BIO TECHNOLOGY

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M.Tech Bio Technology

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DEPARTMENT OF BIOTECHNOLOGY

Vision

Create a strong teaching base in the area of biotechnology through technical knowledge dissemination to the students and to scale new heights in research by etching the concepts of professionalism, social justice, environmental impact and human ethics for welfare of the general public.

Mission

- Disseminate a blending of knowledge acquisition and its application in real-life situations to the students
- Equip the students to adapt to changing global and local needs through well designed curriculum and syllabus
- Groom students to uphold professional ethics and develop leadership qualities
- Train students on issues related to social welfare.

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Kumaraguru College of Technology

Coimbatore – 641 049

Regulation 2015

CBCS – PG Curriculum

Name of the PG Programme: M.Tech Biotechnology

Foundation Courses (FC)

S. No	Course Code	Course Title	Periods/Wk & Credits				Preferred Semester
			L	T	P	C	
1.	P15MAT201	Applied Mathematics for Biotechnologists	3	1	0	4	I

Professional Core (PC)

S. No.	Course Code	Course Title	Periods /Wk & Credits				Preferred Semester
			L	T	P	C	
Specialization 1:							
1.	P15BTT101	Physiology and Biochemistry	3	0	0	3	I
2.	P15BTT102	Applied Microbiology	3	0	0	3	I
3.	P15BTT103	Bioanalytical Techniques	3	0	0	3	I
4.	P15BTT104	Fermentation Technology	3	0	0	3	I
5.	P15BTT105	Enzyme Technology & Applications	3	0	0	3	I
6.	P15BTT106	Chemical Process Engineering	3	0	0	3	I
7.	P15BTP101	Industrial Biotechnology Lab	0	0	6	2	I
8.	P15BTT201	Bioseparation Technology	3	0	0	3	II

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9.	P15BTT202	Recombinant DNA Technology	3	0	0	3	II
10	P15BTT203	Computational Biology	3	0	0	3	II
11	P15BTP201	Recombinant DNA Technology Lab	0	0	6	2	II
12	P15BTP202	Computational Biology Lab	0	0	4	2	II
13	P15BTP203	Bioseparation Technology Lab	0	0	6	2	II
14	P15BTP301	Project Work –Phase I	0	0	6	3	III
15	P15BTP401	Project Work –Phase II	0	0	12	6	IV

Professional Electives (PE)

S. No	Course Code	Course Title	Periods /Wk & Credits				Preferred Semester
			L	T	P	C	
1	P15BTE101	Metabolic Process and Design	3	0	0	3	I
2	P15BTE102	Molecular Therapeutics	3	0	0	3	I
3	P15BTE103	Plant and Animal Biotechnology	3	0	0	3	I
4	P15BTE201	Environmental Biotechnology	3	0	0	3	II
5	P15BTE202	Food Processing and Biotechnology	3	0	0	3	II
6	P15BTE203	Immunotechnology	3	0	0	3	II
7	P15BTE301	Pharmaceutical Biotechnology	3	0	0	3	III
8	P15BTE302	Genomics and Proteomics	3	0	0	3	III
9	P15BTE303	Bioprocess Plant design and Practice	3	0	0	3	III
10	P15BTE304	Biofuels Engineering	3	0	0	3	III
11	P15BTE305	Biotechnology for Pollution Abatement	3	0	0	3	III
12	P15BTE306	Biomedical Engineering and Clinical Research	3	0	0	3	III
13	P15BTE401	Protein Engineering	3	0	0	3	III

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14	P15BTE402	Innovation and new product development	3	0	0	3	III
15	P15BTE403	Bioreactor Design	3	0	0	3	III
16	P15BTE404	Bioprocess Modeling & Simulation	3	0	0	3	III
17	P15BTE405	Biomaterial and Tissue Engineering	3	0	0	3	III
18	P15BTE406	Stem cell in Human Diseases	3	0	0	3	III
19	P15BTE407	Bio Entrepreneurship	3	0	0	3	III

Employability Enhancement Courses (EEC)

S. No	Course Code	Course Title	Periods /Wk & Credits				Preferred Semester
			L	T	P	C	
1.	P15BTP301	Project Work Phase I	0	0	12	6	III
2.	P15BTT301	Technical Seminar	0	2	0	1	III
3	P15BTP401	Project Work Phase II	0	0	24	12	IV

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SEMESTER – I								
	Course Code	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1.	P15BTT101	Physiology and Biochemistry	PC	45	3	0	0	3
2.	P15BTT102	Applied Microbiology	PC	45	3	0	0	3
3.	P15BTT103	Bioanalytical Techniques	PC	45	3	0	0	3
4.	P15BTT104	Fermentation Technology	PC	45	3	0	0	3
5.	P15BTT105	Enzyme Technology & Applications	PC	45	3	0	0	3
6.	P15BTT106	Chemical Process Engineering	PC	45	3	0	0	3
7.	P15BTE----	Elective I	PE	45	3	0	0	3
Practical								
	P15BTP101	Industrial Biotechnology Lab	PC	60	0	0	6	2
							Total credits	**23**

SEMESTER – II								
	Course Code	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1.	P15MAT201	Applied Mathematics for Biotechnologists	FC	45	3	1	0	4
2.	P15BTT201	Bioseparation Technology	PC	45	3	0	0	3

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3.	P15BTT202	Recombinant DNA Technology	PC	45	3	0	0	3
4.	P15BTT203	Computational Biology	PC	45	3	0	0	3
5.	P15BTE----	Elective II	PE	45	3	0	0	3
Practical								
1	P15BTP201	Recombinant DNA Technology Lab	PC	60	0	0	6	2
2	P15BTP202	Computational Biology Lab	PC	45	0	0	4	2
3	P15BTP203	Bioseparation Technology Lab	PC	60	0	0	6	2
								Total credits : 22

SEMESTER – III

	Course Code	Course Title	Category	Contact Hours	L	T	P	C
Theory								
1	P15BTE---	Elective III	PE	45	3	0	0	3
2	P15BTE---	Elective IV	PE	45	3	0	0	3
3	P15BTE---	Self study elective	PE	45	3	0	0	3
4	P15BTT301	Technical seminar	EEC	30	0	2	0	1
Practical								
1	P15BTP301	Project Work –Phase I	EEC	90	0	0	12	6
								Total credits: 16

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SEMESTER – IV								
	Course Code	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Practical								
1.	P15BTP401	Project Work –Phase II	EEC	180	0	0	24	12
							Total credits: 12	
							Grand Total Credits: 73	

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Electives								
	Course Code	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory (Elective I)								
1.	P15BTE101	Metabolic Process and Design	PE	45	3	0	0	3
2	P15BTE102	Molecular Therapeutics	PE	45	3	0	0	3
3	P15BTE103	Plant and Animal Biotechnology	PE	45	3	0	0	3
Theory (Elective II)								
4	P15BTE201	Environmental Biotechnology	PE	45	3	0	0	3
5	P15BTE202	Food Processing and Biotechnology	PE	45	3	0	0	3
6	P15BTE203	Immuno technology	PE	45	3	0	0	3
Theory (Elective III)								
7	P15BTE301	Pharmaceutical Biotechnology	PE	45	3	0	0	3
8	P15BTE302	Genomics and Proteomics	PE	45	3	0	0	3
9	P15BTE303	Bioprocess Plant design and Practice	PE	45	3	0	0	3
10	P15BTE304	Biofuels Engineering	PE	45	3	0	0	3
11	P15BTE305	Biotechnology for pollution abatement	PE	45	3	0	0	3

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12	P15BTE306	Biomedical Engineering and Clinical Research	PE	45	3	0	0	3
Theory (Elective IV)								
13	P15BTE401	Protein Engineering	PE	45	3	0	0	3
14	P15BTE402	Innovation and new product development	PE	45	3	0	0	3
15	P15BTE403	Bioreactor Design	PE	45	3	0	0	3
16	P15BTE404	Bioprocess Modeling & Simulation	PE	45	3	0	0	3
17	P15BTE405	Biomaterial and Tissue Engineering	PE	45	3	0	0	3
18	P15BTE406	Stem cell in Human Diseases	PE	45	3	0	0	3
19	P15BTE407	Bio Entrepreneurship	PE	45	3	0	0	3

ONE CREDIT INDUSTRY COURSES

Code No.	Course Title	Industry that will offer the course
P15BTI N001	Dairy Technology	Sakthi Dairy, Pollachi
P15BTI N002	Mushroom Technology	Mushroom Foundation of India, Coimbatore
P15BTIN 003	Pilot-plant and Industrial fermenter	Golden Bioculture, Tiruchengode
P15BTIN 004	Bioethanol	Sakthi Sugars Limited, Appakudal

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SEMESTER I

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P15BTT101	PHYSIOLOGY AND BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives:

- To learn about the physiology of blood, mammalian digestive system, urinary system and neuronal system
- To understand the role of hormones in mammalian physiology
- To study the metabolic pathways and energy generation in biological systems..

Course Outcomes (COs):
After successful completion of this course, the students should be able to

CO1: Understand physiological principles related to mammalian digestive and urinary system
CO2: Learn the physiology of blood and neuronal system
CO3: Understand the role and interactions of hormones
CO4: Learn the concepts of coenzymes, and energy generation in biological systems
CO5: Understand the interrelationship of metabolic pathways in relation to overall physiological states

Course Assessment methods:			
Direct		**Indirect**	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

PHYSIOLOGY OF DIGESTION AND EXCRETION **9 Hours**

Hydrolysis and resorption of food components; Digestive processes: formation of HCl, Zymogen activation, fat digestion; Bile salts- composition and functions, Biotransformation, Cytochrome P450 system. Liver function and diagnostic tests; Formation and acidification of urine, acid-base balance and maintenance, mechanism of action of diuretics, tests of renal function, composition of urine.

9Hours

PHYSIOLOGY OF BLOOD, AND NEURONAL SYSTEM

Blood composition, plasma proteins, lipoproteins, Buffer systems of plasma, Blood clotting and fibrinolysis; Gas transport, Cerebrospinal fluid; Neurons- types and functions, blood-brain barrier, resting and action potentials; transmission of nerve impulses; neurotransmitters.

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9 Hours

BIOCHEMISTRY AND FUNCTIONS OF HORMONES

Organization and regulation of secretions and function of: Anterior and Posterior pituitary, Thyroid, Adrenal cortex and medulla, Parathyroid, Pancreas; sex hormones; Clinical orientation.

9Hours

BIOENERGETICS AND BIOLOGICAL OXIDATION

Role of High energy phosphates in Bioenergetics and energy capture; Role and mechanism of action of $NAD^+/NADP^+$, FAD, lipoic acid, thiamine pyrophosphate, tetrahydrofolate, biotin, pyridoxal phosphate, B_{12} coenzymes and metal ions; Respiratory chain and its role in energy capture. Mechanism of oxidative phosphorylation.

9Hours

REGULATION OF INTERMEDIARY METABOLISM

Major and unique features of metabolism of the principal organs (liver, brain, muscle, kidney) in various metabolic states- fed and starved states; Coordinated Regulation of glycolysis and glycogenesis; Regulation of gluconeogenesis; Regulation of fatty acid synthesis, and degradation; ketogenesis; Metabolic interrelationships between adipose tissue, the liver, and extrahepatic tissues. Disorders of intermediary metabolism – glycogen storage diseases, diabetes, fatty liver.

