty meeting with module coordinator, program coordinator along with the stake holders to develop the respective lesson/ course plans.
6. The department advisory board may make suitable changes to the course objectives, course outcomes and program objectives according to their finalized course plans.
7. The faculty should complement the teaching with case studies and field visits wherever required.
8. One faculty development program to be conducted to compliment teaching learning process by the department in a year

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2017-2018

B.E- BIOTECHNOLGY

III SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17MAT31	Engineering Mathematics –III*	Maths	04		03	60	40	100	4
2	17BT32	Unit Operations	BT/CHE	04		03	60	40	100	4
3	17BT33	Biochemistry	BT	04		03	60	40	100	4
4	17BT34	Microbiology	BT	04		03	60	40	100	4
5	17BT35	Cell Biology and Genetics	BT	04		03	60	40	100	3
6	17BT36	Basics of Computer Applications	BT/CSE/ISE /MCA	03		03	60	40	100	4
7	17BTL37	Unit Operation Laboratory	BT/CHE/ME	01- Hour Instruction 02- Hour Practical		03	60	40	100	2
8	17BTL38	Microbiology Laboratory	BT	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
TOTAL				**Theory: 24hours Practical: 06 hours**		**25**	**510**	**340**	**850**	**28**

1. Kannada/Constitution of India, Professional Ethics and Human Rights: 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.

2. Audit Course:
(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – I, which is 03 contact hours per week.

1	17MATDIP31	Additional Mathematics –I	Maths	03		03	60	--	60	--

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates)

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CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2017-2018

B.E- BIOTECHNOLOGY

IV SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical / Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17BT41	Biostatistics and Biomodeling	Mathematics/BT	04		03	60	40	100	4
2	17BT42	Biochemical Thermodynamics	BT/CHE/ME	04		03	60	40	100	3
3	17BT43	Molecular Biology	BT	04		03	60	40	100	4
4	17BT44	Bioprocess Principles & Calculations	BT/CHE	04		03	60	40	100	4
5	17BT45	Structural Biology	BT	04		03	60	40	100	4
6	17BT46	Clinical Biochemistry	BT	03		03	60	40	100	4
7	17BTL47	Cell and Molecular Biology Laboratory	BT	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17BTL48	Clinical Biochemistry Laboratory	BT	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
9	17KL/CPH39/49	Kannada/Constitution of India, Professional Ethics and Human Rights	Humanities	01		01	30	20	50	01
			TOTAL	**Theory: 24hours Practical: 06 hours**		**25**	**510**	**340**	**850**	**28**

1. Kannada/Constitution of India, Professional Ethics and Human Rights: 50 % of the programs of the Institution have to teach Kannada/Constitution of India, Professional Ethics and Human Rights in cycle based concept during III and IV semesters.

2.Audit Course:
(i) *All lateral entry students (except B.Sc candidates) have to register for Additional Mathematics – II, which is 03 contact hours per week.

1	17MATDIP41	Additional Mathematics –II	Maths	03		03	60	--	60	--

(ii) Language English (Audit Course) be compulsorily studied by all lateral entry students (except B.Sc candidates)

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CHOICE BASED CREDIT SYSTEM (CBCS)
SCHEME OF TEACHING AND EXAMINATION 2017-2018

B.E-BIOTECHNOLOGY

V SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17BT51	Bio-Kinetics & Bioreaction Engineering	BT/CHE	04		03	60	40	100	4
2	17BT52	Genetic Engineering & Applications	BT	04		03	60	40	100	4
3	17BT53	Immunotechnology	BT	04		03	60	40	100	4
4	17BT54	Bioinformatics	BT	04		03	60	40	100	4
5	17BT55X	Professional Elective-1	BT/CHE	03		03	60	40	100	3
6	17BT56X	Open Elective-1	BT	03		03	60	40	100	3
7	17BTL57	Genetic Engineering & Immunotechnology Laboratory	BT	01- Hour Instruction 02- Hour Practical		03	60	40	100	2
8	17BTL58	Bioinformatics Laboratory	BT	01- Hour Instruction 02- Hour Practical		03	60	40	100	2
			TOTAL	**Theory: 22hours Practical: 06 hours**		**24**	**480**	**320**	**800**	**26**

Professional Elective-1			**Open Elective – 1*** (List offered by Civil Engg Board only)**	
17BT551	Microbial Biotechnology		17BT561	Biology for Engineers
17BT552	Transport Phenomena		17BT562	Biomaterials
17BT553	Animal Biotechnology		17BT563	Biotechnology for Sustainable Environment
17BT554	Bioinstrumentation & Biosensors			

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).
Selection of an open elective is not allowed, if:
· The candidate has no pre – requisite knowledge.
· The candidate has studied similar content course during previous semesters.
· The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).
Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

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SCHEME OF TEACHING AND EXAMINATION 2017-2018

B.E-BIOTECHNOLOGY

VI SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17BT61	Bio-business and Entrepreneurship	BT/MBA	04		03	60	40	100	4
2	17BT62	Bioprocess Control & Automation	BT/CHE	04		03	60	40	100	4
3	17BT63	Enzyme Technology & Biotransformation	BT	04		03	60	40	100	4
4	17BT64	Bioprocess Equipment Design & CAED	BT/CHE/ME	04		03	60	40	100	4
5	17BT65X	Professional Elective-2	BT/CHE	03		03	60	40	100	3
6	17BT66X	Open Elective-2	BT/CHE	03		03	60	40	100	3
7	17BTL67	Bioprocess Control & Automation Laboratory	BT/CHE	01- Hour Instruction 02- Hour Practical		03	60	40	100	2
8	17BTL68	Biokinetics & Enzyme Technology Laboratory	BT/CHE	01- Hour Instruction 02- Hour Practical		03	60	40	100	2
			TOTAL	**Theory:22hours Practical: 06 hours**		**24**	**480**	**320**	**800**	**26**

Professional Elective-2			**Open Elective – 2*** (List offered by Civil Engg Board only)**	
17BT651	Biomolecular Engineering		17BT661	Biological Data Management
17BT652	Advanced Microbiology		17BT662	Nano Biotechnology
17BT653	Cell Culture Techniques		17BT663	Good Manufacturing Practices
17BT654	Economics and Plant Design			

***Students can select any one of the open electives offered by any Department (Please refer to consolidated list of VTU for open electives).
Selection of an open elective is not allowed, if:
· The candidate has no pre – requisite knowledge.
· The candidate has studied similar content course during previous semesters.
· The syllabus content of the selected open elective is similar to that of Departmental core course(s) or to be studied Professional elective(s).
Registration to open electives shall be documented under the guidance of Programme Coordinator and Adviser.

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B.E-BIOTECHNOLOGY

VII SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17BT71	Fermentation Technology	BT/CHE	04		03	60	40	100	4
2	17BT72	Genomics & Proteomics	BT	04		03	60	40	100	4
3	17BT73	Plant Biotechnology	BT	04		03	60	40	100	4
4	17BT74X	Professional Elective-3	BT/CHE	03		03	60	40	100	3
5	17BT75X	Professional Elective-4	BT/CHE	03		03	60	40	100	3
6	17BTL76	Fermentation Technology Laboratory	BT/CHE	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
7	17BTL77	Plant Biotechnology Laboratory	BT	01-Hour Instruction 02-Hour Practical		03	60	40	100	2
8	17BTP78	Project Work Phase–I + Project work Seminar	BT		03	--	--	100	100	2
TOTAL				**Theory:18 hours Practical and Project: 09 hours**		**21**	**420**	**380**	**800**	**24**

Professional Elective-3		**Professional Elective-4**	
17BT741	Health Informatics	17BT751	Dairy Biotechnology
17BT742	Bioreactor Design Concepts	17BT752	Forensic Science
17BT743	Lab to Industrial Scaling	17BT753	Molecular Diagnostics
17BT744	Food Biotechnology	17BT754	Big Data Management

1. **Project Phase – I and Project Seminar:** Comprises of Literature Survey, Problem identification, Objectives and Methodology. CIE marks shall be based on the report covering Literature Survey, Problem identification, Objectives and Methodology and Seminar presentation skill.

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SCHEME OF TEACHING AND EXAMINATION 2017-2018

B.E-BIOTECHNOLOGY

VIII SEMESTER

Sl. No.	Course Code	Title	Teaching Department	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Drawing	Duration in hours	SEE Marks	CIE Marks	Total Marks	
1	17BT81	Clinical & Pharmaceutical Biotechnology	BT	4	-	3	60	40	100	4
2	17BT82	Regulatory affairs in Biotech Industry	BT/MBA	4	-	3	60	40	100	4
3	17BT83X	Professional Elective-5	BT	3	-	3	60	40	100	3
4	17BT84	Internship/ Professional Practice	BT	Industry Oriented		3	50	50	100	2
5	17BTP85	Project Work-II	BT	-	6	3	100	100	200	6
6	17BTS86	Seminar on current trends in Engineering and Technology	BT	-	4	-	-	100	100	1
TOTAL				**Theory: 11 hours Project and Seminar: 10 hours**		**15**	**330**	**370**	**700**	**20**

Professional Elective -5	
17BT831	Protein Engineering and insilico drug design
17BT832	Metbolic Engineering
17BT833	Environmental Biotechnology

1. Internship/ Professional Practice: 4 Weeks internship to be completed between the (VI and VII semester vacation) and/or (VII and VIII semester vacation) period

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BIOTECHNOLOGY BOARD
BE-CBCS SYLLABUS 2017-18 Scheme

THIRD SEMESTER

TITLE OF THE COURSE: UNIT OPERATIONS
B.E., III Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT32	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

- To know the fundamental concepts of fluid mechanics, heat and mass transfer.
- To solve the engineering problems related to fluid flow, heat and mass transfer.
- To understand the design concepts of fluid and particulate technology.
- To design and operate the heat exchange equipment

MODULE – 1

FLUID MECHANICS CONCEPTS:
Fluid definition and classification, Rheological behavior of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non circular conduits - Hagen Poiseuille equation (no derivation).Flow past immersed bodies– drag and drag co-efficients, application of Kozney- Karmen & Burke Plummer equation; Flow through stagnant fluids – theory of Settling and Sedimentation – Equipments (cyclones, thickners) Conceptual numericals..

L1, L2, L3, L4

MODULE –2

FLOW MEASUREMENTS & MECHANICAL OPERATIONS:
Different types of flow measuring devices, flow measurements – Orifice meter, Venturimeter, Rotameter. Pumps – types of pumps (Centrifugal & Reciprocating pumps), application of Bernoulli's equation for Energy calculations in pumps.Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis- Conceptual numericals of differential and cumulative analysis. Size reduction –characteristics of comminuted products, crushing laws, working principle of ball mill., Mixing – types of mixers (ribbon and muller mixer), power number and power number calculation; Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

L1, L2, L3, L4

MODULE – 3

CONDUCTIVE & CONVECTIVE HEAT TRANSFER:
Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficents, log mean temperature difference, individual and

overall heat transfer co-efficients, fouling factor; Condensation – film wise and drop wise (no derivation). Conceptual numericals.

L1, L2, L3

MODULE – 4

HEAT TRANSFER EQUIPMENTS & BASICS OF MASS TRANSFER:

Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger. Diffusion- Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Mass, heat and momentum transfer analogies. Measurement of diffusivity, Mass transfer coefficients and their correlations. Interphase mass transfer- equilibrium, diffusion between phases. Conceptual numericals.

L1, L2, L3,L4

MODULE – 5

MASS TRANSFER OPERATIONS:

Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method. Liquid liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction). Drying- drying operations, batch and continuous drying. Conceptual numerical.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to

- State and describe the nature and properties of the fluids.
- Study the different flow measuring instruments.
- Study and understand the principles of various size reduction, conveying equipments, sedimentation and mixing tanks.
- Comprehend the laws governing the heat and mass transfer operations to solve the problems.
- Design the heat transfer equipment suitable for specific requirement.

1. Process dynamics and control by D E Seborg, T F Edger, John Wiley.
2. Process Control by Wayne C. Bequette, Pearson Education Asia**.**
3. Essentials of Process Control by Luyben and Luyben**.** McGraw-Hill Education.
4. Process Modeling, Simulation and Control by William Luyben**,** McGraw-Hill Education.
5. Biochemical Engineering Fundamentals by Bailey and Ollis, Mcgraw Hill.
6. Bioprocess Engineering by Shule and Kargi, Prentice Hall.
7. Bioprocess Engineering Principles by Pauline M. Doran, Academic Press.
8. Rate controlled separations by Wankat P.C, Elsevier

1. Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson , John Wiley & Sons.
2. Engineering Fluid Mechanics by Kumar K.L. Eurasia Publishing House (P) Ltd., New Delhi, 1984.
3. Mechanics of fluids by B.S. Massey, Chapman & Hall Publishers.
4. Unit Operations of Chemical Engineering by Chattopadhyaya, Vol I & II , Khanna Publishers, Delhi-6, 1996.
5. Chemical Engineering by Coulson and Richardson., J.F.,Vols I & II. Elsevier Science.
6. Process Heat Transfer by Kern D. Q., McGraw Hill, New York.
7. Heat Transfer by J P Holman, McGraw Hill International Ed.
8. Chemical Engineers Hand Book by Perry, McGraw Hill Publications

TITLE OF THE COURSE: BIOCHEMISTRY
B.E., III Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT33	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

- To learn basic principles of biochemistry occurring at cellular and molecular level in living organisms.
- To understand cross-functional nature of biochemistry in life sciences, food, agriculture, pharma, medicine.
- To apply the concepts in the clinical biochemistry aspects

MODULE – 1

BASIC CONCEPTS & BIOMOLECULES:
Types of chemical reactions, pH, buffers and their properties, concentration of solutions. Stereo chemistry of carbon compounds. Carbohydrates, fats and lipids, structure and properties of phospholipids, glycolipids, steroids, amino acids and proteins. Classes of Enzymes with examples. Biologically important peptides, purines, pyrimidines, nucleic Acids- DNA and RNA.

L1, L2, L3

MODULE –2

BIOENERGETICS:
Energy, energy flow cycle, energy conversion. Structure and properties of ATP. High energy compounds, Thermodynamic considerations, coupling reactions of ATP and NDP (Nucleotide di phosphate); photosynthesis, light reaction, dark reaction, ancillary Pigments, Photosystems PS I & II.

L1,L2, L3, L4

MODULE – 3

TRANSPORT MECHANISM:
Biological membranes: structure, permeability, properties, passive transport and active transport, facilitated transport, energy requirement, mechanism of Na+ / K+, glucose and amino acid transport. Organization of transport activity in cell. Action Potentials. Role of transport in signal transduction processes.

L1, L2, L3

MODULE – 4

METABOLISM OF CARBOHYDRATES AND LIPIDS:
Glycolysis –metabolism. Aerobic and anaerobic pathway and regulation, TCA cycle, NADPH Cycle, Glyoxylate cycle, Pentose Phosphate Pathway. Electron transport chain and oxidative phosphorylation, energetics, energy balance sheet, oxidative stress. Gluconeogenesis – regulation of gluconeogenesis. Biosynthesis of polysaccharides. Biosynthesis of fatty acids, cholesterol,phospholipids, glycolipids. Biodegradation of triglycerides and fatty acids.

L1, L2, L3,L4

MODULE – 5

METABOLISM OF AMINO ACIDS & NUCLEIC ACIDS:

Biosynthesis and catabolism of essential amino acids: Lysine, Phenylalanine and Glutamine. Deamination, transamination and urea cycle. Metabolism and regulation of Purines, pyrimidine and precursors of nucleic acids (nucleosides & nucleotides).

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Know about bio molecules
- Understanding basic metabolic pathways
- Understand metabolic regulations

REFERENCE BOOKS

1. Biochemistry by Voet &Voet, Wiley New York.
2. Biochemistry by Trehan. K, New Age International.
3. Biochemistry & Molecular Biology by Elliot, William H., Oxford University Press.
4. Biochemistry of cell signaling by Helmreich, Oxford University Press.
5. Bioorganic Chemistry by Hermann Dugas, Spinger.
6. Biochemistry by U Sathyanarayana, Books & Allied Publishers.
7. Biochemistry & Molecular Biology y Elliott & Elliott, Oxford Press Publishers, 4th Edition.
8. A textbook of Biochemistry for medical students by Rafi.M.D, 2nd edition, University Press.
9. A textbook of Biochemistry for medical students by Rafi.M.D, 2nd edition, University Press.

TEXT BOOKS

1. Principles of Biochemistry by Albert Lehninger, CBS publishers.
2. Biochemistry by Nelson and Cox, Palgrave Macmilan, Freeman Edn.
3. Principles of Biochemistry by Lubert Stryer, Freeman Int. Edition
4. Biochemistry by Mathews, Vanholde & Arhen, Pearson Education.
5. Biochemistry by Garett & Grisham Thompson Learning.
6. Bioenergetics by L Eruster, Greena Publishing Associates.
7. Fundamentals of Biochemistry by Dr.J.L.Jain, Sunjay Jain and Nitin Jain, S.Chand Publishers.

TITLE OF THE COURSE: MICROBIOLOGY

B.E., III Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT34	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

- To learn the details of classification, structural features and functional aspects of prokaryotic and eukaryotic microorganisms.
- To gain insights into microbial metabolism and metabolic pathways.
- To understand the details of microbial techniques for growth, cultivation and characterization of microorganisms.
- To appreciate the recent developments in the area of medical microbiology, environmental microbiology, industrial microbiology, etc.

MODULE – 1

INTRODUCTION TO MICROBIOLOGY AND STUDY OF MICROORGANISMS:

Scope of microbiology, History of microbiology, Origin of life, Prokaryotes and Eukaryotes. Microbial Diversity and Taxonomy. Structure, Classification and Reproduction of bacteria, Fungi, Viruses, Protozoa and Algae. General features of Prions, Spirochetes, Actinomycetes and Rickettsiae.

L1, L2, L3

MODULE –2

METHODS AND TECHNIQUESIN MICROBIOLOGY:

Microscopy: Concepts, Light, Electron, Phase Contrast, Acoustic Microscopy, camera Lucida and Micrometry. Media preparation, types of media, Culture methods, pure culture techniques, Staining Techniques. Sterilization & disinfection.

L1,L2, L3

MODULE – 3

MICROBIAL GROWTH AND METABOLISM:

Growth curve patterns, Physical conditions required for growth. Metabolism; Primary and Secondary metabolites with examples, metabolic pathways important in Microorganisms-Respiration and Fermentation L1, L2, L3

MODULE – 4

MEDICAL MICROBIOLOGY:

Introduction to Medical Microbiology, Common diseases caused by microbes: Bacterial diseases: Typhoid, Diphtheria, Cholera, Tuberculosis, Leprosy, Plague, Syphilis, Gonorrhea; Viral diseases: Herpes, Polio, Hepatitis, AIDS, Rabies, SARS and H1N1; Protozoan diseases: Malaria: common types of fungal infections.

L1, L2, L3, L4

MODULE – 5

SOIL, ENVIRONMENTAL & INDUSTRIAL MICROBIOLOGY:

Soil Microbiology: Soil micro flora and biogeochemical cycles. Bio fertilizers: VAM and Rhizobium. Atmospheric Microbiology: Aerobiology and allergy. Air sampling principles and types of samplers, Selective media for air sampling, significance of aerobiological studies. Aquatic Microbiology: Marine micro flora, fresh water microflora, Microbiology of potable water, Purification, Sewage disposal, Microbes in Bioremediation. Industrial Microbiology: Production of antibiotics (penicillin), Organic acids (citric acid), Enzymes from Microbes (proteases). Production of Vitamin B12.

L2, L3, L5

Course outcomes:

After studying this course, students will be able to:

- Describe the structure and function of typical prokaryotic and eukaryotic cell structure like bacteria, algae, yeast & molds, protozoa, viruses, etc.
- Understand the techniques used for the isolation, growth, identification, disinfection and sterilization of microorganisms.
- Define the role of microorganisms towards environmental protection, industrial applications and infectious diseases.
- Out-line industrial fermentation processes leading to the production of antibiotics, organic acids, enzymes, vitamins and therapeutic products.

1. The Air Spora: A manual for catching and identifying airborne biological particles. Maureen E. Lacey and Jonathan S. West. Springer.
2. Soil Microbiology by NS Subba Rao, Oxford and IBH.
3. Palynology and its applications By Shripad N.Agashe, Oxfor and IBH publishing Pvt. Ltd.
4. Text Book of Microbiology by Anantahnarayan and Jayaram Panicker, Universities Press.

TEXT BOOKS

1. General Microbiology by Roger Y Stanier, John L Ingraham, and Mark L Wheels, Macmillan Press Ltd.
2. Microbiology by Michael J Pelczar Jr Chan ECS, Noel R Krieg, Tata McGraw Hill Publishing co ltd.
3. Microbiology by Prescott, Harley, Klein, McGraw Hill.
4. Industrial Microbiology by Samuel C Prescott, Cecil G Dunn, Agro bios (India)
   Palynology and its applications By Shripad N.Agashe, Oxfor and IBH publishing Pvt. Ltd.
6. Biotechnological Applications of Microbes by Edite-Ajit Verma, IK Intl. Pub House.
7. Alcamos Fundamentals of Microbiology by Jeffery C Pommerville, Jones and Bartlett Publishers.
8. Microbiology, an Introduction, Gerard J. Tortora, Berdell R. Funke, Christine L. Case, Pearson, 2012.
9. Principles of Microbiology: Ronald M Atlas, 1995.McGraw-Hill Inc., US (addition)
10. Microbiology: Principles and Explorations, Jacquelyn G. Black, 8thEdition, John Wiley & Sons, 2012.
11. Roger Y Stanier, John L Ingraham, and Mark L Wheelis- General Microbiology, 5th EditionMacmillan Press Ltd.
12. Jacquelyn G. Black - Microbiology: Principles and Explorations, 8th Edition, John Wiley & Sons. Samuel C Prescott, Cecil G Dunn- Industrial Microbiology, 1st Edition- Agro bios (India)

TITLE OF THE COURSE: CELL BIOLOGY AND GENETICS

B.E., III Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17BT35**	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

- To gain basic concepts of cell biology and genetics.
- To understand cellular processes, pathways occurring at cellular level in living organisms.
- To learn and apply the Fundamental aspects of genetics in biotechnology.

MODULE – 1

CYTOSKELETON:

Eukaryotic and prokaryotic cells, Plant and animal cells, brief mention of membrane organization. Cytosketal elements, Microtubules: structure & functions, shaping of the cells and mechanical support. Microfilaments: structure & functions. Structure of intermediate filaments. Cytoplasmic micro trabecular system (lattice). Covalent modifications of cytosketal proteins. Cytoskeletal architecture. L1, L2

MODULE –2

CELL STRUCTURE AND FUNCTION:

Mitosis and Meiosis. Structure of cytoplasm, Nucleus, Mitochondria, Ribosome, Golgi bodies, Lysosomes. Endoplasmic Reticulum, Peroxisomes, Chloroplast and Vacuoles. Cell to cell integration, Cell locomotion (Amoeboid, Fl agell a, Cillar).Types of cell functions, cell division. Apoptosis and Ageing. L1, L2

MODULE – 3

GENETICS:

Nature of genetic material, Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions, supplementary genes - Comb patterns in fowls, Complementary genes - Flower color in sweet peas, Epistasis-Inhibitory and colored genes in fowls, simple problems. Identification of genetic material, classical experiments-Hershey & Chase, Avery, McLeod etc., Multiple alleles and groups antigens. Numericals based on concepts. L1, L2

MODULE – 4

CHROMOSOMES STRUCTURE AND ORGANIZATION & POPULATION GENETICS:

Chromosome, Centrosome, telomere, Chemical composition of chromatin, structural organization of nucleosomes, heterochromatin. Polytene and lamp-brush chromosomes, human chromosomes. Introduction, Gene frequency, and equilibrium estimation, changes in gene frequency, inbreeding and heterosis, genetic structure of population, speciation and evolution, prospects for the control of human evolution. Spontaneous and induced mutations, Eugenics. Pedigree analysis. L1, L2, L3, L4

MODULE – 5

SEX CHROMOSOMES AND INHERITED DISEASES:

The organ of heredity, chromosomes, morphology, classification. Sex determination in plants, animals XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals. Chromosomal disorders. Sex linked inheritance molecular diseases, hemoglobinpathies. Disorders of coagulation, Color blindness, hemophilia, Non-disjunction as a proof of chromosomal theory of inheritance, Linkage maps, crossing over. Chromosomal maps, interference coincidence. L1, L2, L3, L4

Course outcomes: After studying this course, students will be able to:

- To gather contemporary knowledge of cell biology & genetics
- To be able to understand the basis of inherited disorders.

REFERENCE BOOKS

1. Molecular Cell Biology by Darnell, and Baltimore, Freeman Pub.
2. Molecular Aspects of Cell Biology by Garret and Grisham. Cengage Learning.
3. Cellular & Biochemical Science by G. Tripathi, I K Intl.
4. Genes and Genomes by M Singer, and P Berg, Blackwell Scientific Pub.
5. Developmental Genetics by Gurbachan s & Miglani, I K Intl. Pub.
6. Problems on Genetics, Molecular Genetics and Evolutionary Genetics by Pranab Kr. Banerjee, New Central Book Agency.

1. Cell Biology by Kimbal, Willey Pub.
2. Cell Biology by S C Rastogi, New Age International Pub.
3. Genetics by Monroe W Strickberger, Macmillan Pub. Newyork.
4. Principles of Genetics by Gardener, Simmons and Slustad. Wiley Pub.
5. Principles of Gene manipulation and Genomics by Primrose, Oxford University Press.
6. Genetics W Strick by Monroe, Macmillan Publication
7. Cell Biology by T.Devasana, Oxford Press publishers

TITLE OF THE COURSE: BASICS OF COMPUTER APPLICATIONS

B.E., III Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT36	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

- To gain knowledge about the different languages
- To gain the functioning and understanding the usage of internet, use of HTML in web-based designing
- To learn and implement different languages in biological applications
- To use of ontology for effective representation of data

MODULE – 1

LINUX & XML :

Introduction to Linux, basic commands, working with files, file attributes, installing programs using rpm, working with basic editors sed, awk and vi, using the shell, pipes, wildcards, checking processes, killing processes, basic decision making statements: if...then.... else...if - test - while...do...done - until...do...done - for...in..Do...done - case...in...esac - select...in...do., basic regular expressions, using grep command, string search applications using regular expressions. Structured and unstructured data, XML fundamentals, XML documents and XML files, elements and character tags, attributes, XML names, CDATA sections, XML declarations, DTD, element declarations, attribute declarations, namespaces, programming applications of XML; General features of NCBI's Molecular biology data model, BioXML, NeuroML, Chemical Markup Languages (CML), Microarray ML(MAML), RiboML and SBML.

L1, L2

MODULE –2

INTERNET and DATABASE MANAGEMENT:

Internet Addresses, Internet Protocol, Transport layer, Upper layer protocols, Internet access and applications. Overview of HTML and HTTP; Web servers, Web access, Security, WWW (World Wide Web) proxies, HTML applications related to biotechnology. Novell's WWW service, Web based applications, Biology search engines, legal and ethical issues. Introduction to flat files, DBMS and RDBMS, E-R relationship, Introduction to SQL, basic commands, using SQL in MS Access, creating and modifying tables, joining tables, simple queries using SQL, inner join, outer joins.

L1, L2, L3

MODULE – 3

ONTOLOGIES and MATLAB:

Overview of ontologies, gene ontologies, Open biological ontologies (OBO) and its applications, TAMBIS ontology, cell cycle ontology, GeneX ontology. Building ontology, ontology

development tools (protégé 2000, GKB editor, OilEd), Ontology integration of bioontologies. Different types of data formats (CSV and tabbed formats for general file representation, data cleaning, flat file) Introduction to MATLAB, features of MATLAB toolbox, Usage of MATLAB towards bio statistical and biochemical applications. Modeling of biochemical and biotechnological systems using MATLAB scientific computing environment.