Total Hours: 45

REFERENCES

1. Nelson, D. L. and Cox, M. M., Lehninger's Principles of Biochemistry, 5th Ed, Worth Publishers. 2008.
2. Murray, R. K., Granner, D. K., Mayes, P. A., Rodwell., Harper's Illustrated Biochemistry by, V. W., 26th Ed, The McGraw-Hill Companies, Inc. 2006.
3. Guyton., Textbook of Medical Physiology, 11th Ed, A. C., H. Sanders Philadelphia. 2005.

WEB LINKS

1 www.us.elsevierhealth.com/.../guyton...textbook...e-book-e-book/97814...

2 https://archive.org/details/LehningersPrinciplesOfBiochemistry5e

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P15BTT102 **APPLIED MICROBIOLOGY**

L	T	P	C
3	0	0	3

Course Objectives:

- To understand and learn about various microbes, its interaction with other living organism, its outcome.
- To learn in detail the role of microorganism in allied fields of microbiology and its applications.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1: Students understand the role of microorganism in various fields allied to biotechnology

CO2: Acquire the knowledge to apply various microbes in environment, and agriculture.

CO3: Understand about various microbial diseases of human body.

CO4: Acquire the knowledge to food and allied industries, fermentation processes.

CO5: Students apply knowledge on microbial on allied fields.

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni survey

9 Hours

FUNDAMENTALS OF MICROBIOLOGY

The microbial world, Evolution and Diversity, Taxonomic ranks and Classification, Functional anatomy of Prokaryotic and Eukaryotic cells, Microbial Growth, Metabolism, Control of microbes- physical and chemicals methods.

ENVIRONMENTAL MICROBIOLOGY **9Hours**

Interaction between microorganisms; microorganisms- plants, microorganism- animals Degradation of xenobiotic compounds, Bioremediation, Microbial plastics, Microbial leaching, Biofilms. Microbes in Bio-hydrogen production.

MEDICAL MICROBIOLOGY **9 Hours**

Contamination and diseases, Microbial diseases of skin and eyes, Microbial diseases of digestive system, Microbial diseases of cardiovascular system, Microbial diseases of respiratory system, Microbial diseases of nervous system.

SOIL AND AGRICULTURAL MICROBIOLOGY **9 Hours**

Soil Habitat; Biogeochemical cycle (Nitrogen, Sulfur and Phosphorous), Nitrogen fixation (symbiotic and nonsymbiotic), Microbial interaction- Rhizosphere, Phyllosphere, Spermosphere;

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Endophytes, Biofertilizers, Biopesticides, Microbial Composting.

9 Hours

INDUSTRIAL MICROBIOLOGY

Microbial fermentation- production of organic acids (citric acid, lactic acid), Production of alcohol, production of bread, cheese and pickles. Lactic acid bacteria, Probiotics and Prebiotics and applications.

Total Hours: 45

REFERENCES

1. Tortora, G. J., Funke, B. R., Case, C. L., (2012) Microbiology an Introduction, 11^{h} Ed., Benjamin Cummings
2. Pommerville, J.C., (2013) Alcamo's Fundamentals of Microbiology, 10th ed., Jones and Bartlett Publishers.

OTHER REFERENCES

1. Atlas, R.M., Bartha, R. (1997) Microbial Ecology: Fundamentals and applications, 4th Ed., Benjamin Cummings.
2. Talaro, K. P. (2011) Foundations in Microbiology. 8thEd. NY: McGraw Hill.
3. Ray, B., Bhuniya, A. (2013) Fundamental Food Microbiology, 5th Ed., CRC Press, USA.
4. Pelcza, M. A., (2001) Microbiology, 5th ed., Tata McGraw Hill, New Delhi

WEB LINKS

1. http://www.austincc.edu/rohde/noteref.htm
2. https://www.studyblue.com/notes/b/microbiology-an-introduction-11th-edition/50936/0
3. http://www.microrao.com/mypgnotes.htm

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P15BTT103 BIOANALYTICAL TECHNIQUES

L	T	P	C
3	0	0	3

Course Objectives:

- To make the students' understand the molecular level principle, instrumentation and applications of various analytical techniques.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 : Explain and distinguish microscopy, centrifugation and biosensor techniques
CO2 : Compare and contrast the various types of chromatographic and electrophoretic techniques
CO3 : Recall and summarize the different spectroscopic techniques
CO4 : Demonstrate the cell culture, blotting and microarray techniques
CO5 : Describe the techniques like ELISA, autoradiography and radiotracers

Pre-requisite : Biochemistry, Microbiology

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Industry
3	Assignments	**3**	Alumni
4	End semester examination		

GENERAL TECHNIQUES **9Hours**

Computers for data collection, analysis; scientific statistical packages- SPSS, Electrodes for pH and O_2 measurement. Biosensors- types, working principle and applications, Microscopy – Light, Phase contrast, fluorescence, TEM, SEM, atomic force, scanning tunneling. Centrifugation- differential, density gradient and Ultracentrifugation –basic principle and applications.

CHROMATOGRAPHIC AND ELECTROPHORETIC TECHNIQUES **9Hours**

Theoretical concepts: Rate and Plate theory, Column resolution, Gel filtration, Ion exchange, affinity chromatography- theory, applications. Determination of molecular weight using gel filtration chromatography. GC and HPLC- Theory, instrumentation and Applications. Electrophoresis- theory, native SDS PAGE, 2D PAGE and applications.

SPECTROSCOPIC TECHNIQUES **9 Hours**

Theory, instrumentation and biological applications of UV-Vis, IR, CD/ORD, Fluorescence, NMR, ESR, Mossabaeur, ICP emission and Mass Spectroscopes.

CELL AND MOLECULAR BIOLOGICAL TECHNIQUES **9 Hours**

Growth, maintenance and equipment for bacterial, animal and plant cell cultures. Maintenance of obligate anaerobic cultures using anaerobic glove box. PCR, blotting techniques- Southern, Northern and Western blotting. RFLP analysis, Shot-gun sequencing, Microarray- theory, equipment and applications.

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IMMUNOTECHNIQUES AND RADIOTECHNIQUES **9Hours**

Immunodiagnostics- ELISA, sandwich ELISA; Immuno enzyme assays (IEA), Immunofluorescence (IFA) - theory, equipment and applications. Radioisotopes- basics and applications in biology. Autoradiography, Geiger-Muller counter, Scintillation counting, Radiotracers, Radioimmunoassay (RIA).

Total Hours : 45

REFERENCES

1. Keith Wilson and John Walker Ed., Principles and Techniques of Biochemistry and Molecular Biology, Ed., 5th Edition, Cambridge University Press, 2000.
2. M.L. Srivatsava, Ed., Bioanalytical Techniques, Alpha Science International Ltd, 2007.
3. Irwin. H. Segal, Ed .,Biochemical Calculations,., 2nd Edition, Cambridge University Press, 2005

OTHER REFERENCES

1. Douglas A. Skoog, Brooks Cole Principles of Instrumental Analysis, 6 edition 2006
2. Hobarth Willard, Lynne Merritt, John Dean, Frank Settle., Instrumental methods of Analysis; 7 Sub edition, Wadsworth Publishing Company; 1988.

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P15BTT104 FERMENTATION TECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

- To make the students to understand the products of fermentation process and principles of fermentation technology

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1: Understand the scope of industrial biotechnology.

CO2: Acquires an ability to apply the various of sterilization methods in bioprocesses

CO3: Assess power requirements in bioreactors, modeling of bioprocesses, traditional and new concepts in bioprocess monitoring, and the biological basis for industrial fermentations and cell cultures

CO4: Develop the structural and unstructured models for cell growth and product formation

CO5: Demonstrate the various fermentation configurations

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

SCOPE OF INDUSTRIAL BIOTECHNOLOGY **9 Hours**

Introduction: Nature and Characteristics of Industrial Biotechnology, Patents and Intellectual Property Rights in Industrial Biotechnology, Fermentation, Organizational Set-up in Biotechnology Establishment; Media: Basic Nutrient Requirements of Industrial Media, Criteria for the Choice of Raw Materials Used in Industrial Media, Raw Materials Used in Compounding Industrial Media, Potential Sources of Components of Industrial Media, Use of Plant Waste Materials in Industrial Media, Optimization of Media Components by experimental design

FERMENTERS AND FERMENTER OPERATION **9Hours**

Definition of a Fermenter, Aerated Stirred Tank Batch Fermenter, Anaerobic Batch Fermenter, Fermenter Configurations, Fed-batch Cultivation, Design of Fermenter, Microbial Experimentation in the Fermentation Industry - The Place of the Pilot Plant, Inoculum Preparation, Surface or Solid State Fermenter, Sterility**:** Basis of Loss by Contaminants, Methods of Achieving Sterility, Aspects of Sterilization in Industry.

FERMENTATION PRODUCTS **9 Hours**

Production of fermented products like beer, wine, spirit, vinegar, bread, yoghurt, sauerkraut, citric acid, ethanol, amino acids, enzymes etc.,

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KINETICS IN CELL CULTURES **9 Hours**

Kinetics of Balanced Growth, Transient Growth Kinetics, Structured Kinetic Models, Product Formation Models, Segregated Kinetic Models, Thermal Death Kinetics of cells.

ANALYSIS OF BIOREACTORS **9 Hours**

Reactors with recycle, Reactor Dynamics, Reactors with Non-ideal mixing, Multiphase Bioreactors, Bioprocess consideration in using for plant and animal cell culture

Total Hours: 45

REFERENCES

1. Stanbury, Peter F., Hall, Stephen J. & Whitaker A.,(1995) Principles of Fermentation Technology, Second Edition, USA: Butterworth-Heinemann Publisher..
2. Doran, P. M. (2012) Bioprocess Engineering Principles, second Edition, United Kingdom: Academic Press
3. Nduka Okafor (2007). Modern Industrial Microbiology and Biotechnology, Latest Edition, Enfield.,U.S**:** Science Publishers
4. James Edwin Bailey and David F. Ollis (1986) Biochemical Engineering Fundamentals, Second Edition, New Delhi: McGraw Hill, Inc.
5. Shuler, M. L., & Kargi, F. (1992) Bioprocess Engineering: Basic Concepts, Latest Edition, New Delhi: Prentice Hall of India.
6. Blanch H.W. and Clark, D.S. (1992) Biochemical Engineering, Latest Edition, United Kingdom: CRC Press.

WEB LINKS

1. http://www.indiabix.com/biochemical-engineering/fermentation-kinetics/
2. http://nptel.ac.in/syllabus/syllabus.php?subjectId=102107029

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P15BTT105 **ENZYME TECHNOLOGY AND APPLICATIONS**

L	T	P	C
3	0	0	3

Course Objective(s)

- To understand the various techniques of manipulation of plant and animal cells to produce valuable bioproducts
- To learn various animal improvement strategies

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Ability to understand the mechanism of enzyme kinetics, inhibition and mass transfer effects of immobilized enzymes
CO2 **:** Understand enzyme inhibition and immobilization
CO3 **:** Achieved competence in the area of recombinant enzymes
CO4 **:** Capacity to decode the principles of biosensor fabrication and its applications
CO5 **:** Understand recombinant enzymes

Pre-requisite: Fermentation Technology

Course Assessment methods:		
Direct	**Indirect**	
Internal Test I	**1**	Course end survey
Internal Test II	**2**	Industry Survey
Internal Test III	**3**	Alumni survey
Assignments		
End semester examination		

ENZYME KINETICS **9 Hours**

Classification of enzymes; Enzyme assay – developing assay and analysis of progressive curves; Enzyme units – definition; Estimation of Michaelis-Menten parameters - Lineweaver-Burk plot, Eadie – Hofstee plot, Hanes plot and Eisenthal & Cornish-Bowden plot; Parameters affecting enzyme activity – pH, temperature, ionic strength and special components; Modeling of rate equations for single and multiple substrate reactions; Interfacial enzymes – introduction and catalysis.

9 Hours

INHIBITORY AND IMMOBILIZED ENZYME KINETICS

Enzyme inhibition kinetics – competitive, non-competitive and mixed; Dose response curves on enzyme equilibrium; Mechanism based inhibition – introduction and suicide inhibition; Techniques of enzyme immobilization-matrix entrapment, ionic and cross linking; Effect of external mass transfer resistance; Analysis of intraparticle diffusion and reaction; Simultaneous film and intraparticle mass transfer resistance; Effects of electrostatic potential of the microenvironment; Bioconversion studies with immobilized enzyme packed -bed reactors.

9 Hours

ENZYME APPLICATIONS

Commercial applications of enzymes in food, pharmaceutical and other industries; enzymes for

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diagnostic and therapeutic applications; Use of enzymes in analytical applications; Abzymes.
Case studies on applications - Lipase and pectinase.

9 Hours

BIOSENSORS

Biosensors – general design, types and characteristic features; Microbial biosensor; Avidin-Biotin mediated biosensor; Polymer membrane based potentiometric polyion sensor; Surface Plasmon resonance biosensor – design and applications.

9 Hours

RECOMBINANT ENZYMES

Recombinant enzymes – introduction & current market status; List of enzymes from recombinant microorganisms; Production characteristic features of different host systems; Host systems for the production of recombinant enzymes – *E. coli*, *Bacillus sp.,* Yeast, Plants and mammals.

Total Hours : 45

REFERENCES

1. Bailey J.E. and Ollis, D.F. (2010) Biochemical Engineering Fundamentals, 2nd Ed., Tata McGraw Hill, India.
2. Trevor Palmer. (2007). Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Second Edition, Horwood Publishing Limited.
3. Donald L.Wise (Ed.), (2009). Bioinstrumentation and Biosensors, Marcel Deckker Inc. USA, Special Indian Edition.
4. Nicholas Price and Lewis Stevens. (2009). Fundamentals of Enzymology, 3rd Edition, Oxford University Press, India.
5. Shanmugam.S, Sathishkumar.T and Shanmugaprakash M. (2012). Enzyme Technology, Second Edition, IK International Publishers, India
6. emain A.L and Vaishnav P. (2009). Production of recombinant proteins by microbes and higher organisms. Biotechnology Advances, 27: 297–306.

P15BTT106 CHEMICAL PROCESS ENGINEERING

L	T	P	C
3	0	0	3

Course Objective:

- To make the students to understand the concepts of chemical engineering applied in bioprocess industries

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Understand the Stoichiometry principles
CO2 **:** Enumerate momentum transfer and factors involved in fermentation
CO3 **:** Describe the modes of heat transfer and their equipments
CO4 **:** Explain the principles of mass transfer in bioreactors
CO5 **:** Describe the principles of mechanical operations and their equipment's

Pre-requisite:NA

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Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni survey

MATERIAL AND ENERGY BALANCES **9Hours**

Introduction to flow sheeting, Problems involving material and energy balance with and without chemical reactions, Recycle, Bypass and Purge, Unsteady state material and energy balances, Stoichiometry of growth and product formation, Oxygen consumption and heat evolution in microbial cultures

9Hours

MOMENTUM TRANSFER

Fluids in motion, Momentum transfer, Non-Newtonian fluids, Viscosity measurement, Rheology of fermentation broth, Factors affecting viscosity of fermentation broth

9Hours

HEAT TRANSFER

Modes of heat transfer - Conduction, Convection and Radiation; Heat transfer equipments – Heat exchangers, condensers, reboilers and evaporators; Heat transfer configurations for bioreactors, Design equations for heat transfer systems and their applications

9Hours

MASS TRANSFER

Diffusivity and mass transfer coefficient, Theories and analogies of mass transfer, Mass transfer in bioreactors - Oxygen uptake in cell cultures, Oxygen transfer in fermenter and large vessels, Estimation of oxygen solubility, Overview of methods of measurement of k_La

9Hours

MECHANICAL OPERATIONS

Filtration, Centrifugation, Agitation and Mixing – Mechanism, Principles and Equipments.

Total Hours :45

REFERENCES

1. Doran, P. M. “Bioprocess Engineering Principles”, Latest Edition, United Kingdom: Academic Press. 2012
2. Hougen O A., Watson K M and Ragatz R A, “Chemical process principle” - Part I, New Delhi: CBS publishers. 2004

OTHER REFERENCES

1. Noel de Nevers. “Fluid Mechanics for Chemical Engineers”, Latest Edition, New Delhi: McGraw Hill, Inc. 2005
2. Badger W.L. and Banchero J.T. “Introduction to Chemical Engineering”, New Delhi: McGraw Hill, Inc. 1955
3. Holman, J. P., “Heat Transfer”, Latest Edition, New Delhi: McGraw Hill, Inc. 2005

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4. Treybal, R.E., “Mass Transfer Operations”, Latest Edition, New Delhi: McGraw Hill, Inc. 1980

WEB LINKS

1. http://www.crcnetbase.com/isbn/9780203912454

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P15BTP101 INDUSTRIAL BIOTECHNOLOGY LAB

L	T	P	C
0	0	6	2

Course Objective(s)

- To impart hands of training in industrial biotechnology

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Understand the operation of batch, fed-batch and continuous fermenters
CO2 **:** Describe mass transfer in bioreactors
CO3 **:** Learn the production of various commercial microbial products
CO4 **:** Analyze optimization of medium for fermentation
CO5 **:** An understanding of the production in bioprocess industry

Course Assessment methods:

Direct		Indirect	
1	Continuous Assessment in Lab	**1**	Course end survey
2	Model Practical Examination	**2**	Industry Survey
3	End semester examination	**3**	Alumni survey

LIST OF EXPERIMENTS:

1. Enzyme kinetics – Michaelis-Menten plot & LB plot / Inhibition
2. Enzyme and whole cell immobilization – Gel entrapment / Adsorption
3. Batch / Fed-batch / Continuous cultivation – Specific growth rate and Yp/s
4. K_La determination by sodium sulfite method / power correlation method
5. Medium optimization – Plackett-Burman design / RSM
6. Degradation of xenobiotics with immobilized enzymes - Metabolite analysis by HPLC
7. Production of any one of the following, per group: Ethanol / xylanase / biopesticide / mushroom / lactic acid
8. Production of primary / secondary plant metabolites in suspension cultures
9. Case study involving selection of suitable microbe(s), inexpensive nutrients for fermentation process, fermenters and techno-economic studies of bio-products.
10. Extraction of antibiotics using annular centrifugal extractor

Theory: Nil **Practical: 60 Hours** **Total Hours : 60**

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REFERENCES:

1 Ninfa. A.J, and D.P. Ballou Fundamental laboratory approaches for biochemistry and biotechnology, 2st Edition, Oxford University press, UK. 1998.

2. Sadasivam.S and Manickam, A, Biochemical Methods 3rd Ed, New Age International Publishers, India ,2008

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SEMESTER II

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P15MAT201 **APPLIED MATHEMATICS FOR BIOTECHNOLOGISTS**

L	T	P	C
3	0	0	3

Course Outcome (s) :

After successful completion of this course, the students should be able to

CO1 : Form and solve the ordinary differential equations of certain types
CO2 : Acquire the knowledge in Laplace transforms and its properties.
CO3 **:** Discover the equations of curve fit and compute various statistical measures
CO4 **:** Analyze sample data and interpret the same for population.
CO5 **:** Analyze the experimental design based on one-way, two-way and Latin squares

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni survey

9 Hours

ORDINARY DIFFERENTIAL EQUATIONS

Formation of differential equations – Simple problems - Linear equations of second order with constant coefficients – Euler's and Legendre's linear equations – Simultaneous first order linear equations with constant coefficients.

LAPLACE TRANSFORM **9 Hours**

Laplace Transform – Sufficient conditions – Transforms of elementary functions – Basic properties - Transforms of derivatives and integrals – Transform of periodic functions – Inverse transforms - Convolution theorem.

CURVE FITTING AND BASIC STATISTICS **9 Hours**

Principle of least squares: Fitting of straight line, parabola, exponential curve and power curve. Measures of central tendency: mean, median and mode – Measures of dispersion: Range, mean deviation and standard deviation – correlation and regression

TESTING OF HYPOTHESIS **9 Hours**

Testing of hypothesis for large samples (single mean, difference of means, single proportion, difference of proportion) – Small samples – t – test (single mean, difference of means, paired t-test) – F – test (variance ratio test) – Chi-square test – Tests for independence of attributes and Goodness of fit.

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DESIGN OF EXPERIMENTS **9 Hours**

Principles of experimental design – Completely randomized design– Randomized block design – Latin square design.

Total Hours: 45

REFERENCES

1. Grewal B.S., "*Higher Engineering Mathematics*", Khanna Publishers, Delhi, 38th Edition, 2004.
2. Kreyszig E., "*Advanced Engineering Mathematics*", John Wiley and Sons (Asia) Ltd., Singapore, 8th Edition, 2001
3. Gupta. S. P., "*Statistical Methods*", Sultan Chand & Sons Publishers, 2004.
4. Johnson. R. A., "*Miller & Freund's Probability and Statistics for Engineers*", Pearson Education, Delhi, 6th Edition, 2000.
5. Gupta S.C, and Kapur J.N., "*Fundamentals of Mathematical Statistics*", Sultan Chand, New Delhi, 9th Edition, 1996.

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P15BTT201 BIOSEPARATION TECHNOLOGY

L	T	P	C
3	0	0	3

Course Objective(s)

- To provide an insightful overview of the fundamentals of downstream processing for biochemical product recovery.
- To demonstrate new concepts and emerging technologies that are likely to benefit biochemical product recovery in the future.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Students get skills to understand the various principles involved in protein purification
CO2 **:** Understand the characterization of various biomolecues
CO3 **:** Understand the principles involved in various chromatography techniques
CO4 **:** Develop the structural and unstructured models for cell growth and product formation
CO5 **:** Analysis the non-ideality and reactor dynamics of fermentor

Pre-requisite:

1 Bioprocess Principles

Course Assessment methods:			
Direct		**Indirect**	
1	Internal Test I	**1**	Course end survey
2	Internal Test II	**2**	Industry Survey
3	Internal Test III	**3**	Alumni survey
4	Assignments		
5	End semester examination		

INTRODUCTION TO BIOSEPARATION **7 Hours**

Fundamentals and concepts in bioseperation technology. Characterization and analysis of fermentation broth, Physical methods of structure determination of biomolecules, Guidelines to recombinant protein purification.

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PRIMARY SEPARATIONS AND CELL DISRUPTION **6 Hours**

Cell disruption – Homogenizer, Dynomill – principle, factors affecting disruption, batch and continuous operation. Cell disruption by chemical methods. Separation techniques: filtration, microfiltration and centrifugation

ISOLATION OF PRODUCTS **10Hours**

Extraction – theory and practice: Aqueous two phase extraction, supercritical fluid extraction. Precipitation techniques: salts, solvents, polymers (PEG). Membrane based separation – Microfiltration, Ultrafiltration, reverse osmosis, dialysis.