L1, L2, L3

MODULE – 4

C++ CONCEPTS AND BIOPERL:

Overview of C programming concepts, Variables, Operators, Statements, Functions and Pointers. Introduction to Classes, Objects, C++ string classes, Introduction to OOPs concepts with respect to C++ (Encapsulation, polymorphism, Inheritance, Abstraction, Dynamic binding), data types, Arrays. Introduction to basic concepts of Bioperl. L1, L2, L3, L4

MODULE – 5

APPLICATIONS OF C AND C++ IN BIOTECHNOLOGY:

Writing a C program using numerical analysis technique towards solving the differential equations to biotechnology (such as finding the thermal death kinetics of microorganisms, holding time for sterilization, estimating the length of the lag phase, calculation of specific growth rate, doubling time, and substrate-to-cell yield coefficient, etc.). Write a C++ Program to find the optimum pH and temperature for maximum enzyme activity, to derive the column height needed to achieve the specified degree of conversion in a fluidized-bed biofilm reactor, to find the optimal dilution rate for maximum cell productivity, etc. Usage of NCBI's C++ tool kit to demonstrate certain features of sequence analysis.

L1, L2, L3, L4,L5

Course outcomes: After studying this course, students will be able to:

- Understand C- language with updated tool usage.
- Apply the basic concepts of MATLAB, Internet.
- Use the software with special reference to biotechnological applications.

REFERENCE BOOKS

1. SAMS teach SQL in 10mins by Ben Forta, Williams Publishing.
2. Beginning XML by David Hunter, Wrox Press.
3. Introducing UNIX and LINUX by Mike Joy, Palgrave Macmillan.
4. SQL Simplified: Learn to read and write SQL by Cecelia. L. Allison, Jones and Bartlett.
5. SQL queries for mere mortals: A hands-on guide to data manipulation in SQL by Michael J. Hernandez and John. L. Viescas, Addison Wesley.

1. Linux: the complete reference by Richard Peterson, McGraw Hill.
2. Internet: The complete reference by Margaret Levine Young, Tata McGraw Hill.
3. C Programming by E Balaguruswamy, Tata McGraw Hill.
4. HTML and XML for beginners by Michael Morrison, Microsoft Press.

5. A study in Ontology by Peter Simons, Oxford Press.
6. Essential MATLAB for Scientists and Engineers by Arnold, Wiley, NY.
7. Beginning Perl for Bioinformatics by James Tisdall "O'Reilly Media, Inc".

TITLE OF THE COURSE: UNIT OPERATION LABORATORY

B.E., III Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BTL37	CIE Marks	40
Number of Lecture Hours/week	03=(1 Hour Instruction + 2 Hours Laboratory)	SEE Marks	60
Total Number of Hours	40	Exam Hours	03
RBT Levels	L1, L2, L3, L4,L5		

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in

- Basic unit processes in industrial set up pertaining to fluid mechanics, mechanical operations.
- Trouble shooting of problems related to fluid mechanics & Mechanical operations.

Experiments:

A) Experiments based on principles of Fluid Mechanics & Mechanical Operations

1. Friction losses in circular pipes
2. Flow measurements using Venturi /Orifice/ Rotameter.
3. Centrifugal /Reciprocating pumps
4. Packed bed flow
5. Batch sedimentation.
6. Ball Mill
7. Cyclone separator
8. Leaf / Pressure filter
9. Screen analysis/effectiveness.

B) Experiments based on principles of Heat and Mass Transfer Operations

1. Natural convection in bare and finned tubes.
2. Heat transfer in packed bed.
3. Heat transfer through DPHE
4. Critical thickness of insulation.
5. Diffusion of organic solvent in air.
6. Simple Distillation.
7. Steam Distillation.
8. Single Stage Extraction.
9. Drying-Tray dryer.

Note: Minimum 12 experiments are to be conducted choosing at least 6 from sections A and B.

Course outcomes:

On the completion of this laboratory course, the students will be able to:

1. Record observations systematically and arrive at required results based on experiments conducted.

2. Study and design different flow measuring instruments.
3. Understand and Estimate the shape and size of irregular particles

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Instructions as printed on the cover page of answer script for split up of marks to be strictly followed.
4. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
5. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B.
2. Anderson, John Wiley & Sons.
3. Chemical Engineering by Coulson and Richardson. Vols I & II. Elsevier Science.
4. Chemical Engineers Hand Book by Perry, McGraw Hill Publications.
5. Process Heat Transfer by Kern, McGraw Hill.

TITLE OF THE COURSE: MICROBIOLOGY LABORATORY

B.E., III Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BTL38	CIE Marks	40
Number of Lecture Hours/week	03=(1 Hour Instruction + 2 Hours Laboratory)	SEE Marks	60
Total Number of Hours	40	Exam Hours	03
RBT Levels	L1, L2, L3, L4,L5		

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in:

- Working principle and use of Microbiological Lab equipment's like autoclave, incubators, LAF, microscope, etc.
- The basic laboratory techniques for isolation, characterization, enumeration and control of microorganisms.

Experiments:

1. Study of Laboratory Instruments
2. Media preparation, Preparation of plates and tubes.
3. Pure culture techniques (Streak, pour and spread - plates)
4. Enumeration of microbes by Plate count and haemo-cytometer.
5. Determination of size of cell or fungal spores by Micrometry.
6. Gram staining, Capsule staining, and endospore and flagella staining.
7. Staining of fungi.
8. Characterization of bacteria by Biochemical Tests: IMViC, Starch hydrolysis, carbohydrate fermentation, Catalase, Urease, hydrogen sulphide, Nitrate reduction.
9. Isolation of actinomycetes and rhizobium and their identification
10. Determination of bacterial motility by hanging drop technique.
11. Growth curve studies.
12. Antibiotic sensitivity tests.

- Use different laboratory equipment and instruments such as Microscope, Laminar Air Flow Station, Autoclave, oven, incubators.
- Prepare the media and use for the cultivation of the microorganisms.
- Perform laboratory experiments for the isolation, identification and characterization of microorganisms.
- Carry-out experiments for the enumeration, staining and control

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.

4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Microbiology: A Lab Manual by Cappuccino Pearson education, 2007
2. Lab Math by Dany Spencer Adams, IK Intl. Pub house.
3. Lab Ref by Jaine Roskams& Linda Rodgers IK Intl.Pub house.
4. Case-Microbiology: An Introduction by Gerard J. Tortora, Berdell R. Funke, Christine L. 11th Edition- Pearson publications.
6. Laboratory Manual Of Microbiology And Biotechnology by Aneja K.R. Medtec, 2014

FOURTH SEMESTER

TITLE OF THE COURSE: BIOSTATISTICS AND BIOMODELING
B.E., IV Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT41	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

- Appreciate the wide range of utilities of statistics and probability to Biological data
- Apply the concepts related to curve fitting, correlation coefficient, regression analysis etc., to specific cases.
- Learn the concepts of basic probability and random variables, while deciphering the applications of distributions and stochastic process for defined cases.
- Study the importance of modeling and simulations for biological problems

MODULE – 1

BASIC STATISTICS:
Histogram, Ogive curve, Pie Diagram. Measure of dispersion (range, quartile deviation, mean deviation and standard deviation, coefficient of variation), Skewness & kurtosis**.**

L1, L2

MODULE –2

BI-VARIATE DISTRIBUTION:
Correlation, rank correlation and regression analysis (simple and linear) curve fitting (linear, non-linear and exponential).

L1, L2

MODULE – 3

PROBABILITY:
Axioms, conditional probability, Bayes rule, Genetic Applications of Probability, Hardy - Weinberg law, Wahlund's Principle, Forensic probability determination, Likelihood of paternity, Estimation of probabilities for multi-locus/ allele finger print systems. Random variables- Discrete and Continuous Probability distribution, Mathematical expectations.

L1, L2, L3

MODULE – 4

PROBABILITY DISTRIBUTIONS:
Discrete probability distributions- Binomial, Poisson, normal, exponential derivations. Central limit theorem. T distributions.

L1, L2, L3,L4

MODULE – 5

STATISTICAL INFERENCE:
Estimation theory and testing of hypothesis, point estimation, interval estimation, sample size determination, parametric and non-parametric distributions -F-test, Chi Squared distribution, and goodness of fit test analysis of variance (one-way classifications). Randomization, random assignments, single and double blind experiments. Case studies of statistical designs of biological experiments. Microbial Growth in a Chemostat, Growth Equations of Microbial populations, Models of Commensalisms, Mutualism, Predation and Mutation. Volterra's Model for n Interacting Species.

Cigarette smoking, Lung cancer, epidemics.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Fit a suitable curve for the tabulated data by the method of least squares, find correlation coefficients and analyze.
- Apply different types of tests to test the hypothesis relating to small samples.
- Appreciate the concepts of probability, distributions and various stochastic process.
- Perform modeling and simulations experiments for select biological processes using appropriate data.

REFERENCE BOOKS

1. Statistical methods in Bioinformatics by Warren J. Ewens, Gregory R. Grant, Springer 2nd edition, 2006.
2. An Introduction to Biostatistics by P. S. S. Sundar Rao and J. Richard, Prentice Hall of India, publications, 4th edition, 2006.
3. Biostatistics: A foundation for Analysis in the Health sciences by Wayne W. Daniel, John 7th edition, 2000.
4. Fundamentals of Biostatistics by Veer BalaRastogi, Ane Books India.

1. Principles of Biostatistics by Marcello Pagano & Kimberlee G, Thompson Learning.
2. Introduction to Biostatistics by Ronadd N Forthofer and EunSul Lee, Academic Press.
3. Mathematical Models in Biology and Medicine by J.N.Kapur New Age International.
4. Introduction to Biostatistics by Ipsen, Feigl & Bancroft, Harper & Row, Publishers,NY.
5. Basic Biostatistics & its Applications by Animesh K Datta , New Central Book Agency.
6. Fundamentals of Biostatistics by P Hanumanth Rao and K Janardhan, IK Intl. Publishers.
7. Biostatistics by Rastogi V.B. Medtec 3rd ed , 2015

TITLE OF THE COURSE: BIOCHEMICAL THERMODYNAMICS

B.E., IV Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT42	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

- To know the basic concepts of thermodynamics in process industry.
- To understand the significance of zeroth, I, II & III laws of thermodynamics.
- To be aware of concepts of thermodynamic properties of fluids & demonstrate various equations of state & their applications.
- To illustrate the importance of partial molar properties & the concepts of phase equilibrium.
- To illustrate the concepts of chemical reaction equilibrium.

MODULE – 1

BASIC CONCEPTS & LAWS OF THERMODYNAMICS:

System, Surrounding & Processes, Closed and Open systems, State Properties, Intensive & Extensive Properties, State and Path functions, Equilibrium state, enthalpy, specific heat, Reversible and Irreversible processes.

Zeroth law of Thermodynamics, General statement of First law of Thermodynamics, First law for Cyclic Process, Non- Flow Process, Flow process, Heat capacity. Heat reservoir and Heat engines. General statements of the second law, Concept of entropy, Carnot principle, Calculation of entropy changes, Clausius inequality, Entropy and Irreversibility, Third law of Thermodynamics. Numericals.

L1, L2

MODULE –2

PVT BEHAVIOUR AND COMPRESSIBILITY CHARTS:

PVT Behavior of pure fluids, equations of state & ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic & polytrophic processes, Equations of state for real gases: Vander Waals equation, Redlich-Kwong equation, Peng-Robinson equation, virial equation. Numericals.

Principles of corresponding states, generalized compressibility charts, Heat effects accompanying chemical reactions, Standard heat of reaction, formation, combustion, Hess's law of constant heat summation, effect of temperature on standard heat of reaction. Numericals.

L1,L2, L3

MODULE – 3

PROPERTIES OF PURE FLUIDS & THERMODYNAMIC DIAGRAMS:

Reference properties, energy properties, derived properties, work function, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, modified equations for internal energy (U) & enthalpy (H), Effect of temperature on U, H & Entropy (S). Gibbs-Helmholtz equation. Concept of Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, solids and liquids, Activity: Effect of temperature and pressure on activity. Numericals.

Thermodynamic diagrams – types of diagrams and construction of thermodynamic diagrams. Numericals.

L1, L2, L3

MODULE – 4

PROPERTIES OF SOLUTIONS & PHASE EQUILIBRIA:

Partial molar properties of solution and its determination , chemical potential –effect of temperature and pressure , lewis –randall rule, Raoults law for ideal solutions, fugacity in solutions, Henry's law and dilute solutions – ideal behavior of real solutions and Henry's law, Activity in solutions, Activity coefficients – effect of temperature and pressure, Gibbs - Duhem equation, calculation of activity coefficients using Gibbs-Duhem equation. Numericals.

Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions, Consistency test for VLE data, Azeotropes. Numericals.

L1, L2, L3

MODULE – 5

BIOCHEMICAL ENERGETICS:

Coupled reactions and energy rise compounds, Reaction Stoichiometry, criteria of biochemical reaction equilibrium, equilibrium constant and standard free energy change, effect of temperature, pressure on equilibrium constants and other- factors affecting equilibrium conversion – Le – chatelier's principle, liquid phase reactions, heterogeneous bioreaction equilibria, phase rule for reacting systems, Liquid-Liquid Equilibrium diagrams. Numericals.

L2, L3

Course outcomes:

After studying this course, students will be able to:

- State & describe the concepts of system, surrounding, process, laws of thermodynamics & entropy.
  Explain the PVT behavior of pure fluids & gases & derive equations of state for real gases.
- Distinguish between work function, gibbs free energy & analyze the thermodynamic diagrams.
- Determine the partial molar properties , activity coefficients of the solution.
- Illustrate the phase rule for reacting systems and effect of temperature, pressure on equilibrium constants

1. Chemical Engineering Thermodynamics by Y.V.C. Rao, New Age International.
2. A Textbook of Chemical Engineering Thermodynamics, 1st Ed (2001) by K.V. Narayanan, PHI.
3. Principles of Biochemistry by Lubert Stryer, Freeman Int. Edition.
4. Biochemistry by Mathews, Vanholde & Arhen, Pearson Education.
5. Biochemistry by Garett & Grisham, Thompson Learning.

TEXT BOOKS

1. Introduction to Chemical Engineering thermodynamics, 6th Ed (2003) by J.M. Smith ,H.C. Van Ness & M.M.Abbott. MGH.
2. Biochemical Calculations, 2nd Ed,(1976) by Irwin H.Segel, John Wiley & Sons.
3. Engineering Thermodynamics by R K Singal, I K Intl.

4. Engineering Thermodynamics by Spading and Cole, ELBS.
5. Engineering Thermodynamics by Jones J.B. Hawkins, John Wiley.
6. Principles of Biochemistry by Albert Lehninger, CBS publishers.
7. Bioenergetics by L Eruster, Academic Press, New York

TITLE OF THE COURSE: MOLECULAR BIOLOGY

B.E., IV Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT43	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

- The underlying concepts of Central Dogma and learn the mechanism of replication of DNA, Transcription of a gene and Translation of mRNA.
- Gene expression in a prokaryotic and eukaryotic cell.
- The importance of genetic recombination, damage and repair.

MODULE – 1

INTRODUCTION & REPLICATION OF DNA:

Chromosomal theory of heredity, genes and their location. Genetic code, Information flow in biological systems: central dogma, updated central dogma. Structures and forms of nucleic acids – DNA and RNA. Replication of DNA, structure and function of DNA polymerases, models of replications in prokaryotes, mechanism of DNA replication and enzymes involved.

L1,L2, L3

MODULE –2

TRANSCRIPTION:

Structure and function of RNA polymerases (prokaryotes & eukaryotes), mechanism of transcription in prokaryotes and eukaryotes, transcription factors, post-transcriptional processing (RNA editing, siRNA, splicing, poly A tail and 5' capping),
transcription inhibitors.

L1,L2, L4

MODULE – 3

TRANSLATION:

Mechanism of translation, activation of amino acid initiation, elongation and termination of protein synthesis. Post translational modification and protein targeting, protein splicing. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation.

L1, L2, L3

MODULE – 4

GENE EXPRESSION IN PROKARYOTES & EUKARYOTES:

Regulation of gene expression in prokaryotes: Operon model, gal, lac, trp Operons; positive versus negative regulation. Regulation of eukaryotic gene expression, transcriptional control, homeobox in the control of developments in insects and vertebrates.

L1, L2, L3, L4

MODULE – 5

GENETIC RECOMBINATION, MUTATION & GENE MAPPING:

Genetic recombination in bacteria and viruses, site specific recombination, transposons and insertion sequences; Retroviruses. DNA damage & Repair, Mutation, Role of recombination

and transposition in evolution; gene mapping techniques.

L1, L2, L3, L4

Course outcomes:

After studying this course, students will be able to:

- Explain replication, transcription and translation processes with underlying differences in prokaryotic and eukaryotic systems.
- Elaborate importance of genetic recombination with special reference to bacterial system.
- Outline DNA damage and repair mechanisms

REFERENCE BOOKS

1. Statistical methods in Bioinformatics by Warren J. Ewens, Gregory R. Grant, Springer 2nd edition, 2006.
2. An Introduction to Biostatistics by P. S. S. Sundar Rao and J. Richard, Prentice Hall of India, publications, 4th edition, 2006.
3. Biostatistics: A foundation for Analysis in the Health sciences by Wayne W. Daniel, John 7th edition, 2000.
4. A Textbook of Molecular Biology by S.M Gopinath, Archers & Elevators International Publishing House India. 1st Edition. 2014.
5. Fundamentals of Biostatistics by Veer BalaRastogi, Ane Books India.

1. Essentials of Molecular Biology by David Freifelder, Narosa Pub. House.
2. Molecular Biology of the Cell by Alberts et al., Garland Publishing.
3. Principles of Gene manipulation and Genomics by Primrose, Oxford University Press.
4. Molecular Biology of the Gene by James D Watson et al., Pearson Education

TITLE OF THE COURSE: BIOPROCESS PRINCIPLES & CALCULATIONS

B.E., IV Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT44	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Learn fundamentals of chemical calculations and material and energy balance.
- Discuss the material balance aspects involving chemical reactions and without chemical reactions.
- Highlight the energy balance and material balance for the development of bioprocess technology

MODULE – 1

BASIC CHEMICAL CALCULATIONS AND MATERIAL BALANCE:

Concept of atom and mole, expressing composition of mixtures in Solids, liquids and gases. Expressing composition of mixtures and solutions - Percentage by weight percentage, mole percentage and Volume percentage; Normality, Morality, Molality. Generalized material balance equations for distillation,
absorption, extraction, crystallization, mixing, drying & evaporation.

L1,L2, L3

MODULE –2

MATERIAL BALANCE WITHOUT CHEMICAL REACTIONS AND FUELS

Material balances calculation in Distillation, Absorption, Extraction, Crystallization, Drying, Mixing and Evaporation Operations, Fuels – types of fuels, (solid, liquid and gaseous fuel), relevance to biofuels, characteristics of fuels, Ultimate and proximate analyses of fuels..

L1,L2, L3

MODULE – 3

MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS:

Material balances calculation involving bypass, recycle and operations. Generalized material balance equations, Principles of stoichiometry, Definitions of limiting and excess reactants, fractions and percentage conversion, yield and percentage yield, Selectivity, unit process – neutralization, oxidation, nitration,
hydrolysis, and problems relating to these unit processes.

L1, L2, L3,L4

MODULE – 4

ENERGY BALANCE:

General energy balance equation for steady state. Heat capacit y, estimation of heat capacity for solids, liquids, gases and their mixtures. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion and calorific value, Calculation of heat of reaction at elevated temperature.

L1, L2, L3, L4

MODULE – 5

BIOPROCESS PRINCIPLES & STOICHIOMETRY OF BIOPROCESS:

Historical development of bioprocess technology; Bioprocess principles and operations, generalized process flow sheets. General material balance equation for steady state (for manufacture of penicillin and ethanol) - outline of a bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses. Stoichiometry of microbial growth and product formation.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Discuss the significance of material and energy balance for bioprocess technology.
- Solve problems related to material and energy balance to give solutions for bioprocess development.
- Develop the flow-sheet for general processes operating in bioprocess industry.
- Appreciate the stoichiometry of microbial growth and product formation involved in bioprocess technology

1. Basic Principles and Calculations in Chemical Engineering by David Himmelblau, PHI
2. Bioprocess Engineering by Shule and Kargi, Prentice Hall.
3. Chemical Process Calculations by R. Asokan, University Press, 2011.

1. Principles of Biochemistry by David L. Nelson (Editors), W.H. freeman and company.
2. Bioprocess Engineering Principles by Pauline Doran, Academic Press.
3. Biochemical Engg. Fundamentals by J E Bailey & D. F. Ollis, McGraw Hill.
4. Biochemical Calculations by I.H.Segel, John Wiley & Sons

TITLE OF THE COURSE: STRUCTURAL BIOLOGY

B.E., IV Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT45	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Appreciate the importance of structure, scope and function of macromolecules.
- Understand the structure organization, work and function of macromolecules at molecular level.
- Know the various qualitative and quantitative physical methods available for structure elucidation.
- Learn the various interactions involved in macromolecular structure and their roles towards stability and function

MODULE – 1

INTRODUCTION & PROTEIN STRUCTURE:

Levels of molecular organization, Brief discussions on: Amino acids, Nucleic acids, Adenylates, Carbohydrates, Lipids, Cofactors, Vitamins, and Hormones. Composition and primary structures of proteins, Conformational analysis and forces that determine protein structures, geometries, phi, psi, omega angles, Ramachandran or steric contour diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, hydrophobic interactions, vanderwaals forces, potential energy calculations, alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, folding kinetics, protein-ligand interactions, Scatchard plot, cooperative interactions, allosteric effects, Hill constant; Relationship between the primary, secondary, and tertiary structure of proteins. Structure of IgG, fibrous proteins (structure of collagen, keratin). Quaternary structures - dimers, homo & hetero dimers, trimers, tetramers; Protein folds, structural families and classes, multifunctional domains (qualitative examples).

L1,L2

MODULE –2

STRUCTURE OF NUCLEIC ACIDS AND BIOMEMBRANES:

General characteristics of nucleic acid structures (A, T, G, C, U), forces and stabilizing geometries, glycosidic bond, rotational isomers. Stabilizing ordered forms of DNA (A, B and Z), base pairing types, base stacking, tertiary structure of DNA (Supercoiled DNA), Melting of the DNA double helix (Hyperchromicity), Interaction with small ions and small molecules. Ribose puckering and Tertiary structure of tRNA. Structure and conformational properties of cell membranes, Singer and Nicholson model, integral proteins in membranes, conformational variations during ion transport, Signal transduction and molecular reception (qualitative).

L1,L2, L3

MODULE – 3

BIOPHYSICAL TECHNIQUES:

Rayleigh scattering, ultra-centrifugation, viscometry. Electron microscopy (SEM-TEM, AFM), luminescence (fluorescence & phosphorescence), Calorimetry, DSC, Mass spectrometry, LCMS, MALDI-TOF, Voltage Clamp and Patch Clamp (measurements of membrane potentials).

L1, L2,L3,L4

MODULE – 4

SPECTROSCOPIC TECHNIQUES:
X-ray diffraction: structure determination via single crystal diffraction, fibre diffraction; Neutron diffraction. XAFS. NMR spectroscopy (structure determination). ORD/CD, UV, IR, Laser Raman, ESR/EPR.

L1, L2, L3, L4

MODULE – 5

BIOMOLECULAR INTERACTIONS & MOLECULAR DYNAMICS: Association of macromolecules, molecular conjugates, supramolecular interactions, protein-protein interactions, protein-nucleic acid interactions, lipid/membrane-protein interactions. Molecular mechanics and dynamics (Newtonian and Monte Carlo simulations), theoretical principles and its importance towards insilico simulations, results of molecular dynamics calculations and their implications to biological function.

L2, L3,L4,L5

Course outcomes:
After studying this course, students will be able to:

- Present the foundational principles of macromolecular structure and function.
- Apply diverse techniques that enable the elucidation of molecular structure, their organization, stability, associations and functionalities.

1. Biophysics – An Introduction by Cotterill, Wiley Student Edition.
2. Foundations of Biophysics by A.L. Stanford, Academic Press.
3. Principles of protein structure by G Schulz and R H Schrimer, Springer Verlag.
4. Principles of nucleic acid structure by Sanger, Springer Verlag.
5. Introduction to Protein Science by Arthur M Lesk, Oxford University Press.
6. Biological Spectroscopy by J. D. Campbell and R. A.Dwek, Plenum Press.
7. A Textbook of Biochemistry and Biophysics by S.M Gopinath, Archers & Elevators International Publishing House, India. 1st Edition, 2014.

1. Biophysical Chemistry by Cantor R. and Schimmel P.R, W. H. Freeman.
2. Physical Biochemistry by David Freifelder, W H Freeman and Company.
3. Biophysical Principles of Structure & Function by Fred M. Snell & Sidney Shulman.
4. Introduction to Protein Structure by Carl Branden and John Tooze, Garland Publishing.
5. Proteins Structure – A Practical Approach by Creighton, Oxford University Press.
6. Physical Chemistry: Principles and Applications in Biological Sciences by Tinoco and others, Prentice Hall.

TITLE OF THE COURSE: CLINICAL BIOCHEMISTRY

B.E., IV Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT46	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

- Learn the structure and function of metabolic pathways for carbohydrates, amino acids and lipids; their alterations in disorders.
- Gain insight into the clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions.

MODULE – 1

DISORDERS OF CARBOHYDRATE METABOLISM:

Diabetes mellitus, glycohemoglobins, hypo-glycemias, galactosemia and ketone bodies. Various types of glucose tolerance tests. Glycogen storage diseases. Physiology of lipids/lipoproteins. Lipidosis. Clinical inter-relationships of lipids (sphingolipidosis and multiple sclerosis), lipoproteins and apolipoproteins. Diagnostic tests for HDL-cholesterol, LDL-cholesterol and triglyceride disorders.

L1, L2

MODULE –2

INBORN ERRORS OF METABOLISM:

a) Disorders of amino acid metabolism - Phenylalanemia, homocystinuria, tyrosinemia, MSUD, phenylketonuria, alkaptonuria, albinism and animoacidurias.

b) Disorders of nucleic acid metabolism- Disorders in purine/ pyrimidine metabolism.

L1, L2, L3

MODULE – 3

DISORDERS OF ACID-BASE BALANCE AND THEIR RESPIRATORY AND RENAL MECHANISMS:

Evaluation of organ function tests,Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions. Clinical importance of bilirubin. Diagnostic enzymes: Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase. Enzyme tests in determination of myocardial infarction. Enzymes of pancreatic origin and biliary tract.

L1, L2, L3

MODULE – 4

HORMONAL DISTURBANCES

Protein hormones (anterior pituitary hormones, posterior pituitary hormones), steroid hormones, adrenocorticosteroids, and reproductive endocrinology. Disturbances in thyroid function. Disorders of mineral metabolism: Hypocalcaemia, hypocalcaemia, normocalcaemia, hypophosphatemia and hypophosphatemia.

L1, L2, L3, L4

MODULE – 5

BIOCHEMICAL ASPECTS OF HEMATOLOGY:

Disorders of erythrocyte metabolism, hemoglobinopathies, thalessemias thrombosis and anemias.

Laboratory tests to measure coagulation and thrombolysis. Detoxification in the body: enzymes of detoxification, polymorphism in drug metabolizing enzymes. Mechanism of drug action and channels of its excretion, Disorders of vitamins and trace elements..

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Discuss the biochemistry and pathophysiology associated with various disorders of metabolism and inborn errors of metabolism.
- Describe the structure and function of metabolic pathways for carbohydrates, amino acids and lipids.
- Explain the medical problems associated with abnormal lipoprotein levels and therapeutic agents used to treat lipid disorders.
- Assess the clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions.

REFERENCE BOOKS

1. Review of Medical Physiology (Lange Basic Science) (Paperback) By William F. Ganong. Publisher: McGraw-Hill Medical
2. Harper's Biochemistry (Lange Medical Books) (Paperback) By Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange. 8. Clinical Biochemistry by Richard Luxton. Scion Publishing Ltd.
3. Clinical Biochemistry Paperbackby Nanda Maheshwari, 2008.
4. Appreciate the biochemical aspects of hematology.

TEXT BOOKS

1. Textbook of Medical Biochemistry by MN Chatterjea and Rana Shinde, Jaypee Brothers.
2. Lehninger- Principles of Biochemistry by David L. Nelson and Michael M. Cox, 5th Edition, WH Freeman and Company.
3. Medical Biochemistry (Paperback) By John W. Baynes and Marek Dominiczak. Publisher: Mosby.
4. Clinical Biochemistry: 3rd Ed By Allan Gaw, Michael Murphy, Robert Cowan, Denis O'Reilly, Michael Stewart and James Shepherd. Publisher: Churchill Livingstone.

TITLE OF THE COURSE: CELL & MOLECULAR BIOLOGY LABORATORY

B.E., IV Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BTL47	CIE Marks	40
Number of Lecture Hours/week	03=(1 Hour Instruction + 2 Hours Laboratory)	SEE Marks	60
Total Number of Hours	40	Exam Hours	03
RBT Levels	L1, L2, L3, L4,L5		

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in

- To understand the cell division: Mitosis and Meiosis.
- To study the somatic cell hybridization.
- To learn isolation of DNA from various sources
- To learn agarose gel electrophoresis for separation of nucleic acids

Experiments:

1. Study of divisional stages in Mitosis.
2. Study of divisional stages in Meiosis.
3. Study of Polytene and Lampbrush chromosomes using permanent slides.
4. Isolation and fusion of plant protoplasts.
5. Isolation of plasmid DNA from bacteria.
6. Isolation of genomic DNA (plant / microbial sources)
7. Agarose gel electrophoresis and quantification of nucleic acids (colorimetric, ethidium bromide dot blot and standard DNA marker)
8. Digestion and mapping of plasmid pUC18.
9. Competent cell preparations.
10. Transformation and selection of recombinants.
11. Study of conjugation in *E.coli.*
12. Amplification of DNA by PCR.

Course outcomes:

On the completion of this laboratory course, the students will be able:

- To be able to understand the mitotic and meiotic cell divisions;
- To be able to carry out somatic cell fusion;
- To separate DNA and run various fragments through electrophoresis

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.
- Instructions as printed on the cover page of answer script for split up of marks to be strictly followed.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.

6. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Molecular Cell Biology by Darnell J Lodish& H Baltimore, Freeman Pub
2. Biochemistry & Molecular Biology by William H Elliot and Daphane C Elliot, Oxford University Press
3. Current protocols in molecular biology,edited by Frederick M. Ausubel et al., John Wiley & Sons
4. Methods in enzymology by Berger S.L. & Kimmel A.R., Vol.152, Academic Press.
5. Cellular & Biochemical Science by G. Tripathi, IK Intl.

TITLE OF THE COURSE: CLINICAL BIOCHEMISTRY LABORATORY

B.E., IV Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BTL48	CIE Marks	40
Number of Lecture Hours/week	03=(1 Hour Instruction + 2 Hours Laboratory)	SEE Marks	60
Total Number of Hours	40	Exam Hours	03
RBT Levels	L1, L2, L3, L4,L5		

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in:

- Qualitative and quantitative analyses of cellular components and processes.
- Design lab experiments, to make understand as to how problems are scientifically solved with supporting data.
- Acquire means to manage experiments independently

Experiments:

1. pH measurements, volume / weight measurements, concentration units, sensitivity. Specificity, precision, accuracy, preparation of buffers of constant strength.
2. Titration of amino acids with acids & bases.
3. Qualitative tests for carbohydrate and lipids.
4. Qualitative tests for amino acids and proteins.
5. Estimation of blood sugar by Folin method and by O-toluene method.
6. Estimation of inorganic phosphate by Fiske-Subbarao method.
7. Estimation of amino acid by ninhydrin method.
8. Estimation of total cholesterol from Serum.
9. Determination of Saponification value and iodine value of lipids with error analysis.
10. Determination of acetyl value of a lipid with error analysis.
11. Estimation of urea by diacetyl monooxime method with error analysis.
12. Estimation of iron from hemoglobin with error analysis.

Course outcomes:

On the completion of this laboratory course, the students will be able to:

- Know about biomolecules with special reference to physiological samples.
- Determine the levels of metallic ions, fats and oils and other biomolecules.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% Marks allotted to the procedure

part to be made zero.

Reference Books:

1. Modern Experimental Biochemistry by Rodney Boyer, Pearson Education.
2. Practical Biochemistry by Cole, Cambridge University Press.
3. Practical Biochemistry by Keith Wilson, Cambridge University Press.
4. An introduction to practical biochemistry by Plummer, Tata McGraw Hill.
5. Experimental Biochemistry by Beedu Sashidhar Rao and Vijay Deshpande, I.K.Intl.
6. Lab Math by Dany Spencer Adams, IK Intl. Pub. House.
7. Lab Ref by Jaine Roskams & Linda Rodgers, IK Intl. Pub. House.
8. Manual of Practical Biochemistry for medical students, 2nd edition, University Press.
9. Practical Manual Of Biochemistry by Sharma S. Medtech ,2016

FIFTH SEMESTER

TITLE OF THE COURSE: BIO-KINETICS AND BIO-REACTION ENGINEERING B.E., V Semester, Biotechnology [As per Choice Based Credit System (CBCS) scheme]			
Course Code	17BT51	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

- To discuss the different models of chemical reactions and how various factors such as temperature can affect reaction rate.
- To study the performance and distinguish between the different types of ideal and non ideal reactors
- To determine the optimum pH, temperature and concentration of an enzyme's catalytic power, its substrate affinity and inhibitor role
- To comprehend the fundamentals of Microbial growth kinetics and its stoichiometry
- To describe medium requirements and medium formulation to get optimal bioprocesses model

MODULE – 1

INTRODUCTION:

Law of mass action and rate equation, definitions and examples of elementary and nonelementary reactions, theories of reaction rate and temperature dependency, analysis of experimental reactor data - evaluation of rate equation by integral and differential analysis for constant volume system . Conceptual numericals**.**

L1, L2,L3

MODULE –2

BIOREACTORS:

Design equations for homogeneous system - batch, stirred tank and tubular flow reactor, size comparison of single reactors, combination of reactor systems - Qualitative design for parallel and series reactors and recycle reactors. Conceptual numericals.

L2,L3

MODULE – 3

NON-IDEAL BIOREACTORS:

Non-ideal reactors, residence time distribution studies for pulse and step input, Exit age distribution of fluid in reactors, RTD's for CSTR and PFR, calculations of conversions for First order reactions, tanks in series models. Conceptual numericals.

L2, L3

MODULE – 4

ENZYME KINETICS

Enzyme active site, types of enzyme specificities, enzyme kinetics, initial velocity studies, formation of ES complex, derivation of Michaelis-Menton equation, definition of Km and Vmax, Lineweaver-Burk and Eadie-Hofstee plots. Units of enzyme activity, Enzyme inhibition: competitive, uncompetitive and non-competitive; Regulations – allosteric and feed back regulation. Conceptual numericals.

L1, L2,L3

MODULE – 5

KINETICS OF MICROBIAL GROWTH AND MEDIA DESIGN:

Monod model; Growth of Filamentous Organisms. Growth associated (primary) and nongrowth associated (secondary) product formation kinetics; Leudeking-Piret models; substrate and product inhibition on cell growth and product formation; Conceptual numericals.

Medium requirements for fermentation processes- Carbon, nitrogen, minerals, vitamins and other complex nutrients; oxygen requirements; Medium formulation for optimal growth and product formation - examples of simple and complex media; thermal death kinetics of microorganisms; Batch and continuous heat – Sterilization of Liquid media; Filter sterilization of liquid media.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Understand the different importance of kinetic and thermodynamic considerations for the choice of feed temperature in reactor systems.
- Explain the different steps in reaction mechanisms on catalytic surfaces and identify the rate-determining step.
- Comprehend the fundamentals of Microbial growth kinetics and its stoichiometry
- Analyze the kinetic study of enzymes and its regulation.
- Develop suitable environment for microbial growth by analyzing various parameters.

REFERENCE BOOKS

1. Bioprocess Engineering by Aiba, Humprey & Millis, Academic Press. Biochemical Engineering by James Lee, Prentice-Hall.
2. Biochemical Engineering Fundamentals by Bailey and Ollis, McGraw Hill.
3. Bioprocess Engineering Principles by Pauline M. Doran, Elsevier Science
4. Principles of Biochemistry by Albert Lehninger, CBS publishers
5. Bioenergetics by L Eruster, Greena Publishing Associates.
6. Enzyme Kinetics by Plowman, McGraw Hill.
7. Chemical Engineering Kinetics by Smith J.M., McGraw Hill. Wolf R. Vieth,
8. Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression. A Wiley – Interscience Publication.
9. Chemical Reactor Analysis and Design by Forment G F and Bischoff K B., John Wiley.
10. Biocatalytic Membrane Reactor by Drioli, Taylor & Francis.

1. TEXT BOOKS Chemical Reaction Engineering by Levenspiel O., John Wiley.
2. Elements of Chemical Reaction Engineering by Fogler, H.S., Prentice Hall.
3. Bioprocess Engineering by Shuler and Kargi Prentice Hall.
4. Enzyme Kinetics and Mechanism by Paul F Cook & W W Cleland, Garland Science.

TITLE OF THE COURSE: GENETIC ENGINEERING & APPLICATIONS

B.E., V Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT52	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to learn

- about rDNA technology, vectors and enzymes used in genetic engineering.
- acquire the knowledge of specific techniques like PCR, NA hybridization & libraries.
- about various gene transfer techniques, applications of transgenic plants & animals and importance of gene therapy.

MODULE – 1

VECTORS & ENZYMES IN GENETIC ENGINEERING:

Vectors in rDNA technology, salient features of vectors, types of vectors-plasmids, cosmids, phagemids and viruses. Construction of rDNA & vectors (BAC, Blue script and YAC). Exonucleases and Restriction Endonculeases: classification, mode of action. Enzymes in modification - Polynucleotide phosphorylase, DNase, Methylases, phosphatases, polynucleotide Kinase, Ligases, RNase and their mechansim of action.

L1, L2, L3

MODULE –2

NUCLEIC ACID HYBRIDIZATION, AMPLIFICATION & CONSTRUCTION OF LIBRARIRES:

Methods of nucleic acid detection, polymerase chain reaction (PCR), variants of PCR and applications, methods of nucleic acid hybridization, Southern, Northern & Western hybridization techniques & applications. Isolation of nucleic acids (DNA & RNA). Isolation of plasmids, construction of genomic and cDNA libraries, purification, screening and preservation.

L2, L3

MODULE – 3

METHODS OF GENE/DNA TRANSFER:

Overview & classification of gene transfer techniques in plants, animals and microbes – Transformation, stable & transient transformation, transfection, electroporation, microinjection, liposome mediated gene transfer, transfection of DNA by calcium phosphate coprecipitation, gene gun method. *Agrobacterium*-mediated gene transfer in plants – Ti & Ri plasmids: structure and functions, Ti plasmid based vectors – advantages, disease control of *Agrobacterium tumefaciens*. Chloroplast transformation & its applications.

L2, L3

MODULE – 4

TRANSGENIC SCIENCE IN GENETIC IMPROVEMENT

Transgenic science in plant improvement, biopharming – plants as bioreactors, transgenic crops for increased yield, resistance to biotic and abiotic stresses. Techniques of gene mapping in plants. Marker-assisted selection and breeding for improvement. Transgenic science for animal improvement, biopharming - animals as bioreactors for recombinant proteins, Gene mapping in

farm animals. Marker-assisted selection and genetic improvement of livestock.

L1, L2, L3

MODULE – 5

OTHER APPLICATIONS & GENE THERAPY

Microbial biotechnology - Genetic manipulation, engineering microbes for the production of antibiotics, enzymes, Insulin, growth hormones, monoclonal antibodies, clearing oil spills. Introduction to gene therapy. Methods of Gene therapy. Gene targeting and silencing. Gene therapy in the treatment of cancer, SCID, muscular dystrophy, respiratory disease (emphysema), cystic fibrosis. Challenges & future of gene therapy.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Explain & compare the different vectors & enzymes used in the construction of recombinant DNA in Genetic engineering
- Choose& explain specific techniques like PCR, Blotting & construction of libraries
- Differentiate between & learn the different gene/DNA transfer techniques
- Outline the various methods of producing transgenic organisms and sub-divide/summarize the applications of genetic engineering for the welfare of mankind & society

1. Molecular Biotechnology
2. Genetic Engineering
3. Recombinant DNA
4. Vectors
5. Principles of Microbe & Cell Cultivation
6. Basic Biotechnology
7. Applied Bioremediation and Phytoremediation

TEXT BOOKS

1. The Molecular pathology of human disease- From genetics to gene therapy
2. Introduction to Genetic Engineering
3. DNA Science: A first course
4. Industrial Microbiology
5. Molecular Biotechnology– Principles and Applications of recombinant DNA
6. Industrial Microbiology
7. Industrial Microbiology- An introduction
8. Principles of gene manipulation- An introduction to genetic engineering
9. Genes VIII

TITLE OF THE COURSE: IMMUNOTECHNOLOGY

B.E., V Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT53	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

- Learn the underlying concepts of molecular and cellular mechanisms involved in the development and regulation of the immune response
- Describe the cause and treatment for Immune System Pathologies and Dysfunctions.
- Learn the importance techniques of Immunodiagnosis.

MODULE – 1

IMMUNE SYSTEM :

Cells of immune system, innate and acquired immunity, primary and secondary lymphoid organs, Antibodies and their structure, structure and function of immunoglobulins; immunoglobulin classes and subclasses (allotypes, idiotypes and anti-idiotypic antibodies)antigens: chemical and molecular nature, clonal selection theory, humoral and cellular immunity.

L1,L2, L3

MODULE –2

HUMORAL AND CELL MEDIATED IMMUNITY:

B-lymphocytes and their activation, antibody genes and generation of diversity, production of monoclonal antibodies, polyclonal antibodies and applications, cytokines, Thymus derived lymphocytes (T cells) - their ontogeny and types, MHC Complex, antigen presenting cells (APC), Activation of T-cells, antigen processing and presentation, Major histocompatibility Complex- MHC Class I and II molecules.

L1,L2, L3

MODULE – 3

INFECTION AND IMMUNITY:

Injury and inflammation, immune response to infections: immunity to viruses, bacteria, fungi and parasites, complement, Hypersensitivity, Immunodeficiencies, Criteria and causes of autoimmune disorders, types of autoimmunity, rheumatoid arthritis, animal model.

L1, L2, L3

MODULE – 4

TRANSPLANTATION AND TUMOR IMMUNOLOGY:

Relationship between donor and recipient, role of MHC molecules in allograft rejection, bone marrow and haematopoietic stem cell transplantation, tumor antigens, categories of tumor antigens, tumor immunoprophylaxis. immunosupression, tolerance, resistance and immunization, vaccines.

L1, L2, L3

MODULE – 5

MOLECULAR IMMUNOLOGY & IMMUNODIAGNOSIS

Catalytic antibodies, application of PCR technology to produce humanized antibodies (Single chain fragment variable), immunotherapy with genetically engineered antibodies, Brief mention about stem cells and applications to immunology, Antigen antibody interaction – Precipitation reactions, Agglutination reactions, Blood typing, A, B, ABO & Rh, principles and applications of ELISA,

Radio Immuno Assay (RIA), western blot analysis, immuno-electrophoresis, Immunofluorescence, chemiluminescence assay, fluorescence activated cell sorting analysis.

L1, L2, L3, L4

Course outcomes:

After studying this course, students will be able to:

:

- Outline the molecular and cellular mechanisms involved in the development and regulation of the immune response,
- Describe the cause, challenges and treatment for Immune System Pathologies and Dysfunctions.
- Apply the major immunological laboratory techniques and their application to both clinical analysis and experimental research

REFERENCE BOOKS

1. Essential Immunology by Roitt I. Blackwell Scientific Publications, Oxford.
2. Molecular Immunology By Benjamini E.
3. Immunology a short course by Benjamini E. and Leskowitz S. Wiley Liss.
4. The Immune System by Peter Parham, Garland Science.
5. Understanding Immunology by Peter Wood, Pearson Education.

TEXT BOOKS

1. Immunology – an Introduction by Tizard, Thomson.
2. Immunology by J Kuby, WH Freeman**.**
3. Immunology & Immunotechnology by Ashim K Chakravarthy, Oxford University Press.
4. Immundiagnostics by S C Rastogi, New Age International

TITLE OF THE COURSE: BIOINFORMATICS

B.E., V Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT54	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Learn fundamentals of chemical calculations and material and energy balance.
- Discuss the material balance aspects involving chemical reactions and without chemical reactions.
- Highlight the energy balance and material balance for the development of bioprocess technology

MODULE – 1

DATABASES & SEQUENCE ALIGNMENT TOOLS:

Introduction to Bioinformatics, Need for informatics tools and exercises, Bioinformatics resources: NCBI, EBI, ExPASy, RCSB. Significance of databases towards informatics projects. Primary and Secondary Databases. GenBank, DDBJ, EMBL, PIR, Uniprot-KB, SWISS-PROT, TrEMBL, UniParc. Format of databases, Gene bank flat file. Protein Data Bank (PDB) flat file; FASTA Format, PIR Format; Structure file formats, PDBSUM, PDBLite, MMDB, SCOP, Pfam, ProDOM; Database of structure viewers. Specialized databases: NCBI, Pubmed, OMIM, Medical databases, KEGG, EST databases; Genome databases at NCBI, EBI, TIGR, SANGER. The evolutionary basis of sequence alignment, the Modular Nature of proteins, Optional Alignment Methods, Substitution scores, substitution matrices, PAM, BLOSUM, Gap penalties, Statistical significance of Alignments, Database similarity searching, FASTA, BLAST, Low-Complexity Regions, Repetitive Elements. Practical Aspect of Multiple Sequence Alignment, Progressive Alignment Methods, CLUSTALW, Motifs and Patterns, PROSITE, 3DPSSM. MeMe, PSI-BLAST, PHI-BLAST, PRATT, Hidden Markov Models (HMMs), and Threading methods. Conceptual numericals. Overview of other popular tools for various bioinformatics exercises.

L1,L2, L3

MODULE –2

PHYLOGENETIC ANALYSIS AND PREDICTIVE METHODS:

Introduction to Phylogenetic analysis, rooted and unrooted trees, Elements of phylogenetic Models, Phylogenetic Data Analysis: Alignment, Substitution Model Building, Tree Building, and Tree Evaluation, Tree - Building Methods-Distance based and character based methods, Evaluating Trees and Data- Boot strapping (parametric and non-parametric), Phylogenetic softwares (CLUSTALW, PHYLIP etc), Conceptual numericals.

Predictive Methods using Nucleotide sequences: Framework, Masking repetitive DNA, Database searches, Codon Bias Detection, Detecting Functional Sites in the DNA (promoters, transcription factor binding sites, translation initiation sites), Integrated Gene Parsing, finding RNA Genes, Web based tools (GENSCAN, GRAIL, GENEFINDER).

Predictive Methods using Protein sequences: Protein Identity based on composition, Physical properties Based on sequence, secondary structure and folding classes, specialized structures or

features, tertiary structure. Related web based software (JPRED, PROSEC, NNPREDICT, SOPMA, DSSP, STRIDE).

L1,L2, L3

MODULE – 3

GENOME BIOINFORMATICS:

Sequencing methods, Bioinformatics tools and automation in Genome Sequencing, analysis of raw genome sequence data, Utility of EST database in sequencing, Bioinformatics in detection of Polymorphisms, SNPs and their relevance**,** Bioinformatics tools in microarray data analysis. Tools for comparative genomics: BLAST2, AVID, Vista, MUMmer, COG, VOG. Qualitative discussions on Machine Learning Tools (Artificial Intelligence, Genetic algorithm and neural networks).

L1, L2, L3,L4

MODULE – 4

MOLECULAR MODELING & VIZUALIZATION:

Scope and applications of insilico modeling in modern biology. Comparative modeling, Constructing an initial model, refining the model, manipulating the model; molecular superposition and structural alignment, concept of energy minimization, different types of interactions and formulation of force fields. Basic MD algorithm, its limitations, treatment of long range forces. Structure Visualization and Graphical representation of molecular structures: small molecules (low molecular weight – peptides, nucleotides, disaccharides, simple drugs molecules) and macromolecules (high molecular weight molecules - proteins, DNA, RNA, membranes). Usages of visualization software available in public domain like VMD, Rasmol, Pymol, SpdbViewer, Chime, Cn3D and GRASP. Rotameric Structures of Proteins (Conformational Flexibility), Canonical DNA Forms (DNA Sequence Effects).

L1, L2, L3

MODULE – 5

PLASMID MAPPING, PRIMER DESIGN AND INSILICO DRUG DESIGN:

Restriction mapping, Utilities, DNA strider, MacVector and OMIGA, gene construction KIT, Vector NTI, Web based tools (MAP, REBASE); Primer design – need for tools, Primer design programs and software (PRIME3). Molecular modeling in drug discovery, deriving bioactive conformations, molecular docking, quantitative structure-activity relationship (QSAR), deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Ligand - Receptor Interactions: Docking softwares (AUTODOCK, HEX) Calculation of Molecular Properties, Energy Calculations (no derivation). Conceptual numericals.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Know the relevant online resources, databases and software tools
- Understand the underlying concepts of Bioinformatics
- Apply alignment and modelling tools
- Analyse biological data using phylogenetic, predictive and comparative methods
- Design in silico various biomolecules

REFERENCE BOOKS

1. Computational methods for macromolecular sequence analysis: R F Doolittle. Acad. Press.
2. Computational methods in Molecular Biology. S.L.Salzberg, D B Searls, S Kasif, Elsevier.
3. Bioinformatics – Methods And Applications: Genomics, Proteomics And Drug

4. Discovery by S C Rastogi, Nmendiratta &P Rastogi, PHI.
5. The Molecular Modeling Perspective in Drug Design by N Claude Cohen, Academic Press.
6. Analytical Tools for DNA, Genes & Genomes: By Arseni Markoff, New Age.
7. Introduction to Bioinformatics by Anna Tramontano, Taylor & Francis
8. Bioinformatics by Des Higgins & Willie Taylor Oxford.

TEXT BOOKS

1. Bioinformatics by Andreas D Baxevanis. Wiley Interscience.
2. Essentials of Bioinfomatics, Jin Xinog, Texas A & M University, Cambridge University Press.
3. Bioinformatics: By David W Mount, Cold Spring Harbor.
4. Introduction to Bioinformatics by Arthur Lesk, Iii Edition, Oxford Publications.
5. Structural Bioinformatics by Philip E Bourne, John Wiley & Sons.
6. Bioinformatics: Stuart M Brown, Nyu Medical Center, Ny USA.
7. Discovering Genomics, Proteomics & Bioinformatics by A M Campbell & L J Heyer,Pearson Education.
8. Fundamental Concepts Of Bioinformatics by D E Krane & M L Raymer, Pearson

TITLE OF THE COURSE: MICROBIAL BIOTECHNOLOGY

B.E., V Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT551	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- About the process & products of fermentation such as antibiotics, vitamins, enzymes, vaccines.
- Acquire the basic knowledge on the cloning & expression of therapeutic proteins in bacteria & yeast.
- Will be able to identify the need & importance of microbial by products such as xanthan gum, polyesters and the biodegradation of xenobiotic compounds.
- Define the various bioremediation & bioleaching processes and outline the foods from microorganisms.

MODULE – 1

MICROBIAL PROCESS ENGINEERING:

Introduction to microbial process development. Scale - up of microbial processes -Analysis of experimental data. Design & optimization of fermentation media. Kinetics of cell growth. Sterilization of air and media. Modes of cell culture. Bioreactor systems including utilities. Mass transfer in Microbial processes. Instrumentation and control of process parameters.

L1,L2,L3

MODULE –2

INDUSTRIAL MICROBIAL BT:

Strain improvement and screening of industrially important microorganisms. Industrial production of Vitamins (VitB12 & riboflavin), Antibiotics (β-lactam antibiotics, Aminoglycosides), organic acids (Citric acid, acetic acid) and Enzymes (amylases, proteases). Impact of Biotechnology on vaccine development; sub unit vaccines, DNA vaccines, recombinant vaccines, peptide vaccines. Bioinsecticides-Bacillus thuringinesis, B.sphaericus, B.popilliae, starch processing, textile designing, detergents, cheese industry, leather industry and wood pulp industry.

L1,L2, L3

MODULE – 3

MICROBIAL BY PRODUCTS & ENVIRONMENTAL MICROBIOLOGY:

Bacterial Polysaccharides – structure & role in nature. Xanthan Gum - structure, production & Biosynthesis polyesters. Industrial production of ethanol and amino acids (glutamic acid), Contamination in air, water and soil, Waste water microbiology, Microbiological Degradation of xenobiotics. Biomagnification.

L1, L2,L3

MODULE – 4

BIOREMEDIATION AND BIOLEACHING

Bioremediation: use of bacteria and biodegradation of hydrocarbons, in situ and ex situ Bioremediation, Immobilization of microbes for bioremediation, PCB dechlorination, Genetic engineering of microbes for bioremediation. Phytoremediation – plants capable of assimilating heavy metals. Biomethanation: application of microorganisms of biomethanation and cellulose

degradation- Methanotrophs and other orgnisnms. Bioleaching: direct and indirect mechanisms, microorganism in mineral recovery, recovery of copper by dump leaching, Sulfur Leaching by Thermophilic microorganisms, Microbial coal solubilization.

L1, L2, L3, L4

MODULE – 5

FOODS FROM MICROBES:

Fermented foods- fermented soya products-MISO, TEMPE, SUFU (Soybean cheese) & soya sauce, single cell protein (SCP) and single cell oil (SCO), food additives, preservatives, Antioxidants in foods, nutrient supplements, food colors-natural & synthetic equivalents, Novel food- *Spirulina* (blue green algae)-constituents, nutritional quality & therapeutic applications. Leaf protein concentrates (LPC).

L1, L2,L3

Course outcomes:

After studying this course, students will be able to:

- Describe the process of fermentation & outline the various products from the fermentation industry.
- Identify the appropriate methods for cloning of novel proteins in bacteria & yeast.
- Outline the need & importance of microbial by products such as xanthan gum, polyesters and the biodegradation of xenobiotic compounds.
- Describe the types of bioremediation & bioleaching processes and outline the various foods from microorganisms.

1. Microbiology by Bernard Davis & Renato Dulbecco, Lippincott Company, Philadelphia.
2. Principles of Microbe & Cell Cultivation by SJ Prit, Blackwell Scientific co.
3. Basic Biotechnology by Colin Ratledge & Bjorn Kristiansen, Cambridge University Press.
4. Applied Bioremediation and Phytoremediation by A Singh & O P Ward, Springer

1. Microbial Biotechnology by Alexander N Glazer and Hiroshi Nikaido, W H Freeman & Company New york.
2. Fundamentals of Biotechnology by Edited by Paule Prave, Uwe Faust, Wolfgang Sitting and Dieter A Sukatsch, VCH Publishers.
3. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Pergamon Press.
4. A textbook of Industrial Microbiology by Wulf Cruegar and Anneliese Cruegar, Panima Publishing Corporation.
5. Molecular Biotechnology– Principles and Applications of recombinant DNA by Bernard R Glick & Jack J pasternak , ASM Press.
6. Industrial Microbiology by Prescott and Dunn, CBS Publishers & Distributors.
7. Industrial Microbiology- An introduction by Michael J Waites, Neil L Morgan, Blackwell science.
8. Food microbiology by William C Frazier and Westhoff Dennis C, Tata McGraw Hill publication.
9. Industrial Microbiology by L.E Casida, New Age International.

TITLE OF THE COURSE: TRANSPORT PHENOMENA

B.E., V Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT552	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

- Fundamentals to solve problems involving transports of momentum, energy and mass in biological, mechanical and chemical systems using a unified approach.
- About various transport processes with understanding of solution approximation methods and their limitations.

MODULE – 1

MOMENTUM TRANSFER AND OVERALL BALANCES:

Viscosity And The Mechanism Of Momentum Transport: Effect of temperature and pressure on viscosity of fluids. Numerical problems on the application of Newton's law of viscosity.

Velocity Distribution in Laminar Flow: Steady state shell momentum balance, general boundary conditions applicable to momentum transport problems of Chemical Engineering. The flow situations for a) flow over a flat inclined plate, b) flow through a circular tube, c) flow through annulus. Simple numerical problems using the equations derived in the above fluid flow situations.

L1, L2, L3

MODULE –2

HEAT TRANFER:

Mechanism of Energy Transport: Fourier law of heat conduction. Temperature and pressure dependence on thermal conductivity of solids and fluids. Numerical problems on the application of fourier's law of heat conduction.

Temperature Distribution In Solids And In Laminar Flow: Steady state shell energy balances. General boundary conditions applicable to the heat conduction problems for, a) heat conduction with internal generation by electrical, nuclear, viscous b) heat conduction through compound walls, overall heat transfer coefficient, Forced and Free conduction heat transfer problems (only derivations).

L1, L2, L3

MODULE – 3

MASS TRANFER-I:

Mechanism of Mass Transport: Effect of temperature and pressure on diffusivity in liquid and gases.