CHROMATOGRAPHY **12 Hours**

Theory, practice and selection of media for – gel-filtration chromatography, Ion exchange chromatography, Hydrophobic interaction chromatography, reverse phase chromatography, Affinity chromatography – Metal affinity chromatography, dye affinity chromatography, immunosorbent affinity chromatography & Expanded bed chromatography. Scale-up criteria for chromatography, calculation of no. of theoretical plates and design. Electrophoresis separation

FINAL POLISHING AND CASE STUDIES **10 Hours**

Freeze drying, lyophilization, spray drying and crystallization. Case studies on purification of: cephalosporin, aspartic acid, Recombinant Streptokinase, Monoclonal antibodies, Tissue plasminogen activator, Taq polymerase, Insulin. Case studies of product recovery economics.

Total Hours : 45

REFERENCES

1. Belter, P. A, Cussler, E. L, and Hu, W. (1987). Bioseparations: downstream processing for biotechnology
2. Janson, Jan-Christer, ed. (2011) Protein purification: principles, high resolution methods, and applications. Wiley
3. Scopes R.K.(1994) Protein Purification – Principles and Practice, Narosa publishers.
4. Jenkins, R. O (Ed.) (1992) Product Recovery in Bioprocess Technology - Biotechnology

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by Open Learning Series, Butterworth-Heinemann

5. Bailey, J. E. and Ollis, D. F. (1986)"Biochemical engineering fundamentals" second edition, McGraw-Hill, New Delhi
6. Harrison R.G.; Todd P.; Rudge S.R. and Petrides D.P. (2003). Bioseparations Science and Engineering, Oxford Press.
7. Ladhish, M.R. (2001). Bioseparation engineering, Principles, practice and economics, Wiley Interscience.

WEB LINKS

1. http://ocw.mit.edu/courses/chemical-engineering/10-445-separation-processes-for-biochemical-products-summer-2005/
2. http://www.indiabix.com/biochemical-engineering/downstream-processing/
3. http://www.monzirpal.net/Bioseparation/Contents/Overview%20of%20Bioseparations.pdf

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P15BTT202

RECOMBINANT DNA TECHNOLOGY

L	T	P	C
3	0	0	3

Course Objective(s)

- To provide detail description about various host vector systems for recombinant protein production.
- To explain demonstrate various recombinant DNA techniques and their applications in human healthcare

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Demonstrate the steps in cloning and expression of a foreign gene

CO2 **:** Explain and device various gene isolation methods from the selected organisms.

CO3 **:** Describe expression and purification steps involved in recombinant protein products.

CO4 **:** Relate the application of GMOs in medical and Agriculture

CO5 **:** Understand issues related to release of GMO for commercial cultivation India

Pre-requisite:

1 Molecular Biology

Course Assessment methods:

Direct		Indirect	
1	Internal Test I	**1**	Course end survey
2	Internal Test II	**2**	Industry Survey
3	Internal Test III	**3**	Alumni survey
4	Assignments		
5	End semester examination		

CLONING VECTORS AND HETEROLOGOUS HOSTS **9 Hours**

Expression vectors for bacterial expression; pET system- plant transformation vectors; Binary vector, animal transformation vectors-SV40 based- Heterologous expression hosts; Bacteria-

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E.coli -Bacillus subtilis, *-Saccahromyces cereviciae- Pichia pastoris*-tobacco- Arabidopsis- animal cell lines- mouse.

GENE ISOLATION METHODS **9 Hours**

Construction of gene library; gene and cDNA library, screening of library; dig-dUTP probe, PCR based isolation of gene; designing primers from database sequences -TA cloning, transposable elements based gene isolation-positional cloning.

EXPRESSION OF RECOMBINANT PROTEINS **9 Hours**

Essentials of foreign gene expression; Transient and permanent foreign gene expression; problems related to heterologous gene expression; regulated expression of foreign gene - $_{p}$lac by IPTG- $_{p}$trp by tryptophan, purification of recombinant protein using affinity chromatography; His tag-Ni^{+} column based.

ADVANCED TECHNIQUES IN rDNA TECHNOLOGY **9 Hours**

Advanced nucleic acid sequencing methods; 454 pyrosequenicng- DNA chip based sequencing-nanopore DNA sequencing, screening of libraries using phage display; promoter deletion analysis and elucidation of cis acting elements, gene manipulation by multi- site directed mutagenesis and selection, real time PCR and quantization of gene expression using reporter gene assay- GUS assay, allele specific PCR to detect SNP.

APPLICATIONS OF rDNA TECHNOLOGY **9 Hours**

Recombinant DNA products and their safety: recombinant vaccines, therapeutic hormones, recombinant therapeutic proteins, molecular diagnosis, metabolic engineering of pathways; ABC model for flower development- fatty acid pathway manipulation for oil quality,

Case study: Bt cotton and Bt brinjal release in India.

Total Hours : 45

REFERENCES

1 Glick B. R. and Pasternak J.J. Molecular Biotechnology: Principles and Applications of Recombinant DNA, Washington, ASM Press, 2010.

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2 Primrose S.B and R.Twyman ,Principles of Gene manipulation and Genomics, 7th edition, John Wiley and Sons, 2006.

3. James Greene ,Recombinant DNA Principles and Methodologies, CRC Press,1998

WEB LINKS

1. http://nptel.ac.in/courses/102103013/

2. http://www.dnalc.org/

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P15BTT203 **COMPUTATIONAL BIOLOGY**

L	T	P	C
3	0	0	3

Course Objective(s)

- Understand and apply data analysis tools related to sequences and structures

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Understand the concepts of biological data and databases

CO2 **:** Understand sequence alignment methods

CO3 **:** Describe creation and biological motivation for preparing phylogenetic trees

CO4 **:** Understand machine learning techniques as applied to biological data

CO5 **:** Be able to use UNIX and program in Perl.

Pre-requisite:

1 Molecular Biology

Course Assessment methods:

Direct		Indirect	
1	Internal Test I	**1**	Course end survey
2	Internal Test II	**2**	Industry Survey
3	Internal Test III	**3**	Alumni survey
4	Assignments		
5	End semester examination		

INTRODUCTION TO COMPUTATIONAL BIOLOGY **9 Hours**

Introduction to computational biology and bioinformatics; Applications of bioinformatics; Computer and its components; Hardware basics- Processor, motherboard slots/cards, bus parallel and serial ports and various storage devices; Network – Protocols (OSI, TCP/IP and ftp models), media and topology (Tree, star, bus, ring and hybrid).

DATABASES & SEARCHING ALGORITHMS **9 Hours**

Biological databases – Introduction, classification and functions; Dotmatrix analysis; Dynamic programming - Needleman - Wunsch algorithm and Smith–Waterman algorithm; Parametric

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alignment; Gaps – introduction, types and significance; Scoring matrices – PAM and BLOSUM; Heuristic methods of database searching- FASTA and BLAST family of programs.

Case study – EMBOSS suite, FASTA and BLAST for the analysis of proteins and DNA sequences

MOLECULAR PHYLOGENY **9Hours**

Multiple sequence alignment –CLUSTAL W and Iterative methods; SAGA; Phylogenetic analysis – Molecular clock theory, Jukes – Cantor and Kimura's model; Distance methods – UPGMA, Fitch-Margoliasch and Neighbourhood joining; Character based methods – Maximum parsimony and Maximum Likelihood; Bootstrapping technique.

Case study – Multiple sequence and phylogeny analysis of protein and DNA sequences.

MACHINE LEARNING TECHNIQUES **9 Hours**

Comparative genomics; Homology modeling; Hidden Markov models; Artificial neural nets and their application in computational biology; Eukaryotic and prokaryotic gene finding; shotgun DNA assembly; Protein secondary structure prediction.

INTRODUCTION TO PERL AND APPLICATIONS IN BIOINFORMATICS

9 Hours

Basic UNIX commands; Unix directory structure; Introduction to Perl Variables; Data types, arrays and hashes; File handling; flow control, regular expression usage; simple programs for DNA and protein sequence manipulation, microrrays-data analysis; Introduction to systems biology.

Total Hours : 45

REFERENCES

1 Gusfield, Dan. (2005). Algorithms on strings Trees and Sequences, 1st ed., Cambridge University Press.

2 Baldi, P., Brunak, S. (2001). Bioinformatics: The Machine Learning Approach, 2nd ed., MIT Press

3 Mount D.W. (2001). Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press.

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4 Baxevanis A.D. and Oullette, B.F.F. (2002). A Practical Guide to the Analysis of Genes and Proteins, 2nd ed., John Wiley

5 Tisdall, James, (1998). Beginning PERL for Bioinformatics, Cambridge University Press

6 Bryan Bergeron, (2006). Bioinformatics Computing, Prentice Hall of India Pvt.Ltd. New Delhi

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P15BTP201

RECOMBINANT DNA TECHNOLOGY LAB

L	T	P	C
0	0	6	2

Course Objective(s)

- To impart hands of training in gene cloning and analysis of recombinant proteins

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Carryout and interpret the steps involved in gene cloning and expression.

CO2 **:** Isolate and Characterize bacterial strain using 16S rDNA analysis.

CO3 **:** Overexpress recombinant protein in *E.coli* and purify recombinant protein using Ni^{+} chromatography

Pre-requisite:

1 NIL

Course Assessment methods:

Direct		Indirect	
1	Continuous Assessment in Lab	**1**	Course end survey
2	Model Practical Examination	**2**	Industry Survey
3	End semester examination	**3**	Alumni survey

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LIST OF EXPERIMENTS:

1. Cutting and cleaning up of DNA for ligation
2. Transformation and selection of recombinants using GFP selectable marker
3. Evaluation of transformants containing recombinant plasmid DNA
4. Optimization of concentration of IPTG for gene expression under $_{p}$lac
5. Yeast transformation by electroporation
6. Isolation of phage DNA and phage stock preparation
7. Bacterial strain identification by 16S rDNA sequencing
8. DNA fingerprinting by RAPD analysis
9. Recombinant protein purification using His-tag –Ni^{+}column
10. Detection of gene using Southern blotting and hybridization

Theory: NIL **Practical: 60 Hours** **Total Hours : 60**

REFERENCES

1 Sambrook et al., Molecular Cloning: A laboratory Manual 3rd ed. Cold Spring Harbour Laboratory Press, Cold Spring Harbour, NY,2001.