Concentration Distributions In Solids And In Laminar Flow: Steady state shell mass balance,

General boundary conditions applicable to the mass transport problems of chemical engineering, on a) Diffusion through stagnant gas and liquid film b) Equimolar counter diffusion c) Diffusion with homogeneous and heterogeneous reaction d) Diffusion into falling film-forced convection mass transfer.

L1, L2, L3

MODULE – 4

MASS TRANSFER-II:

Mass transfer and diffusion, molecular diffusion in gases, liquids, biological solutions and gels, and solids.

Unsteady state diffusion, convective mass transfer coefficients, mass transfer to suspensions of small particle, diffusion of gases in porous solids and capillaries, numerical methods for unsteady state molecular diffusion, dimensional analysis in mass transfer, boundary layer flow and turbulence.

L1, L2, L3, L4

MODULE – 5

ANALOGIES BETWEEN MOMENTUM, HEAT AND MASS TRANSPORT & EQUATIONS OF CHANGE:

Numerical problems using analogies. a) Reynolds analogy b) Prandtl's analogy c) Chilton and Colburn analogy & d) Martinnelli's analogy.

Equation of continuity, equation of motion and Navier-Stokes equation, Application of this equation in solving simple steady state problems.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- understand the chemical and physical transport processes and their mechanism.
- do heat, mass and momentum transfer analysis.
- analyze industrial problems along with appropriate approximations and boundary conditions.
- develop steady and time dependent solutions along with their limitations.

1. Review of Medical Physiology (Lange Basic Science) (Paperback) By William F. Ganong. Publisher: McGraw-Hill Medical
2. Harper's Biochemistry (Lange Medical Books) (Paperback) By Robert K. Murray, Daryl K. Granner, Peter A. Mayes and Victor W. Rodwell. Publisher: Appelton and Lange. 8. Clinical Biochemistry by Richard Luxton. Scion Publishing Ltd.
3. Clinical Biochemistry Paperbackby Nanda Maheshwari, 2008.
4. Appreciate the biochemical aspects of hematology.

1. Unit Operations of Chemical Engg. by McCabe & Smith, M G H Publications.
2. Principles of Unit Operations in Chemical Engg. by Geankoplis. Prentice Hall.
3. Fluid Mechanics by K L Kumar, S.Chand Publishers.
4. Mechanics of fluids by B.S. Massey, Kluwer Academic Publishers.

TITLE OF THE COURSE: ANIMAL BIOTECHNOLOGY

B.E., V Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT553	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

- Describe basic principles and techniques in genetic engineering. gene transfer technologies for animals and animal cell lines.
- Learn the recent advances in animal breeding
- Know the role of biotechnology in animal science for sustainable eco-system and human welfare

MODULE – 1

INTRODUCTION TO ANIMAL CELL CULTURE:

History and development of animal tissue culture. Equipment and materials, Principles of sterile techniques. Sources & types of tissues, balanced salt solutions Cell culture media - components of the medium, physical, chemical and metabolic functions of media. Role of serum and supplements, serum-free media, features and specifications of MEM, DMEM, RPMI and Ham's medium. Role of antibiotics in media. Measurement of cell viability and cytotoxicity. Dye exclusion and inclusion tests, colonigenic assay, macromolecular estimation, MTT based assay. Measuring parameters of growth – growth curves, PDT, Plating efficiency and factors influencing growth.

L1, L2, L3

MODULE –2

CELL LINES & ITS CULTURE:

Primary culture, Establishment of Primary Culture, Development of cell lines, characterization of cell lines, maintenance and preservation of cell lines. Contamination -causes, detection and control, cell transformation – normal v/s. transformed cells, growth characteristics of transformed cells. Viral and chemical-mediated methods of cell immortalization, Scale-up of suspension cultures - Batch reactor, continuous culture, perfusion systems. Scale-up of monolayer cultures – roller bottles, Nunc cell factory, micro-carrier cultures, organotypic culture, matrices, factors affecting culture and perspectives.

L1, L2, L3

MODULE – 3

INVITRO FERTILIZATION & CLONING:

Structure of sperms and ovum, cryopreservation of sperms and ova of livestock, artificial insemination, super ovulation, in vitro fertilization, culture of embryos, embryo transfer, embryo-spliting, embryo sexing, transgenic manipulation of animal embryos, different applications of transgenic animal technology, animal viral vectors, animal cloning basic concept, cloning from-embryonic cells and adult cells, cloning of different animals, ethical, social and moral issues related to cloning, *in situ* and *ex situ* preservation of germplasm, *in utero* testing of foetus for genetic defects, anti-fertility animal vaccines, gene knock out technology and animal models for human genetic disorders.

L1, L2, L3

MODULE – 4

MOLECULAR BREEDING:

Introduction to different breeds of cattle, sheep, goats, pigs, canines and poultry, genetic characterization of livestock breeds, marker assisted breeding of livestock, introduction to animal genomics, different methods for characterization of animal genomes, SNP, STR, QTL, RFLP, RAPD, genetic basis for disease resistance, Immunological and nucleic acid based methods for identification of animal species, detection of meat adulteration using DNA based methods, detection food/feed adulteration with animal protein.

L1, L2, L3

MODULE – 5

OTHER APPLICATIONS:

Application of animal cell culture- Concepts of tissue engineering - skin, liver, kidney, Principles and species suitable for aquaculture (Indian major carps and prawns) Pearl culture - pearl producing mollusks, rearing of oysters, nucleation for pearl formation and harvesting of pearls, Probiotics and their significance in aquaculture.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Explain basic principles and techniques in genetic engineering. gene transfer technologies for animals and animal cell lines
- Gain Knowledge of the recent advances in animal breeding
- Explain the contribution 'functional genomics' is making and is likely to make in animal biotechnology now and in the future.
- Appraise the role of biotechnology in animal science for sustainable eco-system and human welfare.

REFERENCE BOOKS

1. Methods in Cell Biology, Vol. 57, Animal Cell Culture Methods Ed. JP Mather and D Bames. Academic Press.
2. Fish & Fisheries of India by V. G. Jhingram, Central Publishing House.
3. Living resources for Biotechnology, Animal
4. Gordon I. 2005. Reproductive Techniques in Farm Animals. CABI.
5. Kun LY. 2006. Microbial Biotechnology. World Scientific.
6. Lincoln PJ & Thomson J. 1998. Forensic DNA Profiling Protocols. Humana Press.
7. Portner R. 2007. Animal Cell Biotechnology. Humana Press.
8. Twyman RM. 2003. Advanced Molecular Biology. Bios Scientific.

1. Culture of Animal Cells by R Ian Fredhney, Wiley-Liss Publications.
2. Animal Cell Biotechnology by Spier, RE and Griffith, JB Academic Press, London.
3. Animal Biotechnology by Murray Moo-Young, Pergamon Press, Oxford Press.
4. Animal Cell Technology: Principles and Practices by Butter M, Oxford Press.

5. Molecular Biotechnology by Sandy B. Primrose, Blackwell Scientific Publishers.
6. An Introduction to Molecular Biotechnology by MICHAEL WINK, WILEY.
7. Molecular Biotechnology: Principles and Practices by Channarayappa, University Press

TITLE OF THE COURSE: BIOINSTRUMENTATION & BIOSENSORS

B.E., V Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT554	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

- The fundamentals of measurement science are applied to optical, electrochemical, and mass and pressure signal transduction.
- The principles, technologies, methods and applications of biosensors and bioinstrumentation.
- The link engineering principles to understanding of biosystems in sensors and bioelectronics.
- Methods and procedures used in the design, fabrication and application of biosensors and bioelectronic devices

MODULE – 1

INTRODUCTION

Electrical quantities and units; functional elements of an instrumentation system; static and dynamic characteristics; principles of analog and digital meters; CRO, energy meters, time and frequency meters; multimeters. Transducers: Classification, resistive strain gauges, RTD, LVDT, Peizoelectric transducers, electromagnetic transducers, optical transducers, transducers for biomedical applications. Conceptual numericals. pH meters, Radiometric Devices, Fluorescence Spectrophotometers, Chromatology (chromatographic techniques – GC & HPLC), Electrophoresis, and Lab on a chip – related instrumentation, Conceptual numericals.

L1, L2, L3

MODULE –2

CELL LINES & ITS CULTURE:

Primary culture, Establishment of Primary Culture, Development of cell lines, characterization of cell lines, maintenance and preservation of cell lines. Contamination -causes, detection and control, cell transformation – normal v/s. transformed cells, growth characteristics of transformed cells. Viral and chemical-mediated methods of cell immortalization, Scale-up of suspension cultures - Batch reactor, continuous culture, perfusion systems. Scale-up of monolayer cultures – roller bottles, Nunc cell factory, micro-carrier cultures, organotypic culture, matrices, factors affecting culture and perspectives.

L1, L2, L3, L4

MODULE – 3

CARDIAC , VASCULAR SYSTEM AND RESPIRATORY SYSTEM

Overview of cardiovascular system, Types of blood pressure sensors, Lumped parameter modeling of a catheter-sensor system, Heart sounds, Cardiac catheterization, Indirect measurement of blood pressure, Measuring blood flow rate, Measuring blood volume, Pacemakers, Defibrillators, Cardiac-assist devices, Replacement heart valves – related instrumentation of equipments involved and sensors. Conceptual numerical. Modeling the respiratory system, Measuring gas flow rate, Measuring lung volume, Tests of respiratory mechanics, Measuring gas concentration, Tests of gas transport, Ventilators, Anesthesia machines, Conceptual numericals.

L1, L2, L3, L4

MODULE – 4

ASSAY TECHNOLOGIES, AUTOMATION AND ROBOTICS:

Introduction; Bioassay Design and Implementation; Radiometric Assays; Scintillation Proximity Assays; Types of fluorescence measurements and instrumentation; Reporter gene Assay applications; Bio-analytical Applications. Introduction to Automation, types, LERT classification system, components of a robot, softwares used in robotics, Barcode technology, objectives, decoding, symbologies used, barcode reader (pen-type, laser type, CCD camera and camera based readers). PC based and Microcontroller based automation.

L1, L2, L3, L4

MODULE – 5

BIOSENSORS:

Introduction to Biosensors: Concepts and applications. Biosensors for personal diabetes management. Microfabricated Sensors and the Commercial Development of Biosensors. Electrochemical sensors, Chemical fibrosensors, Ion-selective FETs, Blood-glucose sensors. Noninvasive Biosensors in Clinical Analysis. Applications of Biosensor-based instruments to the bioprocess industry. Application of Biosensors to environmental samples. Biochips and their application to genomics. BIAcore - an optical Biosensor.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Understand the concept of transduction and methods of extracting information from biosensors.
- Gain knowledge in the state of the art of biological and medical sensors both in research and commercial products.
- Be familiar with a wide range of sensors and instrumentation from electrochemical to optical.
- Understand typical electronic instrumentation for biosensors and important concepts such as calibration and references.
- Gain knowledge of actuators for biological and medical applications from drug delivery devices to microfluidic systems.
- Be familiar with concepts of control systems combining sensing and actuation.
- Analyse sensor outputs through the use of signal processing and analogue circuit concepts.

REFERENCE BOOKS

1. Automation technologies for genome characterization, John Wiley & Sons, Inc.
2. Transducers and Instrumentation by Murthy D V S. Prentice Hall.
3. High Throughput Screening, Edited by John. P. Devlin, Marcel Dekker.
4. Commercial Biosensors by Graham Ramsay, John Wiley & Son, INC.
5. Introduction to bioanalytical sensors by Alice J Cunningham Newyrok, John Wiley.
6. Applied biosensors by Doland L Wise, CRC Press.
7. Encyclopedia of Medical devices and Instrumentation by J G Webster, John Wiley.
8. Introduction to Biomedical equipment technology by J J Carr, J M Brown, Prentice Hall.
9. Introduction to Biomedical Engineering by J Enderle, S Blanchard & J Bronzino, Elsevier

TEXT BOOKS

1. Bioinstrumentation and Biosensors by Donald L Wise, Marcel Dekker Inc.
2. Biosensors by Cooper J M (2004). Oxford Publications.
3. Hand book of Biomedical Instrumentation – R. S. Khandpur, TMH.
4. Biosensors and their applications by Yang Victor C & Ngo That T, Springer.
5. Biosensors – An introduction by Eggins Brain R. Wiley, John & Sons.
6. Advances in Laboratory Automation-Robotics by J.R. Strimaitis and J.N. Little, Zymark Corporation.
7. Principles of Applied Biomedical Instrumentation by Geddes & Baker.

TITLE OF THE COURSE: BIOLOGY FOR ENGINEERS
B.E., V Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17BT561**	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: The objective of this course is to provide a basic understanding of biological mechanisms of living organisms from the perspective of engineers. In addition, the course is expected to encourage engineering students to think about solving biological problems with engineering tools.

MODULE – 1

BASIC CELL BIOLOGY:
Introduction to Biology, The cell: the basic unit of life, Expression of genetic information - protein structure and function, Cell metabolism; Cells respond to their external environments, Cells grow and reproduce, Cellular differentiation. L1, L2, L3

MODULE –2

BIOCHEMISTRY AND MOLECULAR ASPECTS OF LIFE:
Biodiversity - Chemical bonds in Biochemistry; Biochemistry and Human biology, Protein synthesis –DNA; RNA, Transcription and translation factors play key roles in protein synthesis, Differences between eukaryotic and prokaryotic protein synthesis, Stem cells and their applications. L2, L3, L4

MODULE – 3

ENZYMES AND INDUSTRIAL APPLICATIONS:
Enzymes – significance, factors, Mechanism and effective catalysis – proteases, carbonic anhydrase, Restriction Enzymes; Nucleoside Monophosphate Kinases, Photosynthesis and carbon fixation; Biological energy production, Metabolism-anabolism and catabolism. L2, L3, L4

MODULE – 4

MECHANOCHEMISTRY:
Protein motors convert chemical energy into mechanical work, ATP synthase structure, The bacterial flagellar motor, Cytoskeleton, Biosensors - types, applications, Bioremediation.
L1, L2, L3, L4

MODULE – 5

NERVOUS SYSTEM, IMMUNE SYSTEM AND CELL SIGNALING:
Basics of nervous system and neural networks, The cellular basis of immunity, The functional properties and structure of antibodies, T cell receptors and subclasses, General principles of cell signaling. L1, L2, L3

Course outcomes:
After studying this course, students will be able to:

- Appreciate the basic organization of organisms and living being.
- Understand the machinery of the cell that is ultimately responsible for various daily activities.
- Acquire knowledge about biological problems that requires engineering expertise to solve them.

REFERENCE BOOKS

1. Jeremy M. Berg, John L. Tymoczko and Lubert Stryer, Biochemistry, W.H. Freeman and Co. Ltd., 6th Ed., 2006.
2. Robert Weaver, Molecular Biology, MCGraw-Hill, 5th Edition, 2012.
3. Jon Cooper, Biosensors A Practical Approach, Bellwether Books, 2004.
4. Martin Alexander, Biodegradation and Bioremediation, Academic Press, 1994.
5. Kenneth Murphy, Janeway's Immunobiology, Garland Science; 8th edition, 2011.
6. Eric R. Kandel, James H. Schwartz, Thomas M. Jessell, Principles of Neural Science, McGraw-Hill, 5th Edition, 2012.

TEXT BOOKS

1. ThyagaRajan.S., Selvamurugan. N., Rajesh.M.P., Nazeer.R.A., Richard W. Thilagaraj, Barathi.S., and Jaganthan.M.K., “Biology for Engineers”, Tata McGraw-Hill, New Delhi, 2012.

TITLE OF THE COURSE: BIOMATERIALS
B.E., V Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17BT562**	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives:
This course will enable students to learn about various biomaterials, its properties, manufacturing methods and its applications.

MODULE – 1

INTRODUCTION:
Introduction, Historical developments, construction materials, impact of biomaterials, strength of biological tissues, performance of implants, interfacial phenomena. Structure and Properties of Materials: Atomic and molecular bonds, crystal structure of solids, phase changes, crystal imperfections, non-crystalline solids, surface properties, mechanical properties of materials, thermal treatments, surface improvements, sterilization, Stainless steels, Cobalt-Chromium alloys, Titanium based alloys, Nitinol, other metals, metallic Corrosion, biological tolerance of implant metals, Carbons, Alumina, Yttria stabilized zirconia, analysis of ceramic surfaces. L1, L2, L3

MODULE –2

SYNTHETIC POLYMERS AND BIOCOMPATIBILITY :
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, 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, Qualification of implant materials. L2, L3, L4

MODULE – 3

BIOPOLYMERS:
Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli, yield strength and fracture strengths, Biocompatibility of polymers, heparin and heparin-like polysaccharides, proteoglycans, structure and biological activities of native sulphated glycosaminoglycans, chemically modified glycosaminoglycans, heparin like substances from non-glycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins. L2, L3, L4

MODULE – 4

SYNTHETIC POLYMERS AND BIOCOMPATIBILITY:
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, 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, Qualification of implant materials. L1, L2, L3, L4

MODULE – 5

CARDIOVASCULAR BIOMATERIALS:

Tissue properties of blood vessels, Treatments of atherosclerosis; Biomechanical design issues pertaining to stents, balloon angioplasty, and pacemakers. Soft Tissue Reconstruction; Natural and Synthetic. Wound healing. Tissue ingrowths: Stability; Biofixation, Foreign Body response, Soft implants. Case Studies. Tissue Engineering: Current issues and Future Directions. L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- List the various types of biomaterials
- Understand the properties and applications of said materials
- Analyze the regulatory impact of novel biomaterials.

REFERENCE BOOKS

1. Advanced Catalysts and Nanostructures Materials, William R Moser, Academic Press.
2. Biomaterials - Science and Engineering by J B Park, Plenum Press.
3. Biological Performance of materials by Jonathan Black, Marcel Decker.
4. Polymeric Biomaterials by Piskin and A S Hoffmann, Martinus Nijhoff
5. Biomaterials by Lawrence Stark & GyanAgarwal.
6. Biomaterials - An Interfacial approach by L. Hench & E. C. Ethridge.

TEXT BOOKS

1. Biomaterials Science : An Introduction to materials in medicine by Buddy D Ratner. Academic Press.
2. Polymeric Biomaterials by Severian Dumitriu.
3. Material Science by Smith, McGraw Hill.
4. Material Science and Engineering by V Raghavan, Prentice Hall.
5. Biomaterials by Sujata V. Bhat, Narosa Publishing House.
6. Biomaterials, Medical Devices and Tissue Engineering: An Integrated Approach by Frederick H Silver, Chapman and Hall publications

TITLE OF THE COURSE: BIOTECHNOLOGY FOR SUSTAINABLE ENVIRONMENT

B.E., V Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT563	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

- The underlying concepts of Environment and its pollution.
- Treatment of waste water and solid waste.
- The importance of Biofuels against conservative fuels

MODULE – 1

WATER POLLUTION AND TREATMENT OF WASTEWATER:

Water as Resource, Drinking water quality, water consumption standards, Types of Water Pollutants and sources, State and central wastewater quality and its various discharge standards. Wastewater Sampling and Characteristics - Physical, Chemical and Biological characteristics of wastewater: Solving numerical on the sampling, characteristics and estimation of wastewater flow rates. Biotechnological approach for water purification.

L1, L2, L3

MODULE –2

TERTIARY/ADVANCED WASTEWATER TREATMENT:

Secondary/Biological treatment process, aerobic/anaerobic attached and suspended growth process, Sludge treatment & Disposal. Ultrafiltration, Filtration, Adsorption on Activated Carbon, Ion Exchange, Reverse Osmosis, Electro dialysis cell. Wastewater treatment in Industries: Paper and Pulp, distillery, Leather, Food processing such dairy and fruit processing and Textile processing.

L2, L3, L4

MODULE – 3

AIR POLLUTION AND NOISE POLLUTION:

Sources, Classification, Properties of air pollutants, and Effects of air pollution on health, vegetation and materials. Air pollution sampling: Ambient sampling and Stack sampling, Analysis of air pollutants, Control methods and Equipment for particulates and gaseous pollutants, Applications to Industries: Thermal power plants, Metallurgical and Cement industries. Sources, Effects of Noise, Equipment for Noise Measurement, and Approaches for Noise Control.

L2, L3, L4

MODULE – 4

BIOFUELS:

Renewable and non-renewable resources. Conventional fuels and their environmental impacts. Animal oils. Modern fuels and their environmental impacts. Biotechnological inputs in producing good quality natural fibres. Plant sources like Jetropha, Pongamia etc. Waste as an energy core, energy recovery systems for urban waste, technology evaluation, concept of gasification of wastes with molten salt to produce low-BTU gas; pipeline gas from solid wastes by syngas recycling process; conversion of feedlot wastes into pipeline gas; fuels and chemicals from crops, production

of oil from wood waste, fuels from wood waste, methanol production from organic wastes.

L1, L2, L3, L4

MODULE – 5

SOLID WASTE MANAGEMENT:

Definitions, Characteristics and perspectives, Types of solid wastes, Sources of Solid waste, Properties of solid waste –Numerical problems, Solid waste Management – An Overview:-Material flow in society, Reduction in raw material usage, Solid waste generation, and reuse with materials, energy recovery. Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, Dairy wastes, Pulp industry wastes, Textile industry wastes, leather industry wastes and pharmaceutical industry wastes, petroleum wastes treatment.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Apply reasoning to identify the components of environmental eco systems and effect of pollutant on environment.
- Characterize the various parameters for treatment of water, waste water and solid waste from their sources to provide valid conclusions.
- Understand the impact of recovery, recycle of the useful resources from the wastes by adopting advanced techniques to demonstrate the need for sustainable development.
- Identify and demonstrate the knowledge to use suitable equipment for abatement and control of air & noise pollution.

REFERENCE BOOKS

1. Fuels from Waste by Larry Anderson and David A Tillman, Academic Press.
2. Bioprocess Technology- fundamentals and applications, S O Enfors & L Hagstrom, RIT, Stockholm.
3. Comprehensive Biotechnology by M.Y. Young (Eds.), Pergamon Press.
4. Biotechnology, Economic & Social Aspects by E.J. Dasilva, C Ratledge & A Sasson, Cambridge Univ. Press, Cambridge.
5. Environmental Biotechnology by Pradipta Kumar Mahopatra.

TEXT BOOKS

1. Environmental Engineering by Howard S. Peavey, Donald R. Rowe, George Techobanolous, McGraw-Hill International Editions.
2. Wastewater Engineering – Treatment, Disposal and Reuse, METCALF AND EDDY, INC. 3rd Edition Tata McGraw-Hill Publishing Company Limited.
3. Environmental Biotechnology by Foster C.F., John ware D.A., Ellis Horwood Limited.
4. Environmental Biotechnology by Indu Shekhar Thakur, IK Publishers.
7. Industrial Microbiology by L.E. Casida, Willey Eastern Ltd. Industrial Microbiology by Prescott & Dunn, CBS Publishers

TITLE OF THE COURSE: GENETIC ENGINEERING & IMMUNOTECHNOLOGY LABORATORY

B.E., V Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BTL57	CIE Marks	40
Number of Lecture Hours/week	03=(1 Hour Instruction + 2 Hours Laboratory)	SEE Marks	60
Total Number of Hours	40	Exam Hours	03
RBT Levels	L1, L2, L3, L4,L5		

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in

- Learn and demonstrate the various Immunodiagnostic techniques like agglutination, precipitation, immunoelectrophoresis, qualitative analysis, ELISA, separation of Lymphocytes and Immunoblot
- Identify & become skilled at the various genetic engineering techniques like isolation and analysis of nucleic acids, electrophoresis, gene cloning and DNA amplification.
- independently carry out research experiments in immunology and genetic engineering

Experiments:

1. Agglutination Technique: Blood group identification
2. Bacterial Agglutination Technique-Widal test (Tube / slide agglutination)
3. Radial Immunodiffusion (RID)
4. Ouchterlony Double Diffusion (ODD)
5. Rocket immunoelectrophoresis (RIEP)
6. Preparation of DNA for PCR applications- Isolation, purity & quantification
7. Counter-current immunoelectrophoresis (CCIEP)
8. Introduction to PCR – working of PCR equipment, programming, preparation of reagents and buffer
9. Dot ELIZA
10. Isolation of total RNA from plant/animal sources
11. Gene / DNA amplification by random primers-RAPD
12. DNA amplification by specific primer
13. Separation of lymphocytes from peripheral blood.

Course outcomes:

On the completion of this laboratory course, the students will be able:

- To experimentally verify various theoretical concepts of Immunodiagnostic techniques like agglutination, precipitation, immunoelectrophoresis, qualitative analysis, ELISA, separation of Lymphocytes and Immunoblot
- To plan & interpret the various Genetic Engineering techniques for the isolation of NA, quantification, purity check, amplification and gene cloning.
- To apply & infer these techniques in research

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.

- Instructions as printed on the cover page of answer script for split up of marks to be strictly followed.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Introduction to Genetic Engineering by Nicholl. Cambridge Low Price Edition.
2. Genes IX by Benjamin Lewis, Oxford University & Cell Press.
3. DNA Science by David A Micklos, Greg A Freyer and Dvaid A Crotty, I K International.
4. Molecular Biotechnology: Principles and Practices by Channarayappa, University Press.
5. A Text book of Molecular Biotechnology by Ashok Chauhan, IK Intl.
6. Genetic Engineering Vol. 1-4 (Williamson Edition)**.** Academic Press.
7. Current protocols in molecular biology, Greena Publishing Associates, NY.
8. Molecular cloning Volumes I, II and III. Sambrook J et al. Cold Spring Harbor lab Press
9. Principles of gene manipulation - An introduction to genetic engineering, Old R.W., Primrose S.B., Blackwell Scientific Publications.
10. Laboratory manual for Genetic Engineering. John Vennison, PHI Ltd.
11. Immunology & Immunotechnology by Ashim K Chakravarthy, Oxford University Press

TITLE OF THE COURSE: BIOINFORMATICS LABORATORY

B.E., V Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BTL58	CIE Marks	40
Number of Lecture Hours/week	03=(1 Hour Instruction + 2 Hours Laboratory)	SEE Marks	60
Total Number of Hours	40	Exam Hours	03
RBT Levels	L1, L2, L3, L4,L5		

CREDITS – 02

Course objectives: This laboratory course enables students to get practical experience in:

- describe the fundamental concepts of bioinformatics
- explain the uses of various biological databases
- apply online resource tools

Experiments:

1. Bibliographic search from PUBMED, SCIRUS, MEDMINER and Sequence retrieval from Nucleic acid and Protein databases
2. Sequence (FASTA and BLAST) searches – Retrieval of homologs, paralogs, orthologs, and xenologs
3. Pair wise comparison of sequences – Analysis of parameters affecting alignment
4. Multiple alignments of sequences and pattern determination using PROSITE
5. Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees
6. Identification of functional sites in Genes / Genomes.
7. Secondary structure prediction of proteins and nucleic acid (DNA/RNA)
8. Study of posttranslational modifications using relevant tools
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. Comparative Modeling of homologous sequences and validation of modeled structures.
13. Determination of ligand-protein interactions using SPDBV/ LIGPLOT
14. Superposition of structures – Calculation of RMSD.
15. Docking studies – Analysis of substrate / ligand binding using homologous structures
16. Derivation of pharmacophore patterns for selective ligands.

Course outcomes:

After studying this course, students will be able to:

- understand fundamental concepts of bioinformatics
- apply online resource tools
- solve sequence alignment problems
- design primers and peptide sequences

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.

3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Bioinformatics by Andreas D Boxevanis. Wiley Interscience.
2. Bioinformatics by David W Mount, cold spring harbor.
3. Bioinformatics: A biologist's guide to biocomputing and the internet. Stuart M Brown, NYU Medical Center, NY USA.
4. Essentials of Bioinformatics, Jin Xinog, Texas A & M University, Cambridge University press.
5. Analytical Tools for DNA, Genes & Genomes: by Arseni Markoff, New Age.
6. Discovering Genomics, Proteomics & Bioinformatics By A M Campbell & L J Heyer, Pearson Education.
7. Fundamental Concepts of Bioinformatics by D E Krane & M L Raymer, Pearson.
8. Computational methods in Molecular Biology. S.L.Salzberg, D B Searls, S Kasif, Elsevier.
9. Bioinformatics – Methods And Applications: Genomics, Proteomics And Drug Discovery By S C Rastogi, Nmendiratta &P Rastogi, PHI.
10. Introduction to Bioinformatics by Arthur Lesk, Oxford Publications.
11. Structural Bioinformatics by Philip E Bourne, John Wiley & Sons

SIXTH SEMESTER

TITLE OF THE COURSE:BIO-BUSINESS AND ENTREPRENEURSHIP
B.E., VI Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT61	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to learn about the project management, entrepreneurship and IPR.