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L	T	P	C
0	0	4	2

P15BTP202 **COMPUTATIONAL BIOLOGY LAB**

Course Objective(s)

- To enable the student to carry out computational analysis of biological sequence/structure data

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Demonstrate sequence analysis, database searching and alignments

CO2 **:** Carry out gene prediction; analyze protein structures and homology modeling of proteins

CO3 **:** Write programs in Perl and python

CO4 **:** Work with unix/linux operating systems

CO5 **:** Predict epitopes and draw molecular structures

Pre-requisite:

1 NIL

Course Assessment methods:

Direct		Indirect	
1	Continuous Assessment in Lab	**1**	Course end survey
2	Model Practical Examination	**2**	Industry Survey
3	End semester examination	**3**	Alumni survey

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LIST OF EXPERIMENTS

1. Knowledge of different biological database and retrieval of sequences
2. Heuristic methods (BLAST,BLAT, FASTA) of searching for homologous sequences
3. Pair-wise and Multiple sequence alignment
4. Phylogenetic tree building using Phylip
5. Gene prediction methods
6. Unix/Linux – basic operations and working with terminal
7. Perl programming - Simple programs using Operators, Control Structures, Subroutines, Hash, Creating a static HTML file by a Perl Program
8. Python programs – syntax and control structures
9. Epitope prediction
10. Homology Modeling using SPDBV
11. Analysis of 3D structures of proteins
12. Molecule Visualization Using Rasmol –Commands, Domain identification
13. Small molecule building, using ISIS Draw and CHEM SKETCH

Theory: NIL **Practical: 45 Hours** **Total Hours : 45**

REFERENCES

1 Applied Bioinformatics- Selzer, Marhofer, Rohwer, Springer Edition.

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P15BTP203 BIOSEPARATION TECHNOLOGY LAB

L	T	P	C
0	0	6	2

Course Objective(s)

- To impart hands of training in various protein purification techniques involved in biotechnology

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Students get skills to harvest the biomolecules/cells using various solid-liquid separations

CO2 **:** Learn to purify the biomolecules using various chromatography principles

CO3 **:** Learn to purify and quantify the biomolecules using HPLC

Course Assessment methods:			
Direct		**Indirect**	
1	Continuous Assessment in Lab	**1**	Course end survey
2	Model Practical Examination	**2**	Industry Survey
3	End semester examination	**3**	Alumni survey

LIST OF EXPERIMENTS:

1. Harvesting of yeast cells after cultivation by microfiltration
2. Cell disruption technique by homogenization / Ultrasonication
3. Partial purification of enzyme(s) by ammonium sulphate fractionation
4. Concentration of enzyme(s)/protein(s) by ultrafiltration
5. Aqueous two phase extraction of biological samples
6. Gel filtration chromatography of protein
7. Ion exchange chromatography of protein
8. Affinity chromatography of protein
9. Determination of caffeine in soft drinks by High Performance Liquid Chromatography.
10. Preservation of bacteria/yeasts cells by lyophilization
11. Modelling and simulation of primary and secondary metabolites production

Theory: NIL **Practical: 60 Hours** **Total Hours : 60**

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REFERENCES

1. Roger G. Harrison, Paul W. Todd, Scott R. Rudge and Demetri Petrides (2002) Bioseparations Science and Engineering, Oxford University Press.
2. Robert K.Scopes, (2010) Protein Purification: Principles and Practice, third edition, Springer-verlag New York, inc
3. Rosenberg (Ian M) (2003) Protein Analysis and Purification, Bench top techniques, second edition, Springer International
4. Kawamura, S., Murakami, Y., Miyamoto, Y., and Kimura, K. (1995). Freeze-drying of yeasts. Methods Mol. Biol, 38, 31-37.
5. Hatti-Kaul, Rajni. Aqueous two-phase systems: methods and protocols. Vol. 11. Springer, 2000.

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SEMESTER III

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P15BTP301 **PROJECT WORK PHASE - I**

L	T	P	C
0	0	12	6

Objective(s):

- Identify important social needs and problems for research
- To formulate a research component for solve the problem and collect relevant literature survey
- Carry out standardization and foundational work

Course Outcomes (COs):

CO1 **:** Formulate an experimental design to solve biotechnological problems

CO2 **:** Ability to conduct survey of literature

CO3 **:** Acquire knowledge on scientific presentation skills

CO4 **:** Analysis and apply technical skill for carry out standardization and foundational work

CO5 **:** Evaluate and interpretation of obtained results

Course Assessment methods:

Direct	**Indirect**
1 Internal Review assessment Tests	**1** Course end survey
	2 Faculty survey
	3 Industry
	4 Alumni

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SEMESTER IV

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P15BTP401 **PROJECT WORK PHASE -II**

L	T	P	C
0	0	24	12

Objective(s)

- To obtain research proficiency in biotechnology

Course Outcomes (COs):

CO1 **:** Formulate an experimental design to solve biotechnological problems
CO2 **:** Develop skills for identifying critical problems
CO3 **:** Acquire knowledge on scientific presentation skills
CO4 **:** Ability to carry out independent &team oriented research and process innovation
CO5 **:** Analyze, evaluate, interpret and justify an experimental data

Course Assessment methods:

Direct	Indirect
1 Internal Review assessment test	**1** Course end survey
2 End semester Viva voce examination	**2** Faculty survey
	3 Industry
	4 Alumni

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ELECTIVE- I

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P15BTE101 METABOLIC PROCESS AND DESIGN

L	T	P	C
3	0	0	3

Course Objectives:

- To understand the analysis of metabolic networks and metabolic fluxes in cells

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1: Relate various types of cellular metabolism

CO2: Understand material balance in cellular reactions

CO3: Learn the metabolic fluxes

CO4: Understand the metabolic control analysis of linear and branched pathways

CO5: Relate the different metabolic pathways

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry survey
4	End semester examination	**4**	Alumni survey

REVIEW OF CELLULAR METABOLISM 9 Hours

An Overview of Cellular Metabolism, Transport processes, Fuelling reactions: glycolysis, Fermentative pathways, Biosynthetic reactions, polymerization, cellular energetics.

MATERIAL BALANCES AND DATA CONSISTENCY 9 Hours

Comprehensive models of cellular reactions; stoichiometry of cellular reactions, reaction rates, dynamic mass balances, yield coefficients and linear rate equations, analysis of over determined systems- identification of gross measurement errors.

METABOLIC FLUX ANALYSIS 9 Hours

Theory, overdetermined systems, underdetermined systems- linear programming, sensitivity analysis, methods for the experimental determination of metabolic fluxes by

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isotope labeling, applications of metabolic flux analysis.

METABOLIC CONTROL ANALYSIS **9 Hours**

Fundamentals of Metabolic Control Analysis, control coefficients and the summation theorems, Determination of flux control coefficients, MCA of linear pathways, branched pathways, theory of large deviations.

ANALYSIS OF METABOLIC NETWORKS **9 Hours**

Control of flux distribution at a single branch point, Grouping of reactions, case studies, extension of control analysis to intermetabolite, optimization of flux amplifications, consistency tests and experimental validation.

Total Hours: 45

REFERENCES

1 Stephanopoulas, G, *et al*., Introduction to Metabolic engineering – Principles and Methodologies. Elsevier Science, 1996.

2 Christina Smolke, The metabolic pathway engineering Handbook – Fundamentals, CRC Press, 2009.

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P15BTE102 **MOLECULAR THERAPEUTICS**

L	T	P	C
3	0	0	3

Course Objectives:

- To impart knowledge on various gene and cellular therapy protocols for diseases
- To learn the production of recombinant proteins and immunotherapeutics.
- To relate the technique of gene silencing in therapeutics.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1: Learn gene therapy strategies for molecular diseases

CO2: Understand cellular therapies using stem cells and the concept of tissue engineering

CO3: Learn the production of recombinant products and their significance in therapy

CO4: Illustrate the strategies of immunotherapy using monoclonal antibodies and vaccines

CO5: Understand the mechanism of gene silencing and method of gene cloning

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

GENE THERAPY **9Hours**

Intracellular barriers to gene delivery; Overview of inherited and acquired diseases for gene therapy; Viral mediated gene transfer - retro and adeno virus mediated gene transfer; Non-viral mediated gene transfer - liposome and nanoparticles mediated gene delivery.

Gene therapy approaches – single genes disorders (cystic fibrosis, SCID), cancer, AIDS

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CELLULAR THERAPY **9Hours**

Stem cells: definition, properties and potency of stem cells; Sources: embryonic and adultstem cells; Role of adult and embryonic stem cells; clinical trials of stem cell therapy Concept of tissue engineering; Role of scaffolds; Role of growth factors; Clinical applications; Ethical issues

RECOMBINANT THERAPY **9Hours**

Clinical applications of recombinant technology; Production of Recombinant proteins: organisms, production systems – insect cells, mammalian cells, plants, transgenic animalsSource, production and applications of recombinant proteins - Erythropoietin; Insulin analogs and its role in diabetes; Recombinant human growth hormone; Streptokinase and urokinase in thrombosis; Recombinant coagulation factors (Factor VIII).

IMMUNOTHERAPY **9Hours**

Monoclonal antibodies and their role in cancer; Therapeutic monoclonal antibodies; Role of recombinant interferon's; Immunostimulants; Immunosupressors in organ transplants; Role of cytokine therapy in cancers; Vaccines: types, recombinant vaccines and clinical applications

GENE SILENCING AND CLONING **9Hours**

Gene silencing technology - Antisense therapy; triple helix technology
si RNA - mechanism; Tissue and organ transplantation; Transgenics production and their uses; Reproductive cloning – Dolly as an example; Ethical issues

Total Hours :45

REFERENCES

1 Bernhard Palsson and Sangeeta N Bhatia, Tissue Engineering, 2nd Edition, Prentice Hall, 2004.

2 Pamela Greenwell, Michelle McCulley, Molecular Therapeutics: 21st century medicine, 1st Edition, Sringer, 2008.

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P15BTE103	PLANT AND ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective(s)

- To understand the various techniques of manipulation of plant and animal cells to produce valuable bioproducts
- To learn various animal improvement strategies

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Understand and explain the importance of plant tissue culture

CO2 **:** Describe various gene transfer techniques.

CO3 **:** Analyze and interpret the cell culturing techniques and their maintenance.

CO4 **:** Explain the steps in involved in gene transfer in animal cell lines.

CO5 **:** Understand the relationship biological process involved in metabolite isolation from biological samples

Pre-requisite:

1 Recombinant DNA Technology

Course Assessment methods:

Direct		Indirect	
1	Internal Test I	**1**	Course end survey
2	Internal Test II	**2**	Industry Survey
3	Internal Test III	**3**	Alumni survey
4	Assignments		
5	End semester examination		

PLANT TISSUE CULTURE **9 Hours**

Plant growth regulators; Physico-chemical conditions for propagation of plant cells and tissues; Various types of plant tissue culture methods- callus culture, meristem culture, root tip

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culture, continuous culture and cell suspension culture; Protoplast isolation and fusion; Techniques for immobilization of plant cells; Molecular Pharming.

PLANT GENETIC ENGINEERING **9 Hours**

Gene transfer techniques- Particle gun bombardment, Electroporation, and *Agrobacterium* mediated gene transfer*;* plant transformation vectors: cointegrate vector and binary vector, Viral vectors- CaMV, Gemini virus, Golden bean Virus and TMV; Conferring resistance to herbicide and plant pathogens.

SCOPE AND PROSPECT OF ANIMAL CELL CULTURE **9 Hours**

Culture media and growth conditions for animal cell; Development of primary culture, Development of cell line; Maintenance and characterization of different cell lines; growth characteristics and kinetics. Cell culture techniques; Hybridoma technology; Organ culture technology; Basics of Gene Therapy; Tissue engineering.

BIOTECHNOLOGY FOR ANIMAL IMPROVEMENT **9 Hours**

Conventional methods of animal improvement: selective breeding and cross-breeding; *Invitro* fertilization; Super ovulation; *Invitro* maturation of oocytes; - Embryo collection, evaluation and transfer, embryo culture; Micro manipulation; Transgenic animals-mice, pigs; Ethics of animal cloning; Stem cells and its applications

ISOLATION OF BIOACTIVE INGREDIENTS FROM PLANTS AND ANIMALS **9 Hours**

Classification of natural plant products; Isolation techniques- terpenes, steroids, sugars, carboaromatic and related compounds, alkaloids; Isolation and production of pharmaceutically important animal metabolites like hormones, cytokines, Interferons.