MODULE – 1

BIO ENTERPREUNERSHIP:

Introduction to bio-business, from the Indian context, SWOT analysis of bio-business. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its barriers. Small scale industries: Definition; Characteristics; Need and rationale; Objectives; Scope; Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Global bio business and industry future trends.

L1, L2

MODULE –2

ENTREPRENEURSHIP OPPORTUNITY IN AGRI BIOTECHNOLOGY:

Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, polyhouse culture. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agri waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agri management

L1, L2

MODULE – 3

ENTREPRENEURSHIP OPPORTUNITY IN INDUSTRIAL BIOTECHNOLOGY:

Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case study- Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost.

Biopesticide/insecticide production. Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production.Contact research in microbial genomics.

L1, L2, L3

MODULE – 4

PROJECT MANAGEMENT, INTELLECTUAL PROPERTY, TECHNOLOGY

MANAGEMENT AND STARTUP SCHEMES:

Building Biotech business challenges in Indian context-biotech partners (BICEPS,BIRAC,DBT, Incubation centers. Etc.,), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies.

Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Startup schemes in Indian government, Business incubation support schemes, Successful startups-case study.

L1, L2

MODULE – 5

REGULATORY AFFAIRS, BIOETHICS & BIO-SAFETY:

Regulatory affairs in Bio business-regulatory bodies and their regulations (ex.FDA, EU, DSIR, AYUSH, FSSAI etc.,)

Public education of the process of biotechnology involved in generating new forms of life for informed decision-making. Ethical concerns of biotechnology research and innovation-Interference with nature, fear of unknown, unequal distribution of risks.

Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards. biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management.

L1, L2

Course outcomes:

After studying this course, students will be able to:

- Know the importance of bioethics, biosafety and IPR
- Apply for project proposal
- Plan a project with a work plan, budget and schedule

REFERENCE BOOKS

1. Management Fundamentals - Concepts, Application, Skill Development - Robers Lusier - Thomson
2. Intellectual Property and Criminal Law by Gopalakrishnan, N S, Bangalore: National Law
3. School of India Univeristy.
4. Intellectual Property Law by Tina Gart and Linda Fazzani, London: McMillan Publishing Co.
5. Intellectual Property Rights in the WTO and developing contry by Watal Jayashree, Oxford University Press.
6. BIOETHICS & BIOSAFTEY by SATEESH MK, IK Publishers

TEXT BOOKS

1. Principles of Management – P. C.Tripathi, P.N. Reddy – Tata McGraw Hill,

2. Entrepreneurship Development - S.S.Khanka - S.Chand & Co.
3. Practical Approach to IPR by Rachana Singh Puri, IK Intl. Ltd.
4. Cases and Materials on Intellectual Property by Cornish, W R.
5. Project Management by Sahni, Ane Books.
6. Project Management for Business & Technology, Nicholas, PHI.
7. Bioethics & Biosafety by R Rallapalli & Geetha Bali, APH Publication.

TITLE OF THE COURSE: BIOPROCESS CONTROL & AUTOMATION B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT62	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

- To understand the basics of process dynamics principles and instrumentation
- To Study various types of input functions and its response
- To perform computational modelling to study different types of controllers
- To analyse different control algorithms.

MODULE – 1

INSTRUMENTATION:

Instrumentation - principles, Introduction to flow, pressure, temperature and liquid level measurements, measurement of important physico-chemical and biochemical parameters, methods of on-line and off-line biomass estimation, flow injection analysis for measurement of substrates, products and other metabolites. Dynamics and control of bioreactors & sterilizers. On-line data analysis for state and parameter estimation techniques for biochemical processes.

L1, L2, L3

MODULE –2

FIRST ORDER SYSTEMS:

Process characteristics, Laplace transforms, first order systems – examples, mercury in glass thermometer, liquid level system, linearization, response of first order system for step, impulse and sinusoidal changes in input, conceptual numerical. Interacting and non-interacting systems and their dynamic response to step, inputs; conceptual numerical. L2, L3, L4

MODULE – 3

SECOND ORDER SYSTEMS:

Second order systems with transfer functions (spring-damper, control valve, U-tube manometer), response of second order system to step, impulse and sinusoidal input – Overdamped, underdamped and critically damped condition of second order system, transportation lag.

L2, L3, L4

MODULE – 4

CONTROLLERS AND FINAL CONTROL ELEMENTS:

Actuators, Positioners, Valve body, Valve plugs, Characteristics of final control elements, controllers – two position control, proportional control, derivative control, integral control, P-I (proportional-integral) control, P-D (proportional- derivative) control, P-I-D (proportionalintegral-derivative) control, Block diagrams for servo and regulatory problems , conceptual numerical.

L1, L2, L3,L4

MODULE – 5

CONTROLLER DESIGN AND STABILITY:

Criteria for stability, Routh test; Root locus (basics), Introduction to frequency response, Qualitative discussion about Bode criteria and Nyquist criteria; Conceptual numerical.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Understand the basics of process dynamics principles and instrumentation
- Study various types of input functions and its response
- Perform computational modelling to study different types of controllers
- Analyse different control algorithms

REFERENCE BOOKS

1. Process dynamics and control by D E Seborg, T F Edger, John Wiley.
2. Process Control by Wayne C. Bequette, Pearson Education Asia.
3. Essentials of Process Control by Luyben and Luyben. McGraw-Hill Education.
4. Process Modeling, Simulation and Control by William Luyben, McGraw-Hill Education.
5. Biochemical Engineering Fundamentals by Bailey and Ollis, Mcgraw Hill.
6. Bioprocess Engineering by Shule and Kargi, Prentice Hall.
7. Bioprocess Engineering Principles by Pauline M. Doran, Academic Press.
8. Rate controlled separations by Wankat P.C, Elsevier

TEXT BOOKS

1. Process System analysis and Control by Donald R Coughanowr, McGraw-Hill.
2. Chemical Process Control by George Stephanopoulos, Prentice-Hall of India
3. Process equipment design by M V Joshi, Macmilan Indian Limited.
4. Unfired pressure vessel I S Code 2825, JAICO Publishing House.

TITLE OF THE COURSE: ENZYME TECHNOLOGY & BIOTRANSFORMATION B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT63	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

1. To define the enzyme and its classification, catalytic action.
2. To understand the mechanism of enzyme action, purification of enzymes, catalytic action of enzymes, kinetics of enzyme catalyzed reactions

MODULE – 1

INTRODUCTION :

Introduction to enzymes, Classification, Sources, Mechanism of enzyme action. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes. Advantages of enzymes vs chemical catalysts, Isolated Enzymes versus whole cell systems, enzymes in fermentation, Biocatalytic Application, Enzyme catalysis (Acid-base, Covalent, Metal ion catalysis, Substrate strain & entropy effects)

L1, L2, L3

MODULE –2

ENZYMES AND CO- ENZYMES:

Acetylcholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG Co A reductase inhibitors, pseudocholinesterase, 5'-nucleotidase (5NT), glucose-6-phosphate dehydrogenase (GPD), CKisoforms, immunoreactive trypsinogen (IRT) and chymotrypsin; amylase isoenzymes. Mechanism of coenzymes (NAD/NADP, FAD/FADH2, PLP, Coenzyme A, TPP, Biotin).

L2, L3, L4

MODULE – 3

ENZYMATIC TECHNIQUES :

Enzyme and isoenzyme measurement methods with two examples (fixed incubation and kinetic methods); Methods for investigating the kinetics of Enzyme catalysed reactions – Initial velocity studies, rapid-reaction techniques. Standardization and optimization methods, stability of enzymes. Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications of immobilized enzyme technology, Economic argument for immobilization.

L2, L3, L4

MODULE – 4

ENZYMATIC TRANSFORMATION :

Reaction engineering for enzyme-catalyzed biotransformations. q Biocatalysts from extreme Thermophilic and Hyperthermophilic microorganisms (extremozymes). The design and construction of novel enzymes, artificial enzymes, Biotransformation of drugs (hydroxylation of Steroids), Host Guest Complexation chemistry, enzyme design using steroid templates.

L1, L2, L3,L4

MODULE – 5

APPLICATIONS :

Importance of enzymes in diagnostics, Enzyme pattern in diseases like Myocardial infarctions (SGOT, SGPT & LDH). Isoenzymes (CK, LD, ALP). Use of isozymes as markers in cancer and other diseases. Enzymes in immunoassay techniques. Therapeutic enzymes. Inborn errors of metabolism. Enzymes used in detergents, use of proteases in food, leather and wool industries; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes), production of maltose and sucrose, glucose from cellulose, uses of lactase in dairy industry, glucose oxidase and catalase in food industry; Restriction enzymes and DNA ligases.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Define enzymes and its catalytic action, mechanism & kinetics with few examples.
- Explain the various techniques involved in the extraction and utilization of enzymes in biotransformation.

REFERENCE BOOKS

1. Enzyme Technology by Messing, Wiley, New York
2. Purifying Proteins for Proteomics by Richard J Simpson, IK International.
3. Proteins and Proteomics by Richard J Simpson, IK International.
4. Enzymes by Dixon and Webb, IRL Press.
5. Principles of Enzymology for technological Applications by Butterworth Heinemann,
6. Oxford University Press.
7. Biocatalyst for Industry by J.S. Dordrick, Plenum press, New York.
8. Enzymes in Industry: Production and Applications by W. Gerhartz VCH Publishers.
9. Fundaments of Enzymology by Prices and Stevens, Oxford Press.

TEXT BOOKS

1. Fundaments of Enzymology by Nicholas C Price and Stevens, Oxford Press.
2. Enzymes – Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer, Horwood Publishing Limited.
3. Biotransformations in Organic Chemistry by Kurt Faber, Springer Berlin Heidelberg.
4. Enzymes in Industry: Production and Applications by W. Gerhartz, VCH Publishers.
5. Enzyme Technology by M.F. Chaplin and C. Bucke, Cambridge Press.

TITLE OF THE COURSE: BIOPROCESS EQUIPMENT DESIGN & CAED B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT64	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to learn about the design procedures of process equipment double pipe heat exchanger, shell & tube heat exchanger, condenser, fermentor, packed column distillation.

MODULE – 1

PROCESS DESIGN OF DOUBLE PIPE HEAT EXCHANGER:

Introduction to heat exchanger, Functional design – Energy balance equation, log mean temperature difference (co-current, counter counter), Heat transfer coefficients (inside, outside & overall), area, length, number of hair pins, diameter of tube. Pressure drop calculations.

Detailed drawing of sectional front view of Heat exchanger.

L1, L2, L3, L4

MODULE –2

PROCESS DESIGN OF SHELL & TUBE HEAT EXCHANGER:

Introduction to Heat Exchanger, Functional design – Energy balance equation, log mean temperature difference (co-current, counter current), Heat transfer coefficients (inside, outside & overall), area, length, number of tubes, tube sheet diameter, pitch type, diameter of tube sheet.

Mechanical design – baffle, thickness of shell, thickness of tube sheet, thickness of head, pressure drop calculations – tube side and shell side.

Detailed drawing of sectional front view of Heat exchanger (1-1, 1-2) with tube sheet layout.

L1, L2, L3, L4

MODULE – 3

PROCESS DESIGN OF VERTICAL CONDENSER:

Heat balance, shell side heat transfer coefficient, tube side heat transfer coefficient, overall heat transfer coefficient for condensation (Uc), clean surface area, over all coefficient for sub-cooling, area for sub-cooling, total clean surface area, overall heat transfer coefficient(Ud) and pressure drop calculations.

Detailed drawing of sectional front view.

L1, L2, L3, L4

MODULE – 4

PROCESS DESIGN OF FERMENTER:

Functional design- Based on the type of bioreactor (batch reactor MFR) and cell growth

kinetics and performance equation, determine the volume of the reactor, according to H/D ratio determine height and diameter.

Mechanical design- Thickness of the shell (cylindrical, spherical), thickness of top & bottom cover, flange calculations – width and thickness of gasket, number of bolts, bolts circle diameter and bolt diameter.

L1, L2, L3,L4

MODULE – 5

PROCESS DESIGN OF PACKED DISTILLATION COLUMN:

Functional design- material balance, energy balance, height of the packed column using NTU and HTU concepts, Mass transfer coefficients, Diameter of columns, top and bottom free space.

Functional design- material balance, energy balance, height of the packed column using NTU and HTU concepts, Mass transfer coefficients, Diameter of columns, top and bottom free space.

Detailed drawing for the above design (showing clearly inlets, outlets liquid distributors, packing support)

L1, L2, L3, L4

Course outcomes:

After studying this course, students will be able to:

- Differentiate between different types of heat exchangers
- Know the different components of HE
- Do detailed design and drawing of DPHE, STHE and condenser,
- Know the function of fermenter, packed column distillation
- Design and draw the fermenter, packed column distillation

REFERENCE BOOKS

1. "Mass Transfer Operations" by Rober E Treybal, McGraw Hill, 1981.
2. "Process Equipment Design –Vessel Design" by Brownell & Young, John Willey, 1951.
3. "Chemical Engineering" by J. M. Coulson & J. F. Richardson, Vol 6, Pregman Press, 1993.
4. Process equipment and mechanical aspect", B C Bhattacharya.

TEXT BOOKS

1. "Chemical Engineers Handbook" by R. H. Perry & D. W. Green , 6th, 7th Edn, McGraw Hill,.
2. "Process Heat Transfer" by Donald Q. Kern, McGraw Hill, 1997.
3. Process equipment design, M V Joshi.
4. Process Design of Equipment by S.D Dawande- Vol II, Central Techno Publications, 3rd edition, 2003.

TITLE OF THE COURSE: BIOMOLECULAR ENGINEERING

B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

SEMESTER –VI

Course Code	17BT651	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

1. To learn the energetics of biological systems.
2. To understand the kinetics of enzymes, thermodynamics of biomolecular interactions and the applications of bioengineering.

MODULE – 1

THERMODYNAMICS OF BIOMOLECULAR INTERACTIONS :

Volumetric and thermodynamic properties of fluids; equations of state; heat effects; ideal and non-ideal mixtures; fugacities and activity coefficients; vapour-liquid and liquid-liquid phase equilibrium; solubility of gases and solids in liquids; chemical reaction equilibrium. Thermodynamics of biomolecular interactions, noncovalent forces underlying bioenergetics: hydrogen bonding, van der Waals, hydrophobic effect, water in context of molecular recognition biomolecular stability. Case studies: Stability and energetics of Antibody-Antigen; Streptavidin- Biotin.

L1, L2, L3

MODULE –2

ENZYMES KINETICS:

Enzymes as Biological Catalysts, Enzyme Activation, Unireactant Enzymes, Multi-site and Allosteric Enzymes, Simple Inhibition, Multiple Inhibition Models, Multi-Reactant Systems, pH and Temperature Effects. Reaction kinetics and enzyme energetics for the case of Catalytic Antibodies.

L2, L3, L4

MODULE – 3

BIOENERGETICS:

Energetics of Biological Systems, Molecular Recognition. Concepts of Free Energy, Enthalpy and Entropy in the living cell, Biochemical Reactions, Metabolic Cycles, ATP Synthesis (Respiration and Photosynthesis), Membrane Ion Gradients (ATP and Ion Gradients), Protein Folding, Protein-Nucleic Acid interactions. Rheology of DNA. Protein misfolding and disease.

L2, L3, L4

MODULE – 4

BIODESIGN & CELULAR WARFARE:

Rational Biotherapeutic Design: molecular modeling, computational approaches to predicting energetics, Case study: PeptidoMimetic therapeutics. Directed Evolution for Biotherapeutic Design: random mutagenesis approaches and techniques, phage display and selection

techniques, combinatorial approaches and techniques. Case study: Antibody Engineering, enzyme engineering, phage display. Receptor-mediated recognition in immune system surveillance, macrophage-B-Cell collaboration, T-Cell and natural killer cell function, vaccines.

L1, L2, L3,L4

MODULE – 5

APPLICATIONS :

Biodegradable materials, Polymeric scaffolds for tissue engineering applications. Biopolymers: heparin and heparin-like polysaccharides, proteoglycans, chemically modified glycosaminoglycans. Design and production of biomaterials as biosensors. Nanoscale biosensors. Case studies: Engineered T-Cell Therapeutics, Vaccines.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Define bioenergetics.
- Explain the kinetics of enzymes, thermodynamics of biomolecular interactions and the applications of bioengineering.

REFERENCE BOOKS

1. Biocatalyst for Industry by J.S. Dordrick, Plenum press, New York.
2. Enzymes in Industry: Production and Applications by W. Gerhartz VCH Publishers.
3. Fundaments of Enzymology by Prices and Stevens, Oxford Press.

TEXT BOOKS

1. Molecular Cell Biology by H. Lodisch et al, W.H.Freeman and Co.
2. Enzyme Kinetics by I.H.Segal, Wiley Interscience.
3. Comphrehensive Enzyme Kinetics by V. Leskovac, Kluwer Academic/Plenum Publishers.
4. Thermodynamics and Kinetics For the Biological Sciences By G.G. Hammes, Wiley Interscience.
5. Enzymes – Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer, Horwood Publishing Limited.
6. Enzyme Technology by M.F. Chaplin and C. Bucke, Cambridge Press.

TITLE OF THE COURSE: ADVANCED MICROBIOLOGY

B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT652	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- How pathogenic microorganisms interact with eukaryotic host cells
- Mechanism behind the pathogenesis
- Mechanisms involved in cell invasion
- The recent trends in cellular microbiology

MODULE – 1

INTRODUCTION TO CELLULAR MICROBIOLOGY:

Emergence of cellular microbiology – signal molecules, small peptides, adhesisns, exotoxins; Structure, organization and regulation of cells (an overview). microbial virulence and pathogenesis; Molecular Techniques defining bacterial virulence. Bacteria-host interactions, bacterial adhesion to host cells. Quorum sensing and biofilm in microbial pathogenesis.

L1, L2, L3

MODULE –2

CHARACTERISTIC STUDY:

Host cell surface properties, mechanism of adherence of bacteria to host cell. Prokaryotic and eukaryotic signaling mechanism: Eukaryotic cell to cell signaling, endocrine signaling, prokaryotic signaling; quorum sensing and intercellular signaling, basic concepts in molecular cell biology and introduction to various pathogens (bacterial, viral, and eukaryotic).

L2, L3, L4

MODULE – 3

MECHANISM OF MICROBIAL ACTION:

Microbial toxins, mechanism of action, mechanisms and signals that control toxin production. Bacterial invasion of host cells and molecular mechanisms, genes that regulate cell invasion. Apoptosis, cell death and manipulation of host cell death by pathogens. Manipulation of membrane trafficking and cellular transport.

L2, L3, L4

MODULE – 4

ADVANCEMENTS OF CELLULAR MICROBIOLOGY:

New methods of identifying virulence genes and the use of non-vertebrate hosts (plants and insects) to model mammalian infections. Human microbiome, influence of microorganisms in health and diseases. The advances in genomics, proteomics and post genomics in relation to microbes. Advances in microbial genomics. Future prospects of cellular microbiology.

L1, L2, L3,L4

MODULE – 5

TOOLS, TECHNOLOGIES AND APPLICATIONS OF CELLULAR

MICROBIOLOGY:

Tools, technologies and applications of cellular microbiology; Fluorescence, fluorescent dyes and stains, Fluorescence in situ hybridization and immunofluorescence. Cytometry- flow cytometry. Laser scanning cytometry, Image cytometry. Scanning Probe Microscopy, Atomic force microscopy. Scanning electrochemical microscopy Microspectroscopic methods.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Understand molecular and cellular aspects of bacterial and viral diseases
- Explain mechanisms involved in microbial pathogenesis and host responses
- Comprehend mechanism of action of antimicrobial drugs and vaccines
- Carry out research involving molecular microbiology and microbial genomics.

REFERENCE BOOKS

1. Cellular Microbiology - Pascale Cossart, Patrice Boquet, Staffan Normark, and Rino Rappuoli), 2nd Edition, ASM Press
2. Microbiology: Diversity, Disease, and the Environment (Abigail A. Salyers, Dixie D. Whitt) Fitzgerald Scince Press
3. Bacterial Invasion of Host Cells - Edited by Richard J. Lamont, Cambridge University Press

TEXT BOOKS

1. A Textbook of Microbiology-R C Dubey & D K Maheshwari, S Chand Publishing

TITLE OF THE COURSE: CELL CULTURE TECHNIQUES

B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT653	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: The objectives of this course is to educate students about the fundamental concepts of plant, animal and microbial cell system, their differences, related applications, thus preparing them to meet the challenges of the new and emerging areas of biotechnology industry.

MODULE – 1

CELL CULTURE LABORATORY DESIGN AND EQUIPMENTS:

Planning, construction and services; Layout; Sterile handling area; Incubation; Hot room; Air circulation; Service bench; Laminar flow; Sterilizer; Incubators; CO2 incubator; Culture Racks, Colony Counters, Refrigerators and freezers; Centrifuge; Inverted stage microscope; Magnetic stirrer; Liquid nitrogen freezers; Slow cooling system for cell freezing; Water bath; Autoclaves and hot air oven; Pipette washers; Water purification system; Fluid handling systems and other equipments; Washing, packing and sterilization of different materials used in plants, animals and microbial cell cultures; Aseptic concepts; Maintenance of sterility; Cell culture vessels.

L1, L2, L3

MODULE –2

MEDIA AND REAGENTS :

Types of cell culture media for plants, animals and microbial cells; Ingredients of media; Physiochemical properties; Buffers; Oxygen; Osmolarity; Temperature; Balance salt solutions; Antibiotics, growth supplements; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media and other reagents.

L1, L2, L3

MODULE – 3

ANIMAL CELL CULTURES TECHNIQUES:

History of animal cell culture; Different tissue culture techniques; Types of primary culture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture; Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ culture; Behaviour of cells in culture conditions: division, growth pattern, metabolism of estimation of cell number; Development, Characterization and maintenance of cell lines, Cryopreservation; Commercial scale production of animal cells, stem cells and their application; Application of animal cell culture for in vitro testing of drugs; Testing of toxicity of environmental pollutants in cell culture.

L1, L2, L3

MODULE – 4

PLANT CELL CULTURE TECHNIQUES:

Cellular Totipotency, Practical Applications of Cellular totipotency. Organogenesis factors affecting organogenesis. Cyto-differentiation. Somatic Embryogenesis, Synthetic Seeds**,** Techniques for production of haploids, diploidization, production of double haploids, Applications. Triploids production - Endosperm culture and Applications. Secondary metabolite production, selection of high yielding lines, elicitation, immobilization of cultures, hairy root

culture & biotransformation. Factors affecting secondary metabolites, industrial application of secondary metabolites.

L1, L2, L3

MODULE – 5

MICROBIAL CELL CULTURE TECHNIQUES:

Microbial Cell Isolation, Culture maintenance. Isolation of pure-colonies. Bacterial titre estimation. Growth curve. Culture characterization. Auxotroph culture isolation. Biochemical characterization. Antibiotic sensitivity. Bacterial recombination, replica plating technique. Preservation of microbial products. Production of antibiotics. Enumeration and screening of novel microbial secondary metabolites, strain improvement, Use of microbes in industrial waste treatment. Microbial leaching.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Differentiate between the various sources of cells to be used in cell culture techniques
- Correlate between different biological samples and understand the importance of different media in tissue culture
- Comprehend the applications of plant, animal and microbial cell culture in industry, healthcare and environment.

REFERENCE BOOKS

1. Plant Tissue Culture by SATHYANARAYANA BN, IK Intl. Publishers
2. Plant Molecular biology by D. Grierson & S.N. Covey Blackie, London.
3. Animal Cell biotechnology by R.E. Spier and J.B. Griffiths, Academic press.
4. Living resources for Biotechnology, Animal cells by A. Doyle, R. Hay and B.E. Kirsop, Cambridge University Press.
5. Fermentation & Enzyme Technology by D.I.C. Wang et.al., Wiley Eastern.
6. Principle of Microbe & Cell Cultivation by SJ Prit, Blackwell Scientific co.
7. Animal cell culture Techniques by Ian Freshney, Wiley-Liss.
8. Animal Cell Culture - Practical Approach BY Ed. John R.W. Masters, 3rd Edition, Oxford University Press.
9. Animal Cell Culture Techniques BY Ed. Martin Clynes,. Springer

TEXT BOOKS

1. Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press.
2. Experiments in Plant Tissue Culture by John H. Dodds & Lorin W. Robert.
3. Plant tissue Culture: Theory and Practice by S.S. Bhojwani and M.K. Razdan, Elsevier.
4. Animal Biotechnology by Murray Moo-Young, Pergamon Press, Oxford.
5. Microbial Biotechnology by Alexander N Glazer, Hiroshi Nikaido, W H Freeman & Company.
6. Animal Cell Technology by Asok Mukhopadyay, IK Intl. Ltd.

TITLE OF THE COURSE: ECONOMICS AND PLANT DESIGN

B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT654	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- To understand the basic concepts of flow sheeting, material and energy balances and process development.
- To understand the factors necessary for feasibility of the process,
- To estimate capital investment, total product costs, depreciation, cash flows, and profitability,
- Analyze capital investment based on cash flows and breakeven chart.

MODULE – 1

PROCESS DESIGN DEVELOPMENT & GENERAL DESIGN CONSIDERATIONS: Design project procedure, design information from the literature and other sources of information, flow diagrams, comparison of different processes, firm process design, equipment design and specialization, scale up in design, safety factors specifications, materials of construction, detailed study of general design considerations. optimum design and design strategy.

L1, L2, L3

MODULE –2

CAPITAL INVESTMENTS, MANUFACTURING COSTS AND PLANT OVERHEADS: Factors involved in project cost estimation, Fixed capital investments including land, building, equipment and utilities, installation costs, workingcapital investments. Manufacturing Costs: Direct Production costs, fixed charges.

Plant Overheads**:** Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc.

L2, L3, L4

MODULE – 3

COST ANALYSIS:

Methods employed for the estimation of the capital investment. Estimation of working capital.

L2, L3, L4

MODULE – 4

DEPRECIATION, TAXES AND FINANCIAL STATEMENTS:

Depreciation calculation methods. Equivalence after Taxes. Cost comparison after taxes. Cash flow diagrams. Break-even analysis**.** Conceptual numericals.

L1, L2, L3,L4

MODULE – 5

PROFITABILITY ANALYSISAND TIME VALUE OF MONEY:

Methods for the evaluation of profitability. Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Replacement and Alternative Investments. Opportunity costs. Time value of money and equivalence. Conceptual numericals.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Understand concepts of process design and project management
- Understand the factors of general design considerations
- Synthesize feasible and optimum flow-sheet
- Estimation of capital investment, total product costs, and profitability.

REFERENCE BOOKS

1. Rudd and Watson, Strategy of Process Engineering, Wiley.
2. Bioprocess Engineering by Shule and Kargi Prentice Hall.
3. Bioprocess Engineering Principles by Pauline M. Doran, Academic Press.
4. Chemical Engineering Vol. VI - An introduction to Chemical Engineering Design by Coulson J.M. and Richardson, J.F Pergamon Press.
5. Process Equipment Design by Joshi M.V, MacMillan India Ltd.
6. Plant Process Simulation by B V Babu, Oxford University Press.

TEXT BOOKS

1. Plant Design and Economics for Chemical Engineers by Peters and Timmerhaus, McGraw Hill.
2. Process Plant Design by Frank Peter Helmus, Wiley-VCH.
3. Process Plant Design by J.R Backhurst by and J. H Harker, Heieman Educational Books.

TITLE OF THE COURSE: BIOLOGICAL DATA MANAGEMENT

B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT661	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

- To understand the types of databases and their data formats.
- To study the importance of various Omics experiments, data generation techniques, data management strategies and their effective utilization
- To comprehend the nature of Clinical Data, its Management and related basic operations

MODULE – 1

DATABASES OVERVIEW:

PubMed, GenBank, EMBL, DDBJ, SwissProt, Uniprot, TrEMBL, PDB, EST, SCOP, Pfam, SMART; Interaction Databases, (BIND, STRING), Pathway Databases, (KEGG), Signal Transduction database (STKE), Organism Specific database (Yeast, OMIM, HGNC, Flybase, wormbase), Genome databases (GOLD), Pathogen database (PATRIC), About the January Issue of Nucleic Acids Research journal and the catalog of biological databases.Data Models: Relational, Object Oriented. Hierarchical, Semi-structured, Unstructured (e.g. Text), Model of Querying: SQL, Information Integration, Data Mining for various applications.