Total Hours : 45

REFERENCES

1 Slater, Scott and Fowler. Plant Biotechnology, 2nd Edition, Oxford University Press

2 Primrose SB., Twyman RM., Principles of gene manipulation and Genomics, 7th Edition, Blackwell Science, 2006.

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3 B.D. Singh, Biotechnology, Kalyani Publishers, 2003

4 Masters, J.R.W(2007) Animal Cell culture. Practical Approach, Oxford University Press, UK.

5 Harborne, J.B., Phytochemical Methods, Chapman and Hall, London, 1993

6 H.E Street (ed): Tissue culture and Plant science, Academic press, London, 1974

7 M.M.Ranga. Animal Biotechnology. 3rd Edition, Eastern Book Corporation, 2007

8 Ian R Freshney (2011) Animal cell culture: A manual of basic technique and specialized applications, Wiley and sons

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1 http://www.ncbi.nlm.nih.gov/books/NBK26851/

2 http://www.eolss.net/sample-chapters/c17/E6-58-04-15.pdf

3 http://www.biotechnology4u.com/question_bank_question_answer.html

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ELECTIVE II

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P15BTE201 ENVIRONMENTAL BIOTECHNOLOGY

L	T	P	C
3	0	0	3

Course Objectives:

- To acquire a holistic understanding of key concepts in Environmental Biotechnology.
- Be able to apply these concepts in designing waste treatment systems and in developing environmentally safe bioproducts.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1: Develops a comprehensive understanding of wastewater treatment methodologies and waste management strategies in specific industries.

CO2: Understands the biodegradation pathways for xenobiotic compounds.

CO3: Acquires an ability to apply the concepts in real-world scenarios, for environmental clean-up.

CO4: Ability to handle industrial waste treatment.

CO5: Application of environmental concepts.

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry survey
4	End semester examination	**4**	Alumni survey

OVERVIEW **9 hours**

Microbial flora of terrestrial, aquatic and aerial ecosystems; Ecological adaptations; Interactions among microorganisms - mutualism, cooperation, commensalism, antagonism, parasitism, predation and competition; Environmental monitoring; Ecological indicators.

BIODEGRADATION AND BIOREMEDIATION **9 hours**

Introduction; Factors affecting biodegradation of xenobiotics; Biodegradation pathways - ortho and meta cleavage; Petroleum based wastes; Inorganic pollutants; Gaseous pollutants;

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Surfactants, Desulphurization of coal and oil, Bioremediation; Phytoremediation.

BIOLOGICAL WASTEWATER TREATMENT **9 hours**

Wastewater characteristics; Overview of primary, secondary and tertiary treatment processes; Biological treatment processes (suspended and attached growth), Design and modeling of activated sludge process, Trickling biological filter, Aerobic and anaerobic digestion; Nutrient removal - nitrates and phosphates; Biofilters.

MANAGEMENT OF INDUSTRIAL WASTES **9hours**

Overview of each industry with the process flow, typical wastewater characteristics, waste minimization and treatment processes - Dairy, Pulp, Dye, Leather and Pharmaceutical industries; Solid waste management - composting, vermi-composting, incineration and sanitary landfills; Biomedical waste management.

BIORESOURCE TECHNOLOGY AND DEVELOPMENT **9 hours**

Biotechnology for energy production - biological energy sources (biomass) and bio fuels; Biotechnology for enhanced oil recovery; Biomining of metals - concepts of bioleaching; Microbial polymer production and bio-plastic technology; Biosensors and their environmental applications.

Total Hours :45

REFERENCES

1 Bruce Rittman, Perry L Mac Carty (2007). Environmental Biotechnology: Principles and Applications, New York: McGraw Hill

2 Metcalf and Eddy, Tchbanoglous, G., Stensel, D.H. Tsuchihashi, R., Bruton, F. (2013), 5th Ed., Wastewater Engineering: Treatment and Resource Recovery, McGraw-Hill.

3 Stanier R.Y., Ingraham J.L., Wheelis M.L., Painter R.R. (1989). General Microbiology, London: Macmillan Publications.

4 Howard S Peavy, Donald R Rowe, George Tchbanoglous (1985). Environmental Engineering, Singapore: McGraw-Hill, Inc.

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OTHER REFERENCES

1 Atlas R M and Bartha R (2008). Microbial Ecology: Fundamentals and Applications, 6th edition, Benjamin / Cummings Publishing Company.

2 Metcalf and Eddy (2007). Wastewater Engineering: Treatment and Reuse, 5th edition, New Delhi: Tata McGraw Hill Publishing Company.

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1 http://home.eng.iastate.edu/~tge/ce421-521/lecture.htm

2 https://www.mendeley.com/disciplines/environmental-sciences/environmental-biotechnology/

3 http://www.theagarplate.com/EnvMicro.html

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P15BTE202	FOOD PROCESSING AND BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce basics and advances in food processing
- To learn various food processing and preservation techniques

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 : Understand about food and its properties.

CO2 : ibe various food processing techniques

CO3 : Apply various food preservation methods

CO4 : Awareness on food quality and safety

CO5 : Modify foods using biotechnology

Pre-requisite:

1 Biochemistry

2 Applied Microbiology

3 Unit Operations

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

FOOD AND ITS PROPERTIES **9hours**

Constituents of food; Definitions of properties of food: physical properties (roundness, specific gravity), ; dielectric properties: dielectric constant & dielectric loss factor, aerodynamic and hydrodynamic properties: drag force & terminal velocity),textural properties :consistency, hardness, firmness, brittleness; rheological properties : Hookean body, St.Venant body, Newtonian body ; thermal properties: specific heat, enthalpy, thermal

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conductivity, thermal diffusivity.

FOOD PROCESSING **9hours**

Cleaning (wet-spray washers, brush washers, drum washer, floatation techniques) and dry-air classifiers, magnetic separators; grading-sizes, shape; sorting - colour sorter; size reduction-ball mill, hammer mill, attrition mill; mixing- low, medium, high viscous liquids, pastes, dry powders; emulsification-; filtration-plate and frame, rotary vacuum filter; centrifugation-disc bowl centrifuge, nozzle centrifuge; membrane separation-;crystallization of foods.

FOOD PRESERVATION **9hours**

High temperature preservation: sterilization, pasteurization, blanching, canning; Low temperature preservation: freezing characteristics of foods, factors affecting the quality of frozen foods; Irradiation of foods; drying- tray, tunnel, drum, spray, freeze, Osmotic dehydration;, controlled and modified atmospheric packaging and storage of foods; intentional and non-intentional food additives; enzymes in food processing.

FOOD QUALITY AND SAFETY **9hours**

Concept of quality: Quality attributes- physical, chemical, nutritional, microbial, and sensory; their measurement and evaluation; Concepts of quality management: Objectives, importance and functions of quality control; Quality management systems in India; Sampling procedures and plans; Food Safety and Standards Act, 2006; Domestic regulations; Global Food safety Initiative; Various organizations dealing with inspection, traceability and authentication, certification and quality assurance (PFA, FPO, MMPO, MPO, AGMARK, BIS);Food labeling, Food sanitization-CIP.

FOOD BIOTECHNOLOGY **9hours**

Definition of food biotechnology ; role of biotechnology in functional foods; agricultural biotechnology and food safety; genetically modified foods; nutraceuticals in foods and its applications; microbial enzymes; fermented foods : cheese, sausages, sauerkraut, soya sauce, bread, wine, beer ,food chemicals.

Total Hours : 45

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REFERENCES

1 Shankuntala Manay N and Shadaksharaswamy M , Foods : facts and principles – 3rd edition , New Age International Publishers , India,2009.

2 Sri Lakshmi B ,Food Science, New Age International Publishers , India,2007.

3 www.nzift.org.nz/unit operations

4 P.J.Fellows, Food Processing Technology, Principles and practice,3rd Edition,Woodhead publishing,2009.

5 Adams, M.R. and Moss M.O., Food microbiology, New Age International Publishers, India,2008.

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6 www.rpaulsingh.com

7 www.nptel.ac.in chemical engineering/food engineering

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1 Salunkhe, D.K. and Kadam, S.S.: Handbook of Fruit Science and Technology: Production, Composition and Processing. Marcel Dekker, New York, 1995.

2 Salunkhe, D.K. and Kadam, S.S.: Handbook of Vegetable Science and Technology.Production, Composition, Storage and processing Marcel Dekker, New York,1995.

3 Seymour, G.B., Taylor, J.E. and Tucker, G.A: Biochemistry of Fruit Ripening.Chapman and Hall, London,1993.

4 Srivastava, R.P. and Kumar, S.: Fruit and Vegetable Preservation: Principles andPractices. International Book Distributing Co. Lucknow ,2nd Edition, 1998.

5 Dauthy, M.E.: Fruit and Vegetable Processing. International Book Distributing Co.Lucknow, India,1997.

6 Hamson, L.P: Commercial Processing of Vegetables.,Noyes Data Corporation, NewJersey,1975.

7 Jagtiani J., Chan, H.T. and Sakal, W.S., Tropical Fruit Processing Academic Press,London,
1988.

8 Lal, G., Siddappa, G. and Tondon G.L, Preservation of Fruits and Vegetables,Indian Council of Agricultural Research, New Delhi,1986.

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P15BTE203 **IMMUNOTECHNOLOGY**

L	T	P	C
3	0	0	3

Course Objectives:

- To develop the knowledge of the students in the area of Immuno-biology, Immuno-technology and its applications.
- To gain extensive knowledge in Immnotechniques and various assay related to immunology

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1: Acquire the basics of Immunology and immunobiology

CO2: Develop an understanding of various concepts of immunotechniques

CO3: Apply these concepts and techniques in immunobiology

CO4: Acquire knowledge in cellular immunology and immunoassays

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

INTRODUCTION **9Hours**

Innate and adaptive immunity, Cells of the immune system, hematopoiesis - process, growth factors, regulation; Antigens –factors affecting immunogenicity, adjuvants, humoral immune response; cell mediated immune responses; complement- pathways, biological consequence of activation, regulation. Antibodies- structure and classification.

IMMUNOTECHNIQUES **9Hours**

Antigen-antibody interactions – precipitation, aggulutination, radioimmunoassay, ELISA, immunofluorescence – principle and applications. Immuno-electrophoresis,

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Rocket Immuno-electrophoresis. Immunoglobulin quantification – radial immunodiffusion, Laurell Rocket technique, light scattering assays. Monoclonal antibodies – production and their use in diagnostics; Plaque Forming Cell Assay.

CELLULAR IMMUNOLOGY **9Hours**

PBMC separation from the blood; Cryopreservation of PBMC, FACS; Lympho-proliferation assay; Mixed lymphocyte reaction. Measurement of NK cell activity; Cr51 release assay, cytokine bioassays- IL2, gamma IFN, TNF alpha. HLA typing.

VACCINE TECHNOLOGY **9Hours**

Basic concept of vaccine design and development – active and passive immunization, designing vaccines for active immunization; whole organism vaccines, protein based vaccines; DNA vaccines, multisubunit vaccines; Plant based vaccines; recombinant antigens as vaccines; reverse vaccinology

DEVELOPMENT OF IMMUNOTHERAPEUTICS **9Hours**

Engineered antibodies; catalytic antibodies; idiotypic antibodies; combinatorial libraries for antibody isolation. Immunocytochemistry and Immunohistochemistry – principle and applications.

Total Hours :45

REFERENCES

1 Rose, N.R., Hamilton, R.G. and Detrick, B. *Manual of Clinical laboratory Immunology*, 6th ed., ASM Press, Washington DC., 2002.

2 Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kuby J. ,*Immunology*, 5th ed., W.H. Freeman, 2003.

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ELECTIVE- III

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P15BTE301	PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

- To understand concepts in pharmacology.
- To learn about drug interaction via phamacodynamics and Pharmacokinetics.
- To learn and apply various drug forms and its production.
- To conceptualize drug delivery and drug targeting.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1: Student will gain knowledge in drug interaction, drug metabolism

CO2: Acquire knowledge in drug designing and manufacture.