L1, L2, L3

MODULE –2

IMPORTANCE OF MICROARRAY:

DNA Microarray and its importance, Designing a MicroArray Experiment-The Basic steps, Types of MicroArray. NCBI and MicroArray Data Management, GEO (Gene Expression Omnibus), MAML, The benefits of GEO and MAML, The Promise of MicroArray Technology in Treating Disease.MicroArray DataPreprocessing, Data normalization, Measuring Dissimilarity of Expression Pattern-Distance Motifs and Dissimilarity measures, Visualizing MicroArray Data. Principal Component Analysis,MicroArray Data. NCBI and MicroArray Data Management, GEO (Gene Expression Omnibus), MAML, The benefits of GEO and MAML, The Promise of MicroArray Technology in Treating Diseases.Data Mining for specific applications.

L1, L2, L3

MODULE – 3

IMPORTANCE OF OMIC TECHNOLOGIES, NGS DATA COLLECTION AND BIOINFORMATICS PRINCIPLES:

Data standards for omic data: the basis of data sharing and reuse. Omic data management and annotation. Data and knowledge management in cross omics research projects. Statistical analysis principles for omic data. Statistical methods and models for bridging Omics data levels. Analysis of time course omic datasets. The use and abuse of Omes. Computational analysis of High Throughput Sequencing Data Analysis of SNP in case control studies. Bioinformatics for RNomics. The ENCODE project consortium. Data Mining for specific applications.

L1, L2, L3

MODULE – 4

QUALITATIVE AND QUANTITATIVE PROTEOMICS:

Bioinformatics for Mass spectrometry and 2D gels.Concepts of Metabolomics, Transcriptomics and Interactomics. Computational Analysis Workflows for Protein Array Data Interpretation. Integration, Warehousing, and Analysis Strategies of Data. Integration. Data for signaling pathways, interactome reconstruction and functional analysis. Network Inference from Time Dependent data. Omics-Bioinformatics in the context of diseases, Omics-Based Identification of Pathophysiological Processes. Data Mining Methods in Omics-Based Biomarker Discovery.

L1, L2, L3

MODULE – 5

CLINICAL DATA MANAGEMENT:

Overview of Clinical Data Management plan, CRF design consideration, Data cleaning issues and Data processing issues, Database design consideration: Making design decisions, Operating procedures for database design, Dealing with problem data, modifying data, Quality control through database audits, Identifying and managing discrepancies, Quality control and assurance, Managing laboratory data, Storing lab data, Creating report and transferring data, Clinical data management systems, Electronic data capture systems, System Validation, Migrating, data integration and archiving data. Data Normalization and Querying Techniques. Data Mining for desired applications.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Decipher the differences in the types of databases and their data formats.
- Apply the knowledge of various Omics experiments, data generation techniques, data management concepts, data mining strategies and their effective utilization.
- To comprehend the aspects of Clinical Data, data integration, data Management, data mining for defined applications.

REFERENCE BOOKS

1. DovStekel, "Microarray Bioinformatics", Cambridge University Press, 2003.
2. Draghic S., Chapman, "Data Analysis tools for DNA Microarray", Hall/ CRC Press, 2002.
3. Biological Data Mining, Jake Y. Chen, Stefano Lonardi, 2017 by Chapman and Hall/CRC
4. OMICS: Biomedical Perspectives and Applications, DebmalyaBarh, Kenneth Blum, Margaret A. Madigan, CRC, 2017.9
5. Bioinformatics for Omics Data, Methods and Protocols, Editors: **Mayer**, Bernd (Ed.), Methods in Molecular Biology, 719. Humana Press

TEXT BOOKS

1. Bioinformatics Database Systems, Byron et al., CRC Press, 2017, ISBN 978-1-4398-1247-1.
2. Data Mining in Bioinformatics, Wang et al. (eds), Springer, 2005, ISBN 1-85233-671-4.
3. Computational Biology and Genome Informatics, Wang et al. (eds), World Scientific, 2003, ISBN 981-238-257-7.
4. Pattern Discovery in Biomolecular Data: Tools, Techniques and Applications, Wang et al. (eds), Oxford University Press, 1999, ISBN 0-19-511940-1.
5. Microarray Technology and Its Applications, Uwe R. Müller, Dan V. Nicolau, pringer, 2005.

TITLE OF THE COURSE: NANO BIOTECHNOLOGY

B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT662	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to understand the field of nano-biotechnology, the principles behind technology and its current applications and scope.

MODULE – 1

INTRODUCTION:

Background and definition of nanotechnology, chemical bonds in nanotechnology – Scales at the bio-nano interface – Basic capabilities of nanobiotechnology and nanomedicine – Biological tradition and mechanical tradition biotechnology – Applications in biotechnology.

L1, L2, L3

MODULE –2

STRUCTURAL AND FUNCTIONAL PRINCIPLES OF NANO-BIOTECHNOLOGY:

Biomolecular structure and stability – Protein folding – Self-assembly – Self-organization – Molecular recognition – Flexibility – Information – Driven nanoassembly – Energetics – Chemical transformation – Regulation – Biomaterials – Biomolecular motors – Traffic across membranes – Biomolecular sensing – Self-replication – Machine-phase nano-biotechnology.

L2, L3, L4

MODULE – 3

MICROFLUIDICS MEETS NANO:

Concepts and advantages of microfluidic devices – Materials and methods for the manufacture of microfluidic component – Fluidic structures – Surface modifications – Lab-on-a-chip for biochemical analysis.

L2, L3, L4

MODULE – 4

PROTEIN-BASED NANOSTRUCTURES:

S-Layers – Engineered nanopores – Microbial nanoparticle production – Magnetosomes – Nanoscale magnetic iron minerals in bacteria – Nanoparticle – Biomaterial hybrid systems.

L1, L2, L3, L4

MODULE – 5

DNA-BASED NANOSTRUCTURES:

DNA-Protein nanostructures – Biomimetic fabrication of DNA based metallic nanowires and networks – DNA-Gold nanoparticle conjugates – Nanoparticles as non-viral transfection agents.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Define nano-biotechnology as an emerging field and its scope.

- Understand the principles and applications of the technology in various fields.

REFERENCE BOOKS

1. Shoseyov, O. and Levy, I., "Nanobiotechnology: Bioinspired Devices and Materials of the Future", Humana Press, 2007. 2.
2. Bhushan, B., "Springer Handbook of Nanotechnology" Springer-Verlag Berlin Heidelberg, 2004. 3.
3. Freitas Jr R.A., "Nanomedicine", Vol. II, 1st Edition, Landes Biosciences, 2004.
4. Kohler, M. and Fritzsche, W., "Nanotechnology – An Introduction to Nanostructuring Techniques" Wiley-VCH, 2004

TEXT BOOKS

1. Niemeyer, C.M. and Mirkin, C.A., "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley-VCH, 2004.
2. Goodsell, D.S., "Bionanotechnology", John Wiley and Sons, Inc., 2004

TITLE OF THE COURSE: GOOD MANUFACTURING PRACTICES

B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT663	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to understand the aspects of good manufacturing practices from its regulatory and application perspective.

MODULE – 1

REGULATORY BACKDROP:

Introductory – History of GMP - Introduction to US-FDA - Introduction to EMEA (Europe) - EudraLex - Introduction to PMDA (Japan) & Introduction to Schedule M (India) - Introduction to ICH and document series.

L1, L2, L3

MODULE –2

CONCEPTS OF QUALIFICATION AND VALIDATION:

Concepts of equipment qualification - Concepts of Validation and importance of the same - Method & Process development and validation - Validation Master Plan (VMP).

L2, L3, L4

MODULE – 3

GOOD DOCUMENTATION PRACTICES: Importance and need for GDP - Standard Operating Procedures (SOP) and Standard Testing Procedures (STP) - Raw Data Sheet (RDS) to Reports - Batch Manufacturing Record - Electronic records regulation – 21 CFR Part 11.

L2, L3, L4

MODULE – 4

QUALITY MANAGEMENT SYSTEM: Introduction to Quality Assurance function - Incidence –CAPA, complaints & recalls - OOS, OOT and failure investigation - Internal, vendor and regulatory audits.

L1, L2, L3, L4

MODULE – 5

ADVANCES IN GMP:

Parametric release of products - Quality Risk Management System - Process Analytical Technologies - Quality by Design.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Learn and adopt quickly in a GMP environment.
- Understand the principles and applications of the GMP.

REFERENCE BOOKS

1. U.S. Department of Health and Human Services "Q7 Good Manufacturing Practice

Guidance for Active Pharmaceutical Ingredients", 2016.
2. U.S. Department of Health and Human Services "Sterile Drug Products Produced by Aseptic Processing — Current Good Manufacturing Practice" 2004

TEXT BOOKS

1. Syed Imtiaz Haider., "Pharmaceutical Master Validation Plan The Ultimate Guide to FDA, GMP, and GLP Compliance", ST. LUCIE PRESS 2002.
2. WHO "Good manufacturing practices and inspection" 2004.
3. John Sharp ., "Good Pharmaceutical Manufacturing Practice Rationale and Compliance" 2005

TITLE OF THE COURSE: BIOPROCESS CONTROL & AUTOMATION LABORATORY

B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BTL67	CIE Marks	40
Number of Lecture Hours/week	03=(1 Hour Instruction + 2 Hours Laboratory)	SEE Marks	60
Total Number of Hours	40	Exam Hours	03
RBT Levels	L1, L2, L3, L4		

CREDITS – 02

Course objectives: This course will enable students to

- Describe the fundamental concepts of kinetics of reaction and the Enzyme kinetics.
- Understand the rate of reaction for different reactors, ethical responsibilities that come with conducting experiments and communicating data.
- Apply the design equations for predicting the reactor performance.
- Generate the RTD data to identify non idealitites in different reactor configuration.

Experiments:

A) Experiments based on Kinetics

1. Mixed Flow Reactor
2. Plug Flow Reactor
3. Isothermal Batch Reactor
4. RTD in Mixed Flow Reactor
5. RTD in Plug Flow Reactor

B) Experiments based on Enzyme Technology

1. Isolation of enzymes
2. Determination of specific activity of human salivary α- amylase
3. Determination of Vmax & Km of human salivary α- amylase
4. Effect of Inhibitor on human salivary α- amylase
5. Time course of Amylase activity
6. Effect of pH on human salivary α- amylase
7. Effect of temperature on human salivary α- amylase
8. Enzyme Immobilization techniques and kinetics
9. Determination of specific activity of human salivary α- amylase
10. Isolation of papain from papaya and assay of papain using calorimetric method
11. Effect of organic solvents on amylase activity
12. Determination of molecular weight by SDS-PAGE

Course outcomes:

After studying this course, students will be able to:

- State and define the nature of the reaction, rate of the reaction, rate constant and enzyme activity.

- Compare the rate of reaction for different reactors; know the ethical responsibilities that come with conducting experiments and communicating data.
- Use the design equations for predicting the reactor performance.
- Compose the RTD data to identify non idealitites in different reactor configuration.

Course outcomes:

After studying this course, students will be able to:

- Understand the basics of instrumentation , classification, various input function of automatic process control system
- Classify and characterize the transducers based on critical process parameters
- Demonstrate the working of First order systems and controllers.
- Calculate and Analyze the output obtained from different systems and perform theoretical validation

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Students are allowed to pick one experiment from the lot.
3. Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Biochemical Engineering Fundamentals by Bailey and Ollis, Mcgraw Hill.
2. Bioprocess Engineering by Shule and Kargi Prentice Hall.
3. Wolf R. Vieth, Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression. A Wiley – Interscience Publication.
4. Smith J.M. Chemical Engineering Kinetics, McGraw Hill.
5. Carbery J A. Chemical and Catalytic Reactor Engineering, McGraw Hill.
6. Enzymes in Industry: Production and Applications: W. Gerhartz, VCH Publishers, New York.
7. Enzyme Technology by M.F. Chaplin and C. Bucke, Cambridge University Press, Cambridge.
8. Enzymes: Dixon and Webb. IRL Press.
9. Principles of Enzymology for Technological Applications by B Heinemann Ltd, Oxford Press.

TITLE OF THE COURSE: BIOKINETICS & ENZYME TECHNOLOGY LABORATORY

B.E., VI Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BTL68	CIE Marks	40
Number of Lecture Hours/week	03=(1 Hour Instruction + 2 Hours Laboratory)	SEE Marks	60
Total Number of Hours	40	Exam Hours	03
RBT Levels	L1, L2, L3, L4		

CREDITS – 02

Course objectives: This course will enable students to

- Understand the basics of process dynamics principles and instrumentation
- Study various types of input functions and its response
- Perform computational modelling to study different types of controllers
- Learn various sensors, and their control using computer that are industrially important.
- Study of properties of control systems will be dealt.

1. Dynamics of First order system (mercury thermometer) for step input and impulse input
2. Non-interacting system responses to step input
3. Non-interacting system responses to pulse input
4. Interacting System responses to step input
5. Interacting System responses to pulse input
6. Characteristics of Transducers (Temperature)
7. Characteristics of Transducers (Pressure)
8. Characteristics of Transducers (Flow)
9. Temperature controller – responses to set point / load change
10. pH controller – responses to set point / load change
11. Control of DO (Dissolved Oxygen)level
12. Control of Agitation (to monitor DO since they are interlinked)

Course outcomes:

After studying this course, students will be able to:

- Understand the basics of instrumentation , classification, various input function of automatic process control system
- Classify and characterize the transducers based on critical process parameters
- Demonstrate the working of First order systems and controllers.
- Calculate and Analyze the output obtained from different systems and perform theoretical validation

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for

breakup of marks.

- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Process System analysis and Control by Donald R Coughanowr, McGraw-Hill.
2. Chemical Process Control by George Stephanopoulos, Prentice-Hall of India
3. Process dynamics and control by D E Seborg, T F Edger, John Wiley.
4. Process Control by Wayne C. Bequette, Pearson Education Asia.
5. Essentials of Process Control by Luyben and Luyben. McGraw-Hill Education.
6. Process Modeling, Simulation and Control by William Luyben, McGraw-Hill Education.
7. Biochemical Engineering Fundamentals by Bailey and Ollis, Mcgraw Hill.
8. Bioprocess Engineering by Shule and Kargi, Prentice Hall.
9. Bioprocess Engineering Principles by Pauline M. Doran, Academic Press.
10. Rate controlled separations by Wankat P.C, Elsevier

SEVENTH SEMESTER

TITLE OF THE COURSE: FERMENTATION TECHNOLOGY

B.E., VII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT71	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Define the fundamentals of downstream processing for biochemical product recovery.
- Understand the concepts of secondary metabolite production.
- Assess the impact of change in unit's operations and the impact on the process.
- Examine traditional unit operations, as well as new concepts and emerging technology that is likely to benefit biochemical product recovery in the future.
- Analyze both analytical and process validation issues that are critical to successful manufacturing, focusing on large-scale, high-purity protein production.
- Model biochemical product recovery, including small molecule purification.
- Examine strategies for biochemical process synthesis

MODULE – 1

FERMENTATION TECHNOLOGY:

Types of fermentation – submerged and solid state fermentation. Modes of fermentation – Batch, continuous and fed-batch. Microbial growth kinetics. Development (from shake flask to 2L scale for 1st time) and Optimization of fermentation process – physiological and genetic strategies. Production of primary and secondary metabolites. Strategies to optimize product yield. Instrumentation and control.

Preservation of microbial products. Production of antibiotics. Enumeration and screening of novel microbial secondary metabolites, strain improvement.

Process design criteria for various classes of byproducts (high volume, low value products and low volume, high value products), Microbiology of brewing (Distilled and non distilled beverages with examples).

L1, L2, L3

MODULE –2

PRODUCTION OF SECONDARY METABOLITES & ANTIBIOTIC TECHNOLOGY:

Secondary metabolite production-strategies for optimizing product yield, culture conditions, selection of high yielding lines, elicitation, immobilization of cultures, hairy root culture and biotransformation. Factors affecting secondary metabolites, industrial application of secondary metabolites.

Hybridoma technology for monoclonal antibody production. Applications of custom made monoclonal antibodies. Bioreactors considerations for animal cell cultures – Production of Monoclonal antibodies and therapeutic proteins.

L1, L2, L3, L4

MODULE – 3

IMPORTANCE OF DOWNSTREAM PROCESSING AND PRIMARY SEPARATION TECHNIQUES:

Role and importance of downstream processing in biotechnological processes. Problems and

requirements of byproduct purification. Economics of downstream processing in Biotechnology.Cost cutting strategies, Characteristics of biological mixtures,
Cell disruption methods for intracellular products, removal of insolubles, biomass (and particulate debris) separation techniques; flocculation and sedimentation, Centrifugation (ultra and differential) , filtration methods and Principle and Applications of Electrophoresis - their types.

L1, L2, L3

MODULE – 4

MEMBRANE SEPARATION & ENRICHMENT OPERATIONS:

Membrane – based separations theory; Design and configuration of membrane separation equipment; Solute polarization and cake formation in membrane ultra filtration – causes, consequences and control techniques; Applications: Use of membrane diffusion as a tool for separating and characterizing naturally occurring polymers; enzyme processing using ultra filtration membranes; separation by solvent membranes; reverse osmosis.

Precipitation methods with salts, organic solvents, and polymers, extractive separations. Aqueous two-phase extraction, supercritical extraction; In situ product removal / integrated bioprocessing.

L1, L2, L3, L4

MODULE – 5

PRODUT RECOVERY – TRADITIONAL AND ADSORPTIVE SEPARATION:

Chromatographic separation processes, Electrophoretic separations, hybrid separation technologies, Dialysis; Crystallization. Partition chromatography - Single dimensional (Both Ascending and Descending) and two dimensional chromatography - Thin layer chromatography, Gas liquid Chromatography,

Adsorption column chromatography. Ion Exchange Chromatography: Cation Exchange and Anion Exchange chromatography. Gel Filtration Chromatography, Hydrophobic interaction chromatography, Affinity Chromatography, High Performance liquid chromatography (HPLC) – analytical and preparative.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Describe the factors affecting secondary metabolite production and its industrial importance.
- Describe the basic requirements of downstream processing for biochemical product recovery.
- Identify and summarize the effect of change in unit's operations and its impact on the process.
- Illustrate how emerging technologies would benefit the bio chemical product recovery and show the likely benefits it would have over the traditional operations.
- Analyzing both analytical and process validation issues that are critical to successful manufacturing.
- Outline the processes involving large-scale, high-purity protein production

REFERENCE BOOKS

1. Rate controlled separations by Wankat P.C., Elsevier.
2. Animal cell culture Techniques by Ian Freshney, Wiley-Liss.

3. Animal Cell biotechnology by R.E. Spier and J.B. Griffiths, Academic press.
4. Bioprocess Engineering by Shule and Kargi, Prentice Hall.
5. Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression by Wolf
6. R. Vieth, Wiley – Interscience Publication.
7. Enzymes in Industry: Production and Applications : W. Gerhartz, VCH Publishers, New York.
8. Enzyme Technology by M.F. Chaplin and C. Bucke, Cambridge University Press.
9. Bioseparation Engineering by Ajay Kumar, IK Intl.Ltd

TEXT BOOKS

1. Principles of fermentation Technology by P.F. Stanbury and A. Whitaker, Pergamon Press.
2. Animal Cell Technology by Asok Mukhopadyay, IK Intl. Ltd.
3. Downstream Process Technology – A new horizon in Biotechnology by Nooralabetta Krishna Prasad, PHI Learning Private Limited.
4. Bioseparation – Downstream processing for biotechnology by Belter P.A., Cussier E. and Wei Shan Hu., Wiley Interscience Pub.
5. Separation Processes in Biotechnology by Asenjo J. *et al.*, Marcel Dekker Publications.
6. Bioseparations by Belter P.A. and Cussier E., Wiley.
7. Product Recovery in Bioprocess Technology - BIOTOL Series,VCH.
8. Fermentation & Enzyme Technology by D.I.C. Wang *et.al.,* Wiley Eastern.
9. Purifying Proteins for Proteomics by Richard J Simpson, IK International.
10. BIOSEPARATIONS: Science and Engineering by ROGER G HARRISON, Oxford Publications.

TITLE OF THE COURSE: GENOMICS & PROTEOMICS
B.E., VII Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT72	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

1. To inculcate interdisciplinary approach of learning.
2. To comprehend applications of basic aspects of biotechnology
3. To impart knowledge on application of software tools for biological studies

MODULE – 1

INTRODUCTION:

Genes and Proteins, Polymorphisms – types of polymorphism, genome sequences and database subscriptions, discovery of new genes and their function. Early sequencing efforts. Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods, Sanger Di-deoxy method, Fluorescence method, shot-gun approach. Genome projects on *E.coli*., Arabidopsis and rice; Human genome project and the genetic map.

L1, L2, L3

MODULE –2

GENOMICS:

Inheritance pattern in eukaryotes, Mutations, Gene variation and Single Nucleotide Polymorphisms (SNPs), Expressed sequenced tags (ESTs), Gene-disease association, diagnostic genes and drug targets, genotyping tools - DNA Chips, diagnostic assays, diagnostic services; comparative genomics. Functional genomic studies with model systems such as Drosophila, Yeast or *C. elegans*. L2, L3, L4

MODULE – 3

GENOME MANAGEMENT :

Cell differentiation and gene regulation. C-Values of genomes. General architecture of prokaryotic and eukaryotic genome. Organization of eukaryotic genome within the nucleus, chloroplast and mitochondria. Regulation of transcription, transcription factors and the co-ordination of gene expression, translation and post-translational modification in eukaryotes. Interference RNA, RNA silencing, SiRNA: Applications in Functional genomics, Medicine and Gene Knockdown.

L2, L3, L4

MODULE – 4

GENOME ANALYSIS :

Genetic and physical maps: Breeding requirements for mapping. Molecular markers - RFLP, RAPD, AFLP, SCAR, CAPS, microsatellites and SNPs. Methods of molecular mapping, Marker assisted selection. Map-based cloning, T-DNA and transposon tagging. Differential

display via RT-PCR. Micro-array in functional genomics. Bioinformatics analysis – clustering methods. Approaches to Physical mapping, FISH - DNA amplification markers; Telomerase as molecular markers. Genome mapping approaches for microorganisms.

L1, L2, L3,L4

MODULE – 5

PROTEOMICS :

Introduction to proteins, Large scale preparation of proteins and peptides, Merrifield Synthesis of peptides, use of peptides as probes. Proteomics databases, proteins as drugs; two hybrid interaction screens. Mass-spec based analysis of protein expression and post-translational modifications. "Protein Chip" - interactions and detection techniques. Methods of measurement of mRNA expression, Two dimensional PAGE for proteome analysis, Automation in proteomics, Applications of proteome analysis to drug development and toxicology, Phage antibodies as tools for proteomics.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Define structural, comparative and functional genomics and proteomics and its uses in various research fields.
- Explain the various techniques involved in the extraction and utilization of enzymes in biotransformation

REFERENCE BOOKS

1. Biocomputing Informatics and the Genome Projects by Smith D.W., Academic 1993.
2. Genes VIII by Benjamin Lewis. Oxford University & Cell Press, 2007.
3. Bioinformatics – Methods And Applications: Genomics, Proteomics And Drug Dis By S C Rastogi, N Mendiratta & P Rastogi, Phi, 2006

1. Introduction to Genomics by Arthur M Lesk, Oxford University Press, 2007.
2. Plant Genome Analysis. Edited by Peter M Gresshoff, CRC Press.
3. Genetic Analysis – Principles, Scope and Objectives by JRS Finchman, Blackwell Sc 1994.
4. Discovering Genomics, Proteomics & Bioinformatics by A M Campbell & L J Heyer, Pearson Education, 2007
5. Protein Arrays, Biochips and Proteomics by J S Albala & I Humprey-Smith, CRC Press, 2003
6. Genomics & Proteomics by Sabesan, Ane Books, 2007
7. Purifying Proteins for Proteomics by Richard J Simpson, IK International, 2004
8. Proteins and Proteomics by Richard J Simpson, IK International, 2003

TITLE OF THE COURSE: PLANT BIOTECHNOLOGY
B.E., VII Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT73	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students

1. The basic concepts & techniques of plant tissue culture, media preparation, plant transformation, biotic & abiotic stresses wrt transgenic plants.
2. To outline & understand to use the applications of molecular farming in getting useful products for mankind.
3. Sketch the role & importance of BNF & describe the mechanism of signal transduction in plants.
4. Explain the role, importance & applications of algal technologies with suitable examples.

MODULE – 1

PLANT TISSUE CULTURE & GENETIC ENGINNERING OF PLANTS:

Introduction to cell and tissue culture. Tissue culture media (composition and preparation). Organogenesis, somatic embryogenesis. Embyo culture. Androgenesis and gynogenesis. Endosperm culture. Protoplast culture and selection of cybrids. Cryopreservation. Introduction to Plant Genetic Engineering: Types of plant vectors and their use – Particle bombardment, electroporation, microinjection. Agrobacterium mediated transformation – Technique and applications. Ti and Ri-plasmids as vectors. Screening and selection of transformants – PCR and hybridization methods. Viruses as a tool to delivery foreign DNA. Transformation of monoctos. Mechanism of transgene interaction - Transgene stability and gene silencing. Generation and maintenance of transgenic plants.

L1, L2, L3

MODULE –2

PLANTS FOR BIOTIC AND ABIOTIC STRESSES:

Introduction to biotic stresses, types. Application of plant transformation – bt genes, Structure and function of Cry proteins – mechanism of action, critical evaluation. Non-bt like protease inhibitors, alpha amylase inhibitor, Transgenic technology for development of virus, bacterial and fungal resistance plants. Abiotic stress – Introduction to drought and salinity stresses, transgenic strategies for development of drought resistant plants, case studies.

L2, L3, L4

MODULE – 3

PLANT IMPROVEMENT & MOLECULAR FARMING:

Post-harvest losses, long shelf life of fruits and flowers, use of ACC synthase, polygalacturanase, ACC oxidase, male sterile lines, barstar and barnase systems. Herbicide resistance – phosphoinothricin, glyphosate, atrazine; insect resistance. Biosafety regulations and evaluation of transgenics contained conditions. Implications of gene patents. Plant metabolic engineering and industrial products: Molecular farming for the production of industrial enzymes, biodegradable plastics, polyhydroxybutyrate, antibodies, edible vaccines. Metabolic engineering of plants for the

production of fatty acids, industrial oils, flavonoids etc., Engineering of carotenoid and provitamin biosynthetic pathways.

L2, L3, L4

MODULE – 4

NITROGEN FIXATION & SIGNAL TRANSUCTION IN PLANTS:

Nitrogen fixation and biofertilizers - Diazotrophic microorganisms, nitrogen fixation genes. Two component regulatory mechanisms. Transfer of *nif* genes and *nod* genes – structure, function and role in nodulation; Hydrogenase - Hydrogen metabolism. Genetic engineering of hydrogenase genes.Signal transduction in plants: Mechanism, plant hormone signaling- Molecular mechanism of Auxins, Gibberlins, Cytokinins, Abscisic acid and ethylene, transduction, light perception and signaling network in higher plants, calcium and sphingolipids signaling.

L1, L2, L3,L4

MODULE – 5

ALGAL TECHNOLOGIES

Blue-green algae and Azolla - Identification of elite species and mass production for practical application. Mycorrhizae - importance in agriculture and forestry. Algae as a source of food, feed, single cell protein, biofertilizers; industrial uses of algae. Mass cultivation of commercially valuable marine macroalgae for agar agar, alginates and other products of commerce and their uses. Mass cultivation of microalgae as a source of protein and feed.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- State the basic concepts of plant Biotechnology in plant tissue culture, media, tools of genetic engineering in producing transgenic plants (For eg., disease resistant).
- Explain the role & importance of plant Biotechnology in BNF, mechanism of signal transduction in plants & molecular farming.
- Describe the role, importance & applications of plant tissue culture, molecular farming, transgenic plants, Bioinsecticides, Biofertilizers, *nif* genes & algal technologies with suitable examples.

REFERENCE BOOKS

1. Molecular Biotechnology: Principles and Practices by Channarayappa, University Press.
2. Plant Tissue Culture: Applications and Limitations by S.S. Bhojwani, Elsevier,Amsterdam.
3. Plant Cell and Tissue Culture for the Production of Food Ingredients by TJ Fu, G Singh and WR Curtis (Eds): Kluwer Academic Press.
4. Biotechnology in Agriculture by MS Swamynathan, McMillian India Ltd.
5. Gene Transfer to Plants by Polyykus I and Spongernberg, G.Ed. Springer Scam.
6. Genetic Engineering with Plant Viruses by T Michael, A Wilson and JW Davis, CRC Press.
7. Molecular Approaches to Crop Improvement by Dennis Liwelly Eds. Kluwer. Academic Publishers.
8. Plant Cell and Tissue Culture- a Laboratory manual by Reinert J and Yeoman MM,

Springer.

9. Plant Tissue Culture by Sathyanarayana BN, IK Intl. Publishers.

TEXT BOOKS

1. Plant Cell Culture: A Practical Approach by R.A. Dixon & Gonzales, IRL Press.
2. Plant biotechnology in Agriculture by K. Lindsey and M.G.K. Jones, Prentice hall, New Jersey.
3. Plant Biotechnology, Prakash and Perk, Oxford & IBH Publishers Co.
4. Plant Biotechnology by J Hammond, P McGarvey and V Yusibov, Springer Verlag.
5. Biotechnology in Crop Improvement by HS Chawla, Intl Book Distributing Company.
6. Biodegradation and Detoxification of Environmental Pollutants by Chakrabarthy AM. CR Press.
7. Practical Application of Plant Molecular Biology by RJ Henry, Chapman and Hall.

TITLE OF THE COURSE: HEALTH INFORMATICS

B.E., VII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT741	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This objective of this course is to educate the students regarding the current system of handling health and medical data and its requirement, applications and scope.

MODULE – 1

INTRODUCTION:

Aim and scope, historical perspectives, concepts and activities in medical informatics, definition of medical informatics, online learning, introduction to the application of information technology to integrated hospital information systems and patient-specific information; nursing, radiology, pathology, and pharmacy services, Future trends, research in medical informatics, training and opportunities in medical informatics.

L1, L2

MODULE –2

HOSPITAL MANAGEMENT AND INFORMATION SYSTEMS:

Hospital Management and Information Systems (HMIS), its need, benefits, capabilities, development, functional areas. Modules forming HMIS, HMIS and Internet, Pre-requisites for HMIS, why HMIS fails, health information system, disaster management plans, advantages of HMIS. Study of picture archival & communication systems (PACS), PACS Administration, PACS Technology overview, Structuring medical records to carry out functions like admissions, discharges, treatment history etc. Central Registration Module, OPD / Consultant Clinic / Polyclinic Module, Indoor Ward Module, Patient Care Module, Procedure Module, Diet Planning Module, MLC Register Module.

L2, L3

MODULE – 3

ELECTRONIC HEALTH RECORDS:

Pathology Laboratory Module, Blood Bank Module, Operation Theatre Module, Medical Stores Module, Pharmacy Module, Inventory Module, Radiology Module, Medical Records Index Module, Administration Module, Personal Registration Module, Employee Information Module, Financial modules, Health & Family Welfare, Medical Research, Communication, GeneralInformation.

L2, L3

MODULE – 4

COMPUTER ASSISTED MEDICAL EDUCATION

Computer Assisted Medical Education & Surgery (CAME), Education software, Tele-education, Tele-mentoring, CAPE, patient counselling software. Limitation of conventional surgery, computer assisted surgery (CAS), 3D navigation system, intra-operative imaging for

3D navigation system, merits and demerits of CAS. Computer support collaborative learning, Future of Computer Aidede Learning (CAL).

L2, L3

MODULE – 5

APPLICATIONS:

Need, technology, volume image data file, human resources, interface and applications. Virtual environment (VE), technology, applications of VE, advantages of simulators and after effects of VE participation. Millirobotics for remote surgery, Telesurgery, and endoscopy History and advances in telemedicine, Benefits of telemedicine, Medical information storage and management for telemedicine.

L1, L2

Course outcomes:

After studying this course, students will be able to:

- Define the usage of informatics in the health and medical sectors.
- Understand the applications of the various computer technologies incorporated into the health and medical fields

REFERENCE BOOKS

1. Biomedical Information Technology by David D Feng, Elsevier.
2. Emerging Trends in Biomedical Science and Health by D V Rai, IK Intl. Ltd.

TEXT BOOKS

1. Medical Informatics, a Primer by Mohan Bansal, TMH publications.
2. Medical Informatics: Computer applications in health care and biomedicine by E.H.Shortliffe, G.
3. Wiederhold, L.E.Perreault and L.M.Fagan, Springer Verlag.
4. Handbook of Medical Informatics by J.H.VanBemmel, Stanford University Press

TITLE OF THE COURSE: BIOREACTOR DESIGN CONCEPTS

B.E., VII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT742	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Understand the fundamentals of reactor design,
- Specify design criteria for medium sterilization
- Understand the design a complete bioreactor based on targets, constraints and physical properties.
- Apply mass and heat transfer correlations to bioreactor design.
- Identify suitable process instrumentation for monitoring and control of bioreactors.

MODULE – 1

FUNDAMENTALS OF REACTOR DESIGN & MEDIA REQUIREMENTS:

Microbial growth and product formation kinetics, Thermal death kinetics of microorganisms, Heterogeneous reaction kinetics, Enzyme kinetics, Multiple reactions – series, parallel and mixed. Basic Design Equations/ Mole Balances: Batch, Fed Batch and Repetitive Batch Reactors, Continuous: Stirred tank and tubular flow reactors

Microbial death kinetics. Design criterion for sterilization. Batch and continuous sterilization of medium. Air sterilization.

L1, L2, L3

MODULE –2

BIOREACTOR REQUIREMENTS & NON ISOTHERMAL REACTORS:

Fermentation Process – General requirements; Basic design and construction of fermenters and its ancillaries; Material of construction, Vessel geometry, Bearing assemblies, Motor drives, Aseptic seals; Flow measuring devices, Valves, Agitator and Sparger Design, Sensors.

Bioprocess and bioreactor design considerations for plant and animal cell cultures. Effect of media on reactor design.

Non-isothermal homogeneous reactor systems. Adiabatic reactors, batch and continuous reactors, optimum temperature progression.

L2, L3, L4

MODULE – 3

MASS & HEAT TRANSFER EFFECTS:

External mass transfer limitations, correlations for stirred tank, packed bed and fluidized bed reactors. Internal mass transfer limitations, correlations for stirred tank, packed bed and fluidizedbed reactors. Combined effect of heat and mass transfer effects Mass transfer in heterogeneous biochemical reaction systems; Oxygen transfer in submerged fermentation processes; Oxygen uptake rates and determination of oxygen transfer coefficients (kLa); role of aeration and agitation in oxygen transfer. Heat transfer processes in biological systems. Conceptual numericals.

L1, L2, L3, L4

MODULE – 4

DESIGN OF FERMENTORS:

Process and mechanical design of fermenters, volume, sparger, agitator – type, size and motor power, heat transfer calculations for coil and jacket, sterilization system.

L1, L2, L3,L4

MODULE – 5

NOVEL BIOREACTORS DESIGN:

Design of Immobilized enzyme packed bed Reactor. Fluidized bed reactors, Slurry Reactors, Air lift & Loop reactors, Packed bed and Hollow fiber membrane bioreactors, Bioreactors for waste treatment processes; Scale-up of bioreactors, SSF bioreactors. Conceptual numericals.

L1, L2, L3,L4

Course outcomes:

After studying this course, students will be able to:

- Design culture medium based on nutritional requirements of microbial cells.
- Specify design criterion for medium sterilization and solve problems involving both batch and continuous sterilization.
- Understand the bioreactor performance.
- Apply mass and heat transfer correlations to bioreactor design.
- Design a complete bioreactor based on targets, constraints and physical properties.
- Identify suitable process instrumentation for monitoring and control of bioreactors.

REFERENCE BOOKS

1. Wolf R. Vieth, Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression. A Wiley – Interscience Publication.
2. Chemical Kinetic Methods: Principles of relaxation techniques by Kalidas C. New Age International.
3. Chemical Reactor Analysis and Design by Forment G F and Bischoff K B., John Wiley.

TEXT BOOKS

1. Contemporary Enzyme Kinetics and Mechanism by Daniel L. Purich, Melvin I. Simon, John N.Abelson
2. Biochemical Engineering Fundamentals by Bailey and Ollis, McGraw Hill.
3. Bioprocess Engineering by Shule and Kargi, Prentice Hall.
4. Bioprocess Engineering Principles by Pauline M. Doran.
5. Elements of Chemical Reaction Engineering by Fogler, H.S., Prentice Hall.
6. Chemical Reaction Engineering by Levenspiel O., John Wiley.
7. Chemical Engineering Kinetics by Smith J.M., McGraw Hill.
8. Biocatalytic Membrane Reactor by Drioli, Taylor & Francis..

TITLE OF THE COURSE: LAB TO INDUSTRIAL SCALING

B.E., VII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT743	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This objective of this course is to

- Identify fermentation as a basic biochemical process, types of fermentation & fermentation products with medium raw materials, sterilization, optimization, inoculum preparation & economics of fermentation.
- Describe the upstream & downstream processes used in fermentation industry with special emphasis on scale up of media, inoculum, aeration & agitation.
- Sketch the various products of fermentation processes useful for the health of mankind.
- Describe the on-line & off-line analysis of fermentation data for the process parameters (physical, chemical & biological) like temperature, pressure, pH, aeration, agitation, fluid rheology, foam & bacterial growth.
- Explain the various parameters to be considered while designing a fermenter & its ancillary equipment's.

MODULE – 1

INDUSTRIALLY IMPORTANT MICROBES:

Introduction to Fermentation & Fermentation as a Biochemical process, Microbial biomass, Enzymes, Metabolites recombinant products. Isolation of industrially important microorganisms preservation of microbes, Strain developmentby various methods, Isolation of mutants and recombinants, application of continuous, batch andfed batch culture.

L1, L2

MODULE –2

RAW MATERIALS, STERILIZATION & PREPARATION OF INOCULUM:

Selection of typical raw materials, Different media for fermentation, Optimization of media, Different sterilization methods – batch sterilization, continuous sterilization, filter sterilization, Oxygen requirement. Inoculum preparation from laboratory scale to pilot scale and large scale fermentation, maintenance of aseptic condition.

L2, L3

MODULE – 3

FERMENTER DESIGN, AREATION & AGITATION:

Basic structure of fermenter body construction. Description of different parts of fermenter aseptic conditions. Different types of fermenters. Supply of oxygen, fluid rheology, factors affecting aeration and agitation. Scale up and scale down of aeration and agitation.

L1, L2

MODULE – 4

PROCESS CONTROL:

Instruments involved in the fermentation, control of pressure, temperature, flow rate, agitation,

stirring, foaming. Online analysis for measurement of physico chemical and biochemical parameters. Method of online and off line bio mass estimation. Flow injection analysis for measurement of substrates products and other metabolites, computer based data acquisition.

L1, L2

MODULE – 5

INDUSTRIAL OPERATIONS

Recovery and purification of products, Use of filtration and centrifugation, cell disruption, chemical methods, extraction, chromatographs methods, drying and crystallization, membrane process. Effluent treatment: Disposal methods, treatment process, aerobic and anaerobic treatment, byproducts. Economic aspects: Fermentation as a unit process, economy of fermentation, market potential. Legalization of products like antibiotics and recombinants.

L1, L2

Course outcomes:

After studying this course, students will be able to:

- Understand molecular and cellular aspects of bacterial and viral diseases
- Explain mechanisms involved in microbial pathogenesis and host responses
- Comprehend mechanism of action of antimicrobial drugs and vaccines
- Carry out research involving molecular microbiology and microbial genomics.

REFERENCE BOOKS

1. Fermentation & Enzyme Technology by D.I.C. Wang et.al., Wiley Eastern.
2. Purifying Proteins for Proteomics by Richard J Simpson, IK International.
3. BIOSEPARATIONS: Science and Engineering by ROGER G HARRISON, Oxford Publications.

TEXT BOOKS

1. Downstream Process Technology – A new horizon in Biotechnology by Nooralabetta Krishna Prasad, PHI Learning Private Limited.
2. Bioseparation – Downstream processing for biotechnology by Belter P.A., Cussier E. and Wei Shan Hu., Wiley Interscience Pub.
3. Separation Processes in Biotechnology by Asenjo J. et al., Marcel Dekker Publications.
4. Bioseparations by Belter P.A. and Cussier E., Wiley.
5. Product Recovery in Bioprocess Technology - BIOTOL Series,VCH.
6. Cellular Microbiology - Pascale Cossart, Patrice Boquet, Staffan Normark, and Rino Rappuoli), 2nd Edition, ASM Press
7. Microbiology: Diversity, Disease, and the Environment (Abigail A. Salyers, Dixie D. Whitt) Fitzgerald Scince Press.
8. Bacterial Invasion of Host Cells - Edited by Richard J. Lamont, Cambridge University Press

TITLE OF THE COURSE: FOOD BIOTECHNOLOGY

B.E., VII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT744	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: The objective of this course is to educate students about the fundamental concepts of food biotechnology.

MODULE – 1

FOOD SCIENCE & FOOD NUTRITION:

Introduction, history, constituents of food, Regulation of food intake colloidal systems in food, stability of colloidal systems, Carbohydrates, Starches, Proteins , Fats in food, sugars in food, Minerals, Aroma compounds and flavours in food, Browning reactions, anti-nutritional factors in foods, Rancidity of food factors affecting to rancidity, preventive measures. Metabolism in starvation and malnutrition, Diet and nutrition in India, Food faddism and faulty food habits.

L1, L2, L3

MODULE –2

MICROBIAL SPOILAGE, DETECTION:

Intrinsic and extrinsic factors influences the growth of microorganism in food, primary sources of microorganisms found in foods, Synopsis of common food-borne bacteria, genera of molds, genera of yeasts, Food borne infection and intoxication.Brief discussions on food borne gastroenteritis caused by *Salmonella, Shigella, Listeria, Staphylococcus,Clostridium, Vibrio, Yersinia and Campylobacter* Microbial detection in food: Culture, Microscopic & sampling methods, Conventional SPC, Membrane filters, microscope colony Counts, Agar droplets, Dry films, Most probable nos. (MPN), Dye-reduction, roll tube, microscopic count (DMC).

L1, L2, L3

MODULE – 3

FOOD FERMENTATION& PRESERVATION:

Fermented foods – Production of Bread, Cheese andSauerkraut. Fermentation of wines, distilledliquor, vinegar, Fermented Dairy products.Principles underlying preservation of food. Food preservation using chemical preservatives, irradiation, high temperature, low temperature and dehydration.

L1, L2, L3

MODULE – 4

FOOD INDUSTRY AND BIOTECHNOLOGY IN FOOD:

Characteristics of food industry. Food manufacturing and processing, objectives of foodprocessing, effect of food processing on food constituents, methods of evaluation of food,proximate analysis of food constituents, Nutritional value, labeling of constituents, (Soya foods,organic foods, dietary foods, (for individuals, for specific groups),nutritional food supplements,Food packaging, edible films, Factors influencing food product development, marketing andpromotional strategies. Applications of Biotechnology in food industry-Nutraceuticals,flavonoids, antioxidants, vitamins, enzymes in food industry, economic aspects,

enzymegeneration of flavor and aroma com pounds.

L1, L2

MODULE – 5

FOOD TECHNOLOGY

Properties of foods and processing theory, Process control, Raw material processing, Thermal properties of frozen foods, Prediction of freezing rates, Food freezing equipments: Air blastfreezers, plate freezers and immersion freezers. Food dehydration: estimation of drying time, constant rate period and falling rate period. Equipments: fixed tray dehydration, cabinet drying, tunnel drying. Equipments related to pulping, fruit juice extraction, dehulling and distillation, Food safety (HACCP and FSO systems), good manufacturing practice and quality assurance. Current technologies and Future Scope.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Display a solid foundation in understanding the biochemical, nutritional and physiological aspect of food.
- Understand the factors influencing microbial growth, its intoxication, detection methods, food processing techniques and preservation to enhance the shelf life of food.

REFERENCE BOOKS

1. Modern Food Microbiology by James M Jay, Aspen Publishers.
2. Essentials of Food Sciences Vickie A. Vaclavik, Elizabeth W. Christian, Springer.
3. Food Science by N. Potter & Hotchkiss, ASPEN Publication.
4. An introduction to Food Science by Rick Parker and Delmar, Thomson Learning.
5. Food Technology by N W Desroisier, Springer.
6. Food Science & Nutrition by Sunitha Reddy, Publishing House Pvt. Ltd., Delhi.

TEXT BOOKS

1. Food microbiology by William C Frazier and Westhoff Dennis C, Tata McGraw Hill publication.
2. Food Biotechnology by J Polak, J Tramper and S Bielecki, Elsevier Science.
3. Food Science & Food Biotechnology by Gustavo F & Lopez, CRC Press.
4. Food Engineering by Dennis Heldman & R Paul Singh, Academic Press.
5. Food Biotechnology by Kalidas Shetty. CRC Press.

TITLE OF THE COURSE: DAIRY BIOTECHNOLOGY

B.E., VII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT751	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to learn about

- The various microbiological concepts and unit operation involved in dairy plant.
- Understand the different characteristics of various dairy products and the safety and quality guidelines of dairy foods.
- Implementing the general consideration involved in designing the dairy plant with a proper plant layout.

MODULE – 1

DAIRY INDUSTRY:

Overview and characteristics of dairy industry. Status of dairy industry in India. Recent policy changes related to dairy sector (MMPO & WTO). Principles and practices for production of high quality milk. Microbial quality of milk produced under organized versus unorganized milk sector in India. Impact of various stages like milking, chilling, storage and transportation on microbial quality of milk with special reference to psychotropic organisms; Direct and indirect rapid technique for assessment of microbial quality of milk. Microbiological changes in bulk refrigerated raw milk; Mastitis milk: organisms causing mastitis, detection of somatic cell count (SCC). Role of microorganisms in spoilage of milk; souring, curdling, bitty cream, proteolysis, lipolysis; abnormal flavors and discoloration. Significance of antimicrobial substances naturally present in milk.

L1, L2, L3

MODULE –2

DAIRY BIOTECHNOLOGY AND BYPRODUCT UTILIZATION:

Genetic engineering of bacteria and animals intended for dairy-based products: DNA cloning. protoplast fusion & cell culture methods for trait improvement with instances cited. Enzymes in dairy industry & production by whole cell immobilization. Biotechnology of dairy effluent treatment. Ethical issues relating to genetic modification of dairy microbes & milk-yielding animals. Utilization of dairy by-products in India and abroad, associated economic and pollution problems. Physico chemical characteristics of whey, butter milk and ghee residue; by-products from skim milk such as Casein; Whey processing & utilization of products generated from whey.

L2, L3

MODULE – 3

DAIRY ENGINEERING:

Introduction of Dairy Plant design and layout. Classification of dairy plants, selection of site for location. General points of considerations for designing dairy plant, floor plant types of layouts. Arrangement of equipment, milk piping, material handling in dairies. Materials and sanitary features of the dairy equipment. Sanitary pipes and fittings, standard glass piping,

plastic tubing, fittings and gaskets, installation, care and maintenance of pipes & fittings. Description and maintenance of can washers, bottle washers. Homogenization: Classification, single stage and two stage homogenizer pumps, power requirements, care and maintenance of homogenizers, aseptic homogenizers. Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers. Filling Operation: Principles and working of different types of bottle filters and capping machine, pouch filling machine (Pre-pack and aseptic filling), bulk handling system, care and maintenance.

L2, L3, L4

MODULE – 4

DAIRY PROCESS ENGINEERING:

Evaporation: Basic principles of evaporators, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Care and maintenance of evaporators. 60 Drying: Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying- constant and falling rate, Effect of Shrinkage, Classification of dryers spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems. Fluidization: Mechanisms of fluidization characteristics of gas-fluidization systems, application of fluidization in drying. Membrane Processing: Ultra filtration, Reverse Osmosis and electro dialysis in dairy processing, membrane construction & maintenance for electro-dialysis & ultra-filtration, effect of milk constituents on operation.

L1, L2, L3

MODULE – 5

QUALITY AND SAFETY MONITORING IN DAIRY INDUSTRY:

Current awareness on quality and safety of dairy foods; consumer awareness and their demands for safe foods; role of Codex Alimentations Commission (CAC) in harmonization of international standards; quality (ISO 9001:2000) and food safety (HACCP) system and their application during milk production and processing. National and international food regulatory standards; BIS, PFA, ICMSF, IDF etc., their role in the formulation of standards for controlling the quality and safety of dairy foods. Good Hygiene Practices (GHP). Quality of water and environmental hygiene in dairy plant; treatment and disposal of waste water and effluents.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Gain an in-depth understanding of biochemical, microbiological and unit operations involved in the dairy processing.
- Demonstrate a broad coherent knowledge of safety and quality factors that determine the acceptability of the dairy products by consumers.
- Explain the general considerations involved in designing the dairy plant with the use

of proper layout.

REFERENCE BOOKS

1. Comprehensive Biotechnology, Edited by N.C Gautam, Shree Pblns.
2. General Microbiology, Powar & Daginawala, Himalaya Publishers
3. Milk composition, production & biotechnology (Biotechnology in Agriculture Series 18)-CABI Publishers.
4. Handbook of Farm, Dairy & Food Machinery by Myer Kutz, Andrew Publishers

TEXT BOOKS

1. Diary Science & Technology Handbook, Edited by Hui, Y.H, Wiley Publishers
2. Diary Microbiology Handbook, Edited by Robinson, R.K., Wiley Publishers

TITLE OF THE COURSE: FORENSIC SCIENCE
B.E., VII Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT752	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This objective of this course is to educate the students regarding the applications of various branches of science and specialized techniques for the purpose of settling legal disputes categorized under forensic science

MODULE – 1

INTRODUCTION:

Introduction, Definition and Scope, History and Development of Forensic science, Legal procedures and use of court. Types of Evidence. Organization of a crime Laboratory services of the crime laboratory, Basic services provided by full service crime laboratories, Physical Science unit, Biological unit, Firearms unit, Document Examination unit. Functions and duties performed by each unit and lab.

L1, L2, L3

MODULE –2

FORENSIC ANALYSIS AND IMAGING:

Analysis of Physical evidence, Expert unit men, specially trained evidence collection technician, Analytical technician. Digital cameras and forensic imaging, Uses of digital imaging, Maintaining chain of control with digital images, digital videos, scanners, presenting pictures in courtroom, Detecting compression and forgeries and Maintaining Records.

L2, L3

MODULE – 3

FORENSIC BIOLOGY:

Forensic Pathology: Rigor mortis, Lovor mortis, Algor mortis. Forensic Anthropology, Forensic Entomology, Forensic Psychiatry, Forensic Odontology, Foresnsic Engineering, DNA Analysis, Dactyloscopy, Fingerprints: Classification and patterns. Characterization of blood stains, stain patterns of blood, preservation of blood evidence, characterization of semen, role of toxicologist, toxicology of alcohol, techniques used in toxicology, role of toxicological findings and drug recognition experts.

L1, L2, L3

MODULE – 4

FORENSIC APPLICATIONS:

Probability population and sampler, weight of evidence and the Bayesian likelihood ratio, Transfer evidence application of statistics to particular areas of forensic science, Knowledge base systems, Quality base of system General concepts and tools, Arithmetic and logical operation, Developing an algorithm to solve problem, Modularization, Function and procedures, Arrays, File processing , Reports and control breaks, Processing the date.

L1, L2, L3

MODULE – 5

ETHICS IN FORENSICS:

The importance of professional ethics to science practitioners, Development of a code of conduct

and code of ethics for forensic science, Application of codes and ethics, How ethical requirement, impact the daily work of a forensic scientist, ethical dilemmas and their resolution.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- List the various types of forensic branches of science.
- Explain the various applications of techniques and usage of technology to gain knowledge and insight that have legal implications.

REFERENCE BOOKS

1. Principles of Forensic Medicine by Apurba Nandy, New central book agency Ltd.
2. Computer forensics: evidence collection and management by Robert C. Newman and Boca Raton FL, Taylor and Francis.
3. Forensic Computer Crime Investigation By Jr Thomas A Johnson, Taylor and Francis, CRC Press
4. Introduction to Statistics for Forensic Scientists by David Lucy, Wiley publications.
5. Digital Evidence and Computer Crime, Academic Press

TEXT BOOKS

1. Criminalistics : An Introduction to Forensic Science by Richard Saperstein, Prentice Hall.
2. Introduction to Forensic Sciences by William G Eckert, CRC Press.
3. Understanding Forensic Digital Imaging by Blitzer, Herbert L. and Stein-Ferguson, Academic Press.
4. Forensic Uses of Digital Imaging by John C. Russ Publisher, CRC Press.
5. Principles of Bloodstain Pattern Analysis: Theory and Practice by Stuart H. James, Paul E. Kish, T. Paulette Sutton, CRC Press Taylor and Francis.
6. Principles of Forensic Toxicology by Barry Levine, AACC Press.
7. Textbook of Forensic Medicine and Toxicology by V.V. Pillay, Paras Medical Publishers.
8. Essential Forensic Biology by Alan Gunn, Wiley Blackwell.
9. The Use of Statistics in Forensic Science by C. G. G. Aitken and David A. Stoney Ellis Harwood series in forensic science.
10. Ethics in Forensic Science: Professional Standards for the Practice of Criminalistics by Peter D. Barnett, Taylor and Francis Inc

TITLE OF THE COURSE: MOLECULAR DIAGNOSTICS
B.E., VII Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT753	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: The students acquire the

- Basic knowledge of symptoms, diagnosis, & treatment of various diseases, their importance and applications.
- Knowledge on DNA & PCR-based diagnostic techniques like FISH, SKY, CGH, PAGE, Southern Blotting, PCR-SSCP & G- Banding.
- Knowledge on Biochemical and Cell based diagnostic techniques in detail.
- Identify the different Immunodiagnostic tools available for the diagnosis of various infectious, respiratory, viral, bacterial, enteric, parasitic &mycobacterial diseases.
- Knowledge about the basic working principle, procedure & applications of various Imaging diagnostic methods such as ECG, EEG, US, CT, MRI, Endoscopy, Radiography, Nuclear Medicine, SPECT& PET.
- Knowledge on the various product development, assay development, evaluation, validation, reagent formulation & concepts and applications of biosensors for personal diabetes management.

MODULE – 1

DNA BASED DIAGNOSTICS:

Introduction, importance and applications of health diagnostics. PCR based diagnostics (Fragile X chromosome detection and SRY in sex chromosomal anomalies), PCR-SSCP (Sickle cell anemia, Thalassemia), Ligation Chain Reaction, Southern blot diagnostics (Triple nucleotide expansions in Fragile X chromosome and SCA), PAGE (band detection of enzyme variants), DNA Sequencing (DNA Sequencing of representative clones to detect mutations), SNP analysis, Array based diagnostics, Genetic Profiling, G Banding- Detection of autosomal and sex chromosomal disorders (translocation, deletion, Down's Syndrome, Klenefelter's Syndrome, Turner's Syndrome), In situ hybridization-FISH (detection of translocations and inversions – chromosome 9-22 translocation, X-Y translocations), Comparative Genomic Hybridization, Cancer cytogenetics, Karyotyping & Spectral Karyotyping.

L1, L2, L3

MODULE –2

BIOCHEMICAL & CELL BASED DIAGNOSTICS :

Introduction to inborn errors of metabolism, haemoglobinopathies, mucopolysaccharidoses, lipidoses, lipid profiles, HDL, LDL, Glycogen storage disorders, amyloidosis.Antibody markers, CD Markers, FACS, HLA typing, Bioassays.

L2, L3

MODULE – 3

IMMUNODIAGNOSTICS:

Introduction, Antigen-Antibody Reactions, Conjugation Techniques, Antibody Production, Enzymes and Signal Amplification Systems, Separation and Solid-Phase Systems, Case studies

related to bacterial, viral and parasitic infections. Diagnosis of infectious diseases, respiratory diseases (influenza, etc.) Viral diseases-HIV etc., bacterial diseases, enteric diseases, parasitic diseases and mycobacterium diseases. Phage display, immunoarrays, FACs

L2, L3

MODULE – 4

IMAGING DIAGNOSTICS:

Imaging Techniques - Basic Concepts, Invasive and Non-Invasive techniques; ECG, EEG, Radiography, Nuclear Medicine, SPECT, PET, CT, MRI, Ultrasound Imaging, Photoacoustic imaging, Digital Mammography, Endoscopy; Planning and Organization of Imaging Services in Hospital, PACS, Staffing, Records, Policies, Safety measures and Radiation Protection.