CO3: Understand the principles and drug manufacture

CO4: Acquire knowledge about advances in drug delivery systems

CO5: Understand the therapeutics function and use to treat humans

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

INTRODUCTION **9 Hours**

History of pharmacy, the pharmaceutical industry & development of drugs, approval process; economics and regulatory aspects.

PHARMACOKINETICS AND PHARMACODYNAMICS **9 Hours**

Understanding principles of pharmacology, pharmacodynamics, Pharmacokinetics: Mechanism of drug absorption, distribution, metabolism and excretion – factors affecting the ADME process, bioequivalence

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PRINCIPLES OF DRUG MANUFACTURE **9Hours**

Liquid dosage forms – solutions, suspensions and emulsions, Topical applications – ointments, creams, suppositories, Solid dosage forms – powders, granules, capsules, tablets, coating of tablets, Aerosols. Preservation, package and storage methods, quality management; GMP.

ADVANCES IN DRUG DELIVERY **9 Hours**

Advanced drug delivery systems – controlled release, transdermals, liposomes and drug targeting.

BIOPHARMACEUTICALS **9 Hours**

Study of a few classes of therapeutics like laxatives, antacids and drugs used in peptic ulcers, drugs used in coughs and colds, analgesics, contraceptives, antibiotics, hormones.

Total Hours: 45

REFERENCES

1 Harvey, R.A., Clark, M.A., Finkle, R., (2011), Pharmacology (Lippincott Illustrated Reviews Series, LWW Publishers, 5th Ed.,

2 Katzung, B., Masters, S., Trevor, A., (2009), Basic and Clinical Pharmacology (LANGE Basic Science), McGraw-Hill Medical, 11th ed.,

3 Remington, (2005), The Science and practice of Pharmacy, Lippincott Williams and Wilkins, 20th edition.

4 Allen, V.L., Popovich, N.G, Ansel, H.G., (2005), Ansel's Pharmaceutical Dosage Forms and Drug Delivery Systems, Lippincott Williams & Wilkins, 8th ed.,

OTHER REFERENCES

1 Brunton, L., Lazo, J., Parker, K., (2005), Goodman & Gilman's The Pharmacological Basis of Therapeutics, McGraw-Hill Professional, 11th ed.,

WEB LINKS

2 http://watcut.uwaterloo.ca/webnotes/Pharmacology/

3 http://ocw.mit.edu/courses/health-sciences-and-technology/hst-151-principles-of-pharmacology-spring-2005/lecture-notes/

4 www.mccc.edu/~behrensb/documents/.../2011Pharmacologywk1.pdf

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P15BTE302 **GENOMICS AND PROTEOMICS**

L	T	P	C
3	0	0	3

Course Objective(s)

- To impart solid foundation in fundamental concepts in genome mapping and whole genome sequencing techniques
- To learn genomics and proteomics related data generation, databases and analysis

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Understand and explain the importance of genome mapping and HGP.

CO2 **:** Describe various genome sequencing methods.

CO3 **:** Analyze and interpret the microarray data for gene expression profiling.

CO4 **:** Explain the steps in 2D electrophoresis and peptide mass fingerprinting.

CO5 **:** Understand the relationship biological process as systems biology

Pre-requisite:

1 Recombinant DNA Technology

Course Assessment methods:

Direct		Indirect	
1	Internal Test I	**1**	Course end survey
2	Internal Test II	**2**	Industry Survey
3	Internal Test III	**3**	Alumni survey
4	Assignments		
5	End semester examination		

ORGANIZATION AND MAPPING OF GENOMES **9 Hours**

Genome size; C-value and C-value paradox; Complexity of genomes, genome mapping methods; cytogenetic map- restriction map-Optical mapping-STS mapping- importance of high resolution genome maps. Genomes of model organisms (*C.elegans*, Drosophila, Zeebra fish) and human genome.

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GENOME SEQUENCING AND SEQUENCE ANALYSIS **9 Hours**

Advanced genome sequencing methods; automated sequencing- nextgen sequencing- whole genome sequencing, data acquisition using genome browsers, genome assembly, Ensembl, genome annotation, comparative genomics; gene prediction rules; Genscan for gene finding- UTR scan for functional element prediction, SNP analysis, ENCODE project

GENE EXPRESSION AND DATA ANALYSIS **9 Hours**

EST database, assembly of database using CAP3, Principle of Serial Analysis of Gene Expression, SAGE data acquisition and analysis, quantization of gene expression, Microarray principle, fabrication of different types, experimental design in microarray, comparative microarray data analysis and interpretation gene expression, metagenomics; methods-applications.

PROTEOMICS TECHNIQUES **9 Hours**

High throughput protein separation ; 2D gel image acquisition and analysis, protein digestion techniques; in- gel and on-blot, protein identification by peptide mass fingerprinting, protein sequencing using MS, protein expression profiling using MS, phosphoptotomics; phosphoprotein purification and identification by IMAC- MS data, interactomics, Yeast two hybrid and phage display.

APPLICATION OF PROTEOMICS AND SYSTEMS BIOLOGY **9 Hours**

Proteomics for biomarker identification, Protein chips for disease diagnosis, challenges in clinical proteomics, Over view of systems biology, biological networks, Genetic switches, computational prediction of protein interactions, network motifs in biology, pathway modeling using KEGG.

Case study: Serum proteomics

Total Hours : 45

REFERENCES

1 Brown TA., Genomes 2, 3rd edition Bios Scientific Publishers Ltd, Oxford, 2006.

2 Primrose SB., Twyman RM., Principles of gene manipulation and Genomics, 7th Edition,

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Blackwell Science, 2006.

3 Pevsner J. Bioinformatics and Functional genomics, 2nd Edition, John Wiley. 2009.

4 Saraswathy N. and P.Ramalingam Concepts and Techniques in genomics and proteomics; Woodhead Publications, Cambridge, UK. 2011.

5 Rigoutsos I, and G. Stephanopoulos Systems Biology: Genomics", Oxford University Press,2007.

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1 http://nptel.ac.in/courses/102101040/Advanced Clinical Proteomics and
http://nptel.ac.in/courses/102103017/Proteomics and Genomics
http://nptel.ac.in/courses/102106035/Systemns biology

2 https://cbse.soe.ucsc.edu/research/expgenomics
http://www.ebi.ac.uk/training/online/

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P15BTE303	BIOPROCESS PLANT DESIGN AND PRACTICE	L	T	P	C
		3	0	0	3

Course Objective:

- To make the students to understand the concepts of equipment design with relevance to bioprocess industries

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 : Learn the concepts of pressure vessel design with relevance to bioprocess industries

CO2 : Understand the concepts of vessel design with relevance to bioprocess industries

CO3 : Learn the mechanical aspects of equipment design with relevance to bioprocess industries

Pre-requisite:

1 Chemical Process Engineering

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry survey
4	End semester examination	**4**	Alumni survey

INTRODUCTION TO DESIGN AND FLOWSHEET **9hours**

Nature of design, design factors, degrees of freedom, design variables, optimization, nature of process equipments, general design procedure, basic considerations in design, standards, codes, and their significance, equipment classification and their selection, design pressure, design temperature, design stress, design loads, review of fabrication techniques, economics and environmental considerations in design procedure. Sketching techniques, Equipment symbols, Process flow sheeting

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PRESSURE VESSEL DESIGN **9hours**

Design of unfired pressure vessels: Types of pressure vessels, codes and standards for pressure vessels (IS: 2825; 1969), material of construction, selection of corrosion allowance and weld joint efficiency. Proportioning of pressure vessels, selection of L/D ratio, optimum proportions of vessels. Complete design as per IS: 2825; 1969 involving shells: cylindrical, spherical.

VESSEL DESIGN **9hours**

Design of vessel closures - flat, hemispherical, torispherical, elliptical and conical, design of nozzles, gasket, flange and bolt

MECHANICAL ASPECTS OF BIOREACTOR DESIGN **9hours**

Introduction, Bioreactor design – Requirements, Guidelines, Vessels, Agitator assembly

VESSEL SUPPORT DESIGN **9hours**

Vessel support - Introduction and classification of supports, design of skirt supports considering stresses due to dead weight, wind load, seismic load, design of base plate, skirt, bearing plate, anchor bolts, bolting chairs and skirt shell plates. Design of saddle supports

Total Hours :45hours

REFERENCES

1 R. K. Sinnott, "*Chemical Engineering Design*", Coulson and Richardson‟s Chemical Engineering Series, Volume-6, Fourth Edition, United Kingdom: Butterwoth-Heinemann, Elsevier. 2005

2 V. V.Mahajani and S. B. Umarjii. "*Joshi„s Process Equipment Design*", 4th Edition, New Delhi:Mac Millan Publishers India Limited. 2009

3 B.C. Bhattacharyya. ".*Introduction to Chemical Equipment Design Mechanical Aspects*", New Delhi: CBS Publishers & Distributors. 2000

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OTHER REFERENCES

1 R. H. Perry. "*Chemical Engineers' Handbook*", 7th Edition., New Delhi: McGraw Hill, Inc. 1998

2 L. E. Brownell and E.H. Young."*Process Equipment Design - Vessel Design*", New York: Wiley Eastern Edition. 1968

3 Robin Smith. "*Chemical Process Design and Integration*, Eighth Edition, New Delhi: Wiley India Pvt Ltd. 2006

WEB LINKS

1 www.massey.ac.nz/~ychisti/Education.PDF

2 people.ufpr.br/~meleiro/graduacao/tq066/Bioproc_Design.pdf

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P15BTE304 **BIOFUELS ENGINEERING**

L	T	P	C
3	0	0	3

Course objective:

- Evaluate and select appropriate software, optimization tools and techniques for performance and optimization of biofuels processes, predicting the performance of biofuels processes and biomass energy conversion systems

Course Outcomes (Cos):

After successful completion of this course, the students should be able to

CO1 **:** Understand in depth the current theory and practice of biofuels production processes.

CO2 **:** Critically evaluate the current techniques and bioprocesses appropriate for the production of biofuels.

CO3 **:** Review and assess the technical and economic issues involved in the design and operation of biofuels plants.

CO4 **:** Recognize and appraise the different techniques and feedstocks use for the production of biofuels.

CO5 **:** Describe and appraise current research activities in selected topics in the area of biofuels from a technical, economic and environmental perspective.

Pre-requisite:

1 Fermentation Biotechnology

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

CLASSIFICATION AND RESOURCES **9Hours**

Introduction, Biofuel as a renewable energy, Classification of biofuels – First, second, third and fourth generation biofuels, Different plant sources as biofuel feedstocks, Biogases, Physical and

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chemical characteristics of vegetable oils – iodine number, hydroxyl, acid values, rancidity, hydrogenolysis and hydrolysis, Food vs. energy, Edible and non-edible oils as fuels – their extraction

BIODIESEL **9Hours**

Definition, basics and chemistry of biodiesel, vegetable oils in biodiesel production, Transesterification: Chemical methods, enzymatic methods and types of catalysts, separation and purification, physical properties and characterization of biodiesel – Cloud point, pour point, cold filter plugging point, flash point, viscosity and cetane number. Purification – washing and drying options (bubble and mist washing), storage.

QUALITY BIODIESEL AND ENVIRONMENT **9Hours**

Producing Quality Biodiesel, quality control, test methods, ASTM specifications. Oxidative and thermal stability, estimation of mono, di, triglycerides and free glycerol, engine performance test, blending of ethanol with biodiesel, blending of biodiesel with high speed diesel (HSD) and their combustion properties. Comparison of biodiesel with high speed diesel

BIOETHANOL AND BIOGASES **9Hours**

Ethanol as a fuel, microbial and enzymatic production of ethanol from biomass – lignocellulose, sugarcane, sugar beet, corn, wheat starch, purification – wet and dry milling processes, saccharification – chemical and enzymatic .Production of biomethane and biohydrogen. Enzymes employed in the fermentation of sugars to ethanol and ethanol estimation.

BIOREFINERIES **9Hours**

Definition and types of biorefineries, co-products of biorefineries – oil cake and glycerol, purification of glycerol obtained in biodiesel plant; anaerobic and thermal gasification of biomass, economics of biorefineries, Application of biorefinerie in chemical, pharmaceutical and polymer industries

Total Hours : 45hours

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REFERENCES

1 Caye Drapcho, John Nghiem and Terry Walker, Biofuels Engineering process technology, McGraw Hill Professional, 2008

2 Mousdale, Biofuels , CRC Press, 2008

3 Ahindra Nag, Biofuels Refining and Performance, McGraw Hill Professional, 2007.

4 William H. Kemp, Biodiesel Basics and Beyond: A Comprehensive Guide to Production and Use for the Home and Farm, Aztext Press, 2006

5 Lisbeth Olsson, Biofuels (Advances in Biochemical Engineering/ Biotechnology), Springer, 2007

WEB LINKS

1 http://www.intechopen.com/books/biofuel-s-engineering-process-technology/the-challenge-of-bioenergies-an-overview

2 http://www.intechopen.com/books/biofuel-s-engineering-process-technology/bioresources-for-third-generation-biofuels

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L	T	P	C
3	0	0	3

P15BTE305 **BIOTECHNOLOGY FOR POLLUTION ABATEMENT**

Course Objective(s):

- To inculcate an in-depth understanding of ecosystems, pollution impacts, adopting green technologies for pollution abatement and environmental regulations.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Acquire knowledge in ecological concepts and the pollution scenario of various ecosystems

CO2 **:** Apply the knowledge in designing advanced wastewater treatment systems

CO3 **:** Devise green technologies that could be adopted for environmental management and sustainable development

CO4 **:** Comprehend regulatory policies and laws pertaining to the environment

CO5 **:** Gain understanding of role of biotechnology in pollution preventation

Pre-requisite: Nil

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Industry
3	Assignments	**3**	Alumni
4	End semester examination		

9 Hours

ECOLOGY CONCEPTS AND POLLUTION

Natural resources - disturbance and pollution; water quality standards and assessment; transformation and transport processes in water bodies; water quality in lakes, rivers, ground water; air and noise pollution

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ADVANCED WASTEWATER TREATMENT AND WASTE RECYCLING 9 Hours

Technologies used in advanced treatment – classification of technologies; removal of colloids and suspended particles – depth filtration, surface filtration, membrane filtration, absorption, ion exchange, advanced oxidation process - activated carbon, air stripping, heavy metals removal, steam stripping, chemical precipitation and electrolysis; recycling of industrial wastes - paper, plastics, leather and chemicals.

GREEN TECHNOLOGY 9 Hours

Introduction to green chemistry - principles of green chemistry, reasons for green chemistry (resource conservation and waste minimization concepts); criteria for choosing appropriate green energy technologies; green technologies for addressing the problems of water and energy; design for sustainability; green tax incentives and rebates; environmental reporting.

GREEN ENERGY AND SUSTAINABLE DEVELOPMENT 9 Hours

The inseparable linkages of life supporting systems; biodiversity and ecosystem services and their implications for sustainable development – global warming; greenhouse gas emissions, impacts, mitigation and adaptation; future energy systems - clean/green energy technologies; international agreements/conventions on energy and sustainability - United Nations Framework Convention on Climate Change (UNFCC); sustainable development.

ENVIRONMENTAL REGULATIONS 9 Hours

Environmental regulations and technology - regulatory concerns, technology; laws, regulations and permits- air, water, solid waste, environmental auditing, national environmental policy act, occupational safety and health act (OSHA), storm water regulations.

Total Hours : 45

REFERENCES

1 Rittman B. and Mac Carty L., Environmental Biotechnology: Principles and Applications, New York: McGraw Hill Publishing Company, 2007.

2 Atlas R.M. and Bartha R., Microbial Ecology: Fundamentals and Applications, 6th edition, Benjamin / Cummings Publishing Company, 2008.

3 Environment – A Policy Analysis for India, Tata McGraw Hill, 2000.

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OTHER REFERENCES

1 Peavy S., Rowe R. and Tchobanoglous, Environmental Engineering, New York: McGraw Hill Publishing Company, 2010.

2 Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, 5th edition, New Delhi: Tata McGraw Hill Publishing Company, 2007.

3 Fowler J.M., Energy and the Environment, 2nd Ed., New York: McGraw Hill Publishing Company, 1984.

WEB LINKS

1 http://unaab.edu.ng/colleges/environmental-resources-management/environmental-management-and-toxicology/lectures-notes.htm

2 http://home.engineering.iastate.edu/~tge/ce421-521/lecture.htm

P15BTE306 **BIOMEDICAL ENGINEERING AND CLINICAL RESEARCH**

L	T	P	C
3	0	0	3

Course Objective(s)

- Understand and apply data analysis tools related to sequences and structures

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Understanding biomedical instrumentation and applications

CO2 **:** Learn biomechanics and biomaterials

CO3 **:** Understand the origin of biosignals and their intrepretation

CO4 **:** Understand the working of various diagnostic and therapeutic devices

CO5 **:** To develop an understanding of experimental design and data management in clinical research.

Pre-requisite:

1 Physiology and Biochemistry

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Course Assessment methods:

Direct		Indirect	
1	Internal Test I	**1**	Course end survey
2	Internal Test II	**2**	Industry Survey
3	Internal Test III	**3**	Alumni survey
4	Assignments		
5	End semester examination		

BASICS OF SIGNAL TRANSDUCTION **9Hours**

Different types of noises in measurements and its Suppression methods; Transducers – Classification - circuit based on transduction, temperature transducers, Pressure transducer , catheter tip transducers, Photoelectric transducer, Flow transducers, Piezoelectric transducers and their applications; Biosensors - Chemoreceptors, hot and cold receptors, baro receptors, sensors for smell, sound, vision, osmolality and taste.

BIOMECHANICS AND BIOMATERIALS **9Hours**

Biomechanical properties of bone and spine; mechanical properties of blood vessels; Biofluid mechanics – Newton's laws, stress-strain, Newtonian visions fluid; Blood physical characteristics, Blood Rheology; Classification of biomaterials – polymers, metals, ceramics, composites; Biocompatibility – invitro and assessment; Implantable cardiac assist devices; skin substitutes; Burn dressing; soft tissue replacements.

BIOMEDICAL INSTRUMENTATION **9Hours**

Bioelectric potential and its measurement; Measurement of blood pressure; blood flow and cardiac output; Gas exchange instrumentation; ECG, EEG instruments; Pacemakers; Defibrillators; Heart lung machine.

DIAGNOSTIC EQUIPMENT & MEDICAL IMAGING **9Hours**

Ultrasonic techniques – Echocardiograms, Echo encephalagrams; Magnetic Resonance Imaging; Emission imaging systems; Radiographic imaging systems.

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CLINICAL RESEARCH **9Hours**

Discovery and development of new drugs, therapies and diagnostics; Ethical Guidelines and Regulation in clinical Research; Clinical trial designs; Analysis and interpretation for studies in humans; Clinical Trial documentation; Quality control in Clinical Trials; Clinical data management.

Total Hours : 45

REFERENCES

1 L.A.Geddes and L.E.Baker, Principles of Biomedical Instrumentation and Measurement.; 1st Edition ,John Wiley and Sons; 1989.

2 Adern Hilger ,The Physics of Medical Imaging, Bristol and Philadelphia, 1988

3 J.B. Park ,Biomaterial Science and Engineering, 1st Edition ,Plenum Press, 2000..

4 Duane Knudson ,Fundamentals of Biomechanics, 2003.

5 David Machlin, Simon Day, Sylvan Green, The textbook of Clinical Trials, 2nd Edition, 2007

6 Enderle,U, Blanchard,S Bronzino, S Introduction to Biomedical Engineering, 2nd Indian Edition, Academic press, 2005.

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ELECTIVE IV

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P15BTE401 **PROTEIN ENGINEERING**

L	T	P	C
3	0	0	3

Course Objective(s):

- To impart knowledge on various protein structures and their interaction modalities.
- To learn and understand the strategies of protein engineering.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1: Recall and understand the mechanism of various post-translational modifications

CO2: Demonstrate the structural characteristic features of globular and fibrous proteins

CO3: Explain the supersecondary and quaternary structural features of proteins

CO4: Describe the protein – DNA interactions

CO5: Explain the various strategies of protein engineering

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

AMINO ACIDS AND THEIR CHARACTERISTICS **9hours**

Different covalent and non-covalent bonds in protein structure. Detection of amino acids, peptides and proteins. Amino acids (the students should be thorough with three and single letter codes) and their molecular properties (size, solubility, charge, pKa), Chemical reactivity in relation to post-translational modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups). and peptide synthesis.

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GLOBULAR AND FIBROUS PROTEINS **9hours**

Properties of globular and fibrous proteins. Salient features of silk fibroin, coiled coils, collagen and keratin. Ramachandran plot and its uses.

PROTEIN ARCHITECTURE **9hours**

Primary structure: peptide mapping, peptide sequencing - automated Edman method & mass-spec. High-throughput protein sequencing setup Secondary structure: Alpha, beta and loop structures and methods to determine.

Super-secondary structure: Alpha-turn-alpha, beta-turn-beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds, prediction of substrate binding sites

Tertiary structure: Domains, folding, denaturation and renaturation, overview of methods to determine 3D structures, Quaternary structure: Modular nature, formation of complexes.

STRUCTURE-FUNCTION RELATIONSHIP **9hours**

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eucaryotic transcription factors, Zn fingers, helix-turn helix motifs in homeodomain, Leucine zippers, Membrane proteins: General characteristics, Trans-membrane segments, prediction, bacteriorhodopsin and Photosynthetic reaction center, Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase.

PROTEIN ENGINEERING **9hours**

Advantages and purpose, overview of methods, underlying principles with specific examples: thermal stability T4-lysozyme, recombinant insulin to reduce aggregation and inactivation, de novo protein design. Substrate-assisted catalysis other commercial applications. Brief account on bioinformatics tools used to analyze protein structure .

Total Hours :45

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REFERENCES

1 Creighton T.E. Proteins, 2nd Edition Freeman WH, 1993.

2 Moody P.C.E. and Wilkinson A.J. Protein Engineering, IRL Press, Oxford, UK, 1990.

3 Voet D. and Voet G.,Biochemistry, Third Edn. John Wiley and Sons, 2001.

4 Branden C. and Tooze J., Introduction to Protein Structure, Second Edition, Garland Publishing, NY, USA, 1999.

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P15BTE402	INNOVATION AND NEW PRODUCT DEVELOPMENT	L	T	P	C
		3	0	0	3

Course objective:

- To study the various issues related to Creativity, Innovation and New Product Development.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** To impart the knowledge of various aspects of Creativity, Innovation and New Product Development

CO2 **:** To impart the knowledge of various aspects of Project Selection and Evaluation

CO3 **:** To impart the knowledge of various aspects of New Product Development and Planning

Pre-requisite:

1 NIL

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry survey
4	End semester examination	**4**	Alumni survey

INTRODUCTION **9Hours**

The process of technological innovation - factors contributing to successful technological innovation - the need for creativity and innovation - creativity and problem solving - brain storming - different techniques