L1, L2

MODULE – 5

PRODUCT DEVELOPMENT & BIOSENSORS:

Immunoassay Classification and Commercial Technologies, Assay Development, Evaluation, and Validation, Reagent Formulations and Shelf Life Evaluation, Data Analysis, Documentation, Registration, and Diagnostics Start-Ups.Concepts and applications, Biosensors for personal diabetes management, Noninvasive Biosensors in Clinical Analysis, Introduction to Biochips and their application in Health.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Outline the basic concepts of health diagnostics with special emphasis on the role & importance DNA-based and PCR-based diagnostic methods.
- Describe the diagnosis of disorders such as haemoglobinopathies, mucoploysaccharidoses, lipidoses, amyloidoses using biochemical & cell-based assays.
- Identify the different immunodiagnostics & imaging diagnostic techniques.
- Explain the different ways of product & assay development methods with special emphasis on biosensors for personal diabetes management.

1. Molecular Biotechnology
2. Genetic Engineering
3. Recombinant DNA
4. Vectors

1. Medical Informatics, a Primer by Mohan Bansal, TMH publications.
2. Tietz Textbook of Clinical Chemistry
3. Commercial Biosensors
4. Essentials of Diagnostic Microbiology
5. Diagnostic Microbiology
6. Molecular Biotechnology– Principles and Applications of recombinant DNA
7. Principles of gene manipulation- An introduction to genetic engineeringGenes VIII

TITLE OF THE COURSE: BIG DATA MANAGEMENT

B.E., VII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT754	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This course will enable students to

- Learn what big data is, and how it differs from traditional approaches
- Learn about the Plan and use the primary tools associated with big data in creating systems to take advantage of big data.
- Extract knowledge and intelligence from datasets which exhibit high volume, velocity, and/or variety.
- Plan and execute a project that includes the use of at least one big data dataset.
- Discuss the meta issues around big data such as governance, security, privacy, and OAM&P.
- Execute analyses oriented to streaming data.
- Have a framework with which to understand new advances in the field, and distinguish hype from reality.
- Discuss organizational issues related to big data.

MODULE – 1

OVERVIEW:

An introduction to Big Data, differences with traditional Data, Definitions, Applications, Tools, and Governance. An introduction to the core technologies for scale and distribution, including map/reduce, Hadoop, compression, GFS and HDFS. Internet of Things, Data Stream Management Systems, Infosphere Stream, STREAM, Gigascope, Analytics.

L1, L2, L3

MODULE –2

DATA ANALYTICS IN A BIG DATA:

Data analytics in a big data, distributed world. R over Hadoop. Issues related to the governance of large data sets, including: security, privacy, integrity, quality, and OA&M. More detailed discussion of the issues of security, privacy, integrity, quality, OA&M, and management of big data, including related technologies. Privacy Policies of selected companies. Discussions of selected applications of big data in a few different industries.

L1,L2, L3

MODULE – 3

DATABASE MANAGEMENT:

Parallel database management, Distributed databases and distributed query processing, MapReduce and other parallel programming models, Big data: theory and practice, Volume: tractability revisited; parallel scalability; bounded evaluability, techniques for querying big data, by making big data small, Veracity: data quality, the other side of big data; central issues of data quality; dependencies for improving data quality; discovering data quality rules; cleaning distributed data; data repairing; entity resolution.

L2, L3

MODULE – 4

BIG DATA MANAGEMENT:

Opportunities and Challenges; Science of data analytics; Data growth and associated computational complexity; Algorithmic techniques of data mining; The MapReduce framework and HADOOP; Conventional Extract Transform Load (ETL) and Extract Load Transform (ELT) for large data preprocessing; Data preprocessing and transformation; Dimensionality reduction methods; Feature selection, distance metrics, algorithm design and analysis.

L1,L2,L3

MODULE – 5

DATA ANALYTICS:

Data analytics using clustering, algorithms and frameworks; Categories of clustering algorithms; Data analytics using supervised learning and classification; Multi-class classification; Differences and shared challenges between classification and clustering; Classification based models for clustering; Spatio-temporal data structures for range queries for data mining applications; Intricacies of image feature extraction for content-Based image retrieval.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Understand and discuss what big data is, and how it differs from traditional approaches
- Plan and use the primary tools associated with big data in creating systems to take advantage of big data.
- Extract knowledge and intelligence from datasets which exhibit high volume, velocity, and/or variety.
- Plan and execute a project that includes the use of at least one big data dataset.
- Understand and discuss the meta issues around big data such as governance, security, privacy, and OAM&P.
- Understand and be able to execute analyses oriented to streaming data.
- Have a framework with which to understand new advances in the field, and distinguish hype from reality.
- Understand and discuss organizational issues related to big data.

REFERENCE BOOKS

1. Big Data Management and Processing, Kuan-Ching Li, Hai Jiang, Albert Y. Zomaya, CRC Press, 2017
2. Large Scale and Big Data: Processing and Management, SherifSakr, Mohamed Gaber, CRC Press, 2016

TEXT BOOKS

1. Big Data Management, Editors: Garcia Marquez, Fausto Pedro, Lev, Benjamin (Eds.) 2017
2. Big Data Management, Technologies, and Applications by Naima Kaabouch, Wen-Chen Hu, Publisher: IGI Global, October 2013.

FERMENTATION TECHNOLOGY LABORATORY

B.E., VII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17BTL76**	CIE Marks	40
Number of Lecture Hours/week	03=(1 Hour Instruction + 2 Hours Laboratory)	SEE Marks	60
Total Number of Hours	40	Exam Hours	03
RBT Levels	L1, L2, L3, L4		

CREDITS – 02

Course objectives: This course will enable students to

- Define the fundamentals of downstream processing for biochemical product recovery.
- Understand the concepts of secondary metabolite production.
- Assess the impact of change in unit's operations and the impact on the process.
- Examine traditional unit operations, as well as new concepts and emerging technology that is likely to benefit biochemical product recovery in the future.
- Model biochemical product recovery, including small molecule purification.
- Examine strategies for biochemical process synthesis.

1. Cell disruption techniques.
2. Solid-liquid separation methods: Filtration
3. Solid-liquid separation methods: Sedimentation
4. Solid-liquid separation methods: Centrifugation.
5. Product enrichment operations: Precipitation – (NH4)2 SO4 fractionation of a protein.
6. Product drying techniques.
7. Separation of Amino acids / Carbohydrates by TLC.
8. Preparation of the fermenter
9. Production of Ethanol in fermenter - Study of growth, product formation kinetics, end substrate utilization
10. Estimation of % of ethanol from fermented broth.
11. Production and estimation of citric acid from *Aspergillus niger*
12. Estimation of Citric acid from fermented broth
13. Shake flask studies; Comparison of biomass yield in defined & complex media

Course outcomes:

After studying this course, students will be able to:

- Describe the factors affecting secondary metabolite production and its industrial importance.
- Describe the basic requirements of downstream processing for biochemical product recovery.
- Identify and summarize the effect of change in unit's operations and its impact on the process.

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.
- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Protein Purification by Scopes R.K., IRL Press.
2. Rate controlled separations
3. Bioseparations: Science & Engineering
4. Product Recovery in Bioprocess Technology
5. Separation processes in Biotechnology

PLANT BIOTECHNOLOGY LABORATORY
B.E., VII Semester, Biotechnology
[As per Choice Based Credit System (CBCS) scheme]

Course Code	**17BTL77**	CIE Marks	40
Number of Lecture Hours/week	03=(1 Hour Instruction + 2 Hours Laboratory)	SEE Marks	60
Total Number of Hours	40	Exam Hours	03
RBT Levels	L1, L2, L3, L4		

CREDITS – 02

Course objectives: This course will enable students to

- The basic concepts & techniques of plant tissue culture, media preparation, plant transformation, biotic & abiotic stresses wrt transgenic plants.
- Outline & understand to use the applications of molecular farming in getting useful products for mankind.
- Sketch the role & importance of BNF & describe the mechanism of signal transduction in plants.

1. Preparation of media for plant tissue culture.
2. Callus Induction Techniques – Carrot/Beet root/ or any other material
3. Development of suspension culture from callus
4. Induction of Secondary metabolite – Anthocyanin/catheranthin
5. Estimation of Lycopene from tomato fruits
6. Estimation of Anthocyanin from leaf /callus tissue
7. Estimation of DNA (by DPA method)
8. Protein estimation by Lowry's method / Bradford's method.
9. Somatic Embryogenesis
10. Embry/Endosperm Culture
11. Isolation of protoplasts
12. Shoot tip culture

Course outcomes:

After studying this course, students will be able to:

- State the basic concepts of plant Biotechnology in plant tissue culture, media, tools of genetic engineering in producing transgenic plants (For eg., disease resistant).
- Explain the role & importance of plant Biotechnology in BNF, mechanism of signal transduction in plants & molecular farming.
- Describe the role, importance & applications of plant tissue culture, molecular farming, transgenic plants

Conduct of Practical Examination:

- All laboratory experiments are to be included for practical examination.
- Students are allowed to pick one experiment from the lot.

- Strictly follow the instructions as printed on the cover page of answer script for breakup of marks.
- Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Plant Molecular biology by D. Grierson & S.N. Covey Blackie, London.
2. Plant Cell Culture : A Practical Approach by R.A. Dixon & Gonzales, IRL Press.
3. Experiments in Plant Tissue Culture by John H. Dodds & Lorin W. Robert.
4. Plant tissue Culture : Theory and Practice by S.S. Bhojwani and M.K. Razdan, Elsevier.

EIGHTH SEMESTER

TITLE OF THE COURSE: CLINICAL & PHARMACEUTICAL BIOTECHNOLOGY B.E., VIII Semester, Biotechnology [As per Choice Based Credit System (CBCS) scheme]			
Course Code	17BT81	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: The objective of this course is to educate students about drug design, formulation; importance of pharmacokinetics & pharmacodynamics study. To list the applications & advantages of Pharmaceutical & Clinical Biotechnology

MODULE – 1

DRUG MANUFACTURE AND FORMULATION:

Introduction to pharma industry, Biotechnology and Drug design, Basic concepts and applications, composition, preparation, physicochemical considerations in manufacture of current biotech products & herbal medicines. Need of formulation and formulation development considerations. Concept & testing of preformulation & their parameters. Tablets: compressed, granulation, coatings, pills, capsules. Parental preparations, herbal extracts, Oral liquids, Ointments. Analytical methods and tests for various drugs, packaging techniques- Glass containers, plastic containers, film wrapper, bottle seals; storage and stability of biotech products.

L1, L2, L3

MODULE –2

PHARMACOKINETICS AND PHARMACODYNAMICS:

Pharmacodynamics and Pharmacokinetics of protein based drugs. Disease target identification and selection, receptor-based approaches, agonists, antagonists, enzyme inhibitors Basic concepts, ADME definitions, Need of pharmacokinetic study; Interpretations from pharmacokinetics parameters, Examples of Pharmacodynamic parameters of various drugs; Evolution of Drug Metabolism Phase I Metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II Metabolism (Drug conjugation pathway) CYP Families.

L1, L2, L3

MODULE – 3

PHARMACOTHERAPY

Classification of drugs based on therapeutic actions using suitable examples Special emphasis on Vitamins, cold remedies, laxatives, analgesics, non-steroidal contraceptives, external antiseptics, antacids, antibiotics, biologicals, herbal products. Pharmacotherapy of migraine, cancer, TB, diabetes and male sexual dysfuntion. Hormone replacement therapy.

L1, L2, L3

MODULE – 4

BIOTHERAPEUTICS AND STEM CELLS

Clinical importance of Therapeutic Proteins and Enzymes; Hormones and Growth Factors used as therapeutics (erythropoietin & insulin as examples). Interferons, Interleukins, Preservation and clinical use of blood and blood components, principles and safety guide lines for blood transfusion. Advanced Sustained Release, Advanced drug Delivery Systems: Liposomes and

Nanoparticles, biodegradable drug delivery system (hydrogel based). Types and identification of stem cells, Fate Mapping of Stem Cells, Use of stem cells in therapy of neurological, hematopoietic, hepatic, pancreatic disorders, Applications of epidermal stem cell in Tissue engineering.

L1, L2, L3, L4

MODULE – 5

CLINICAL RESEARCH:

The philosophy behind and organization of clinical research. Pre-clinical development to support testing in humans: In vitro and in vivo testing of new compounds, Relationship between animal and human pharmacology. Safety testing – acute, sub acute toxicology, immunotoxicology, Concepts of pharmacovigilance, General principles and guide to data sources, types of epidemiology study designs, ecological (correlation) studies, case reports, prevalence surveys or cross-sectional studies, case control studies, Clinical trials-informed consent, Placebo Responses, Clinical Registries. Clinical Research Institutes, Data Management, Clinical Research from Pharmaceutical Industry.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Explain the significance of pharmaco-kinetic models, pharmaco-dynamic principles, various dosage forms and formulation
- Understand the specific techniques used in biotherapy & clinical Biotechnology
- Comprehend specific applications of pharmaceutical & clinical Biotechnology

REFERENCE BOOKS

1. Basic & Clinical Pharmacology by Bartram G. Katzung, Mc Graw Hill.
2. The Theory & Practice of Industrial Pharmacy by Leon Lachman, Herbert A. Lieberman & Joseph & Kanig, Vergese Publishing House Bombay.
3. Enzyme Technologies for pharmaceutical and biotechnological applications by Herbert A Kirst, Wu-Kuang Yeh, Milton J. Marcel Dekker Publications.
4. Developmental Biology, by Scott F. Gilbert, Wiley Publications.
5. Current Trends in Pharmacology by Arunabha Ray & Kavitha Gulati, IK Intl.
6. Developmental Biology, Scott F. Gilbert, Cambridge University Press.
7. Molecular Biology of the Cell, by Bruce Alberts, Dennis Bray, Julian Lewis, Martin Raff, Keith Roberts, James D. Watson, Garland Science.
8. Text book of Medical Biochemistry by R L Nath, New Age Publishers.
9. Pharmaceutical Biotechnology by K Sambamurthy & Ashutosh Kar, New Age Publishers.
10. ICH guideline Q6B, Freelance Publishing.
11. Basic & Clinical Pharmacology by Bartram G. Katzung, Mc Graw Hill.

TEXT BOOKS

1. Biochemistry and Biotechnology by Gary Walsh, John Wiley & Sons Ltd.
2. Principles and Practice of Clinical Research by J. I. Gallin and F. P. Ognibene, Elsevier Publication.
3. Hematology by William J. Williams, Ernest Beutler, Allan JU. Erslev, Marshall A. Lichtman, IK Publishers.

4. Stem Cell Biology by Marshak, Cold Spring Harbour Symposium Pulblications.
5. Current Trends in Pharmacology by Arunabha Ray & Kavitha Gulati, IK Intl.
6. An Introduction to Synthetic Drugs by Singh & Rangnekar, Himalaya publishing House.
7. Biopharmaceuticals, Biochemistry and Biotechnology by Gary Walsh, Wiley Pub.
8. Principles of Medicinal Chemistry by Foye, Lippincott Williams & Wilkins Publishers.
9. Industrial Pharmaceutical Biotechnology by Heinrich Klefenz, Wiley-VCH edition.
10. Biopharmaceutical Drug Design and Development by S Wu-Pong, Y Rojanasakul, and J Robinson.
11. Pharmaceutical Biotechnology by K Sambamurthy & Ashutosh Kar, New Age.
12. Pharmaceutical Biotechnology by S P Vyas and V K Dixit, CBS Publishers.

TITLE OF THE COURSE: REGULATORY AFFAIRS IN BIOTECH INDUSTRY B.E., VIII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT82	CIE Marks	40
Number of Lecture Hours/week	04	SEE Marks	60
Total Number of Hours	50 (10 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: The objective of this course is to educate students about regulatory rules and guidelines that specify parameters of the safety and quality standards in the biotech industry

MODULE – 1

INTRODUCTION:

Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & how it Differs from Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation including the use of Statistical Process Control (SPC) Techniques. ISO 9000 Series & International Harmonization & their effect upon GMP's.

L1, L2, L3

MODULE –2

VALIDATION:

Validation of Water & Thermal Systems, including HVAC Facilities & Cleaning Validation. Validation of Active Pharmaceutical Ingredients (APIs) & Aseptic Processes. Validation of Non-Sterile Processes (used in the manufacture of Solids, Liquids, & Semisolid Dosage Forms). Overview of method evolution, FDA and ICH guidelines, Development and validation, Basic statistical concepts, Outliers, Specificity: sample preparation, Specificity: separations, Specificity: detectors, Linearity, Accuracy, Precision, Limits of detection (LOD) and quantification (LOQ), Minimum detectable amount (MDA), Sample stability and method robustness, Window diagrams, System suitability, Statistical process control for HPLC, Sustainable validation, Troubleshooting out-of-control systems, Case studies. L1, L2, L3

MODULE – 3

STANDARDS:

Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques, ISO-9001-2000, Scope, Normative Reference, Terms and Definitions, Quality Management, System, Documents Requirements, Management's Responsibility, Resource Management, Infrastructure, Product Realization, Measurement, Analysis and Improvement, ISO-14001, Environmental Management Systems.

L1, L2, L3

MODULE – 4

QUALITY AND IMPLEMENTATION:

Terminology Relating to Quality, Quality Requirement, Customer Satisfaction, Capability; Terms Relating to Management, Management System, Quality Management System, Quality Policy, Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement,

Continual Improvement, Effectiveness, Efficiency, Terms relating to Characteristics, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Correction, Rework, Repair, Scrap, Concession, Deviation Permit, Release; Objective Evidence, Inspection, Test, Metrological Confirmation. Quality System, Contract Review, Design Control, Document and Data Control, Purchasing, Control of Customer Supplied Product, Product Identification and Traceability, Process Control, Inspection and Testing, Final Inspection and Testing, Inspection and Test Status, Handling, Storage, Packaging, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques.

L1, L2, L3

MODULE – 5

QUALITY MANAGEMENT:

The development of regulatory requirements for validation, The V model and Life Cycle model approach to validation and documentation, Risk Analysis Techniques: Impact Assessment; Failure Mode and Effects Analysis (FMEA), Validation Master Plans, Commissioning and Qualification, Process Validation, Routine validation and revalidation, Contamination Control, Risk Management in the Pharmaceutical Industry, Solid Dose Manufacture Principles and Practices, Liquid and Cream Manufacture Principles and Practices, Good Laboratory Practices (for Non-Clinical Laboratories), Computer Systems Validation Principles and Practices, Good Aseptic Practices and Sterile Products, Clinical Trials Quality Assurance Management, GxP and Quality Auditing Practices, Pharmaceutical Engineering – Facility, Equipment and Process Design, Fundamentals of Process Analytical Technology, Quality and Continuous Improvement in the Biotech Industry.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Outline the importance of the quality and compliance in the biotech industry
- Comprehend the various regulatory guidelines and rules as well as the organizations governing the same.

1. Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook, Phillip A. Cloud, Interpharm Press.
2. Commissioning and Qualification, ISPE Pharmaceutical Engineering Baseline Guides Series.
3. ICH guideline Q6B, Freelance Publishing

TEXT BOOKS

1. Pharmaceutical Process Validation by Robert Nash and Alfred Wachter, Marcel Dekker.
2. Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control from Manufacturer to Consumer, Sidney J. Willig, Marcel Dekker.
3. Validation of Pharmaceutical Processes: Sterile Products, Frederick J. Carlton (Ed.) and James Agalloco (Ed.), Marcel Dekker.
4. Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries, Syed Imtiaz Haider, Saint Lucie Press.
5. Pharmaceutical Biotechnology by S P Vyas and V K Dixit, CBS Publishers

TITLE OF THE COURSE: PROTEIN ENGINEERING AND IN SILICO DRUG DESIGN

B.E., VIII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT831	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: The course imparts advanced knowledge on proteins through a detailed study of protein Structure, its characteristic properties and significance in biological systems.

MODULE – 1

INTRODUCTION:

Overview of protein structure, PDB, structure based classification, Databases, Ramachandran plots. Strategies for design of novel proteins-strategies for the design of structure and function.

L1, L2, L3

MODULE –2

CHARACTERIZATION & APPLICATIONS OF PROTEIN ENGINEERING:

NMR spectroscopy, crystallography, spectroscopic and calorimetric methods. Design of polymeric biomaterials, nicotinic acetylcholine receptors as a model for a super family of ligand - gated ion channel proteins.

L2, L3, L4

MODULE – 3

MOLECULAR MODELING:

Constructing an Initial Model, Refining the Model, Manipulating the Model, Visualization. Structure Generation or Retrieval, Structure Visualization, Conformation Generation, Deriving Bioactive Conformations, Molecule Superposition and Alignment, Deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Calculation of Molecular Properties, Examples of Small Molecular Modeling Work, Nicotinic Ligands.

L2, L3

MODULE – 4

INSILICO DRUG DESIGN:

Generation of Rational Approaches in Drug Design, Molecular Modeling: The Second Generation, Conceptual Frame and Methodology of Molecular Modeling, The Field Currently Covered, Importance of the "Bioactive Conformation", Molecular Mimicry, Structural Similarities and Superimposition Techniques, An Important Key and the Role of the Molecular Model, Limitations of Chemical Intuition Major Milestones and Future Perspectives.

L1, L2, L3

MODULE – 5

DOCKING METHODS:

Program GREEN Grid: Three – Dimensional Description of Binding Site Environment and Energy Calculation, Automatic Docking Method, Three-Dimensional Database Search Approaches, Automated Structure Construction Methods, Structure Construction Methods with known Three-Dimensional Structure of the Receptor, Structure Construction in the case of Unknown Receptor Structure. Points for Consideration in Structure Construction Methods, Handling of X-Ray Structures of Proteins, Future Perspectives. Other web based programs available for molecular modeling, molecular docking and energy minimization techniques – Scope and limitations, interpretation of results.

L1, L2, L3

Course outcomes:

After studying this course, students will be able to:

- Outline the structural properties of proteins and their determination methods
- Understand protein design principles and database analysis
- Design Proteins *in silico*.

REFERENCE BOOKS

1. Bioinformatics Methods & Applications: Genomics, Proteomics & Drug Discovery, S C Rastogi,N Mendiratta & P Rastogi, PHI.
2. A.R Leach, Molecular Modeling Principles and Applications, Longman, 1996.
3. J.M. Haile , Molecular Dynamics Simulation Elementary methods, , John Wiley and Sons ,1997

TEXT BOOKS

1. Protein engineering and design by Paul R. Carey, academic press, 1996, 361 pages.
2. Protein Structure by Creighton, Oxford University Press.
3. Introduction of protein structure by Branden C. and Tooze R., Garland.
4. The molecular modeling perspective in drug design by N Claude Cohen, Academic Press

TITLE OF THE COURSE: METABOLIC ENGINEERING

B.E., VIII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT832	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: The course aims to empower the students with the knowledge on metabolic engineering.

MODULE – 1

INTRODUCTION TO METABOLIC ENGINEERING:

Induction-Jacob Monod Model, catabolite regulation, glucose effect, camp deficiency, feed back regulation, regulation in branched pathways, differential regulation by isoenzymes, concerted feed back regulation, cumulative feed back regulation, amino acid regulation of RNA synthesis, energy charge, permeability control passive diffusion, facilitated diffusion, active transport group transportation.

L1, L2

MODULE –2

SYNTHESIS OF PRIMARY METABOLITES:

Alteration of feedback regulation, limiting accumulation of end products, feed back, resistant mutants, alteration of permeability.

L2, L3

MODULE – 3

BIODEGRADATION OF XENOBIOTIC BIOSYNTHESIS OF SECONDARY METABOLITES:

Precursor effects, prophophase, idiophase relationships, enzyme induction, feed back regulation, catabolite regulationby passing control of secondary metabolism, producers of secondary metabolites.

L2, L3

MODULE – 4

BIOCONVERSIONS:

Advantages of Bioconversions, specificity, yields, factors important to bioconversions, regulation of enzyme synthesis, mutation, permeability, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances.

L1, L2, L3

MODULE – 5

REGULATION OF ENZYME PRODUCTION

Strain selection, improving fermentation, recognizing growth cycle peak, induction, feed back repression, catabolite repression, mutants resistant to repression, gene dosage.

L1, L2,L3,L4

Course outcomes:

After studying this course, students will be able to:

- Outline the basic concepts about enzymology followed by primary and secondary metabolites biosynthesis.
- Understand the importance of bioconversions of substances and the regulation of enzyme production

REFERENCE BOOKS

3. Zubay G., Biochemistry, Macmillan Publishers, 1989.

TEXT BOOKS

1. Wang D. I. C., Cooney C. L., Demain A. L., Dunnil P., Humphrey A. E., Lilly M. D., Fermentation and Enzyme Technology, John Wiles and Sons., 1980.
2. Stanbury P. F. and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984

TITLE OF THE COURSE: ENVIRONMENTAL BIOTECHNOLOGY

B.E., VIII Semester, Biotechnology

[As per Choice Based Credit System (CBCS) scheme]

Course Code	17BT833	CIE Marks	40
Number of Lecture Hours/week	03	SEE Marks	60
Total Number of Hours	40 (8 Hours per Module)	Exam Hours	03

CREDITS – 04

Course objectives: This objective of this course is to understand the basic concepts of environmental biotechnology.

MODULE – 1

INTRODUCTION TO ENVIRONMENTAL POLLUTANTS:

Water, Soil and Air: their sources and effects. Removal of Specific Pollutants: Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal Accumulation, Biosorption & detoxification mechanisms.

L1, L2, L3

MODULE –2

MICROBIOLOGY AND BIOCHEMISTRY OF WASTE WATER TREATMENT:

Biological Treatment of anaerobic and aerobic; methanogenesis, methanogenic, acetogenic, and fermentative bacteria- technical process and conditions; Use of Genetically Engineered Organisms. emerging biotechnological processes in waste - water treatment; Applications include treatment of municipal and industrial wastewaters.

L2, L3, L4

MODULE – 3

BIODEGRADATION OF XENOBIOTIC COMPOUNDS & BIOREMEDIATION:

Xenobiotic compounds: Aliphatic, Aromatics, Polyaromatic Hydrocarbons, Polycyclic aromatic compounds, Pesticides, Surfactants and microbial treatment of oil pollution. Introduction to Bioremediation, Types of Bioremediation, Bioremediation of surface soil and sludges, Bioremediation of subsurface material, In situ technologies, Ex-situ technologies, Phytoremediation.

L1, L2, L3

MODULE – 4

BIOTRANSFORMATIONS & BIOCATALYSTS:

Basic organic reaction mechanism - Common prejudices against Enzymes.- Advantages & Disadvantages of Biocatalysts - Isolated Enzymes versus whole cell systems.- Mechanistic Aspects and Enzyme Sources.- Biocatalytic Application - Catalytic Antibodies; Stoichiometry, kinetics, and thermodynamics of microbial processes for the transformation of environmental contaminants.

L1, L2, L3,L4

MODULE – 5

BIOOXIDATION & MICROBIAL LEACHING:

Biooxidation – Direct and Indirect Mechanisms – Biooxidation Kinetics; Bacterial oxidation of Sphalerite, Chalcopyrite and Pyrite.; Extraction of metals from ores; Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal, gene

closing - use of genetically altered microorganisms for field biodegradation of hazardous materials.

L1, L2, L3,L4

Course outcomes:

After studying this course, students will be able to:

- Understand the role of various environmental pollutants, biooxidation, biotransformation.
- Explain the involvement of microbes in waste water treatment, chemicals.

REFERENCE BOOKS

1. Biotreatment Systems, Vol. 22, D. L. Wise (Ed.), CRC Press, INC.
2. Standard Methods for the Examination of Water and Waste Water (14 th Education), 1985. American Public Health Association.

TEXT BOOKS

1. Environmental Microbiology, W.D. Grant & P.E. Long, Blakie, Glassgow and London.
2. Microbial Gene Technology, H. Polasa (ED.) South Asian Publishers, New Delhi.
3. Environmental Biotechnology by Bruce Rittmann and Perry McCarty
4. Biotransformations : K. Faber (1995), Springer- Verlag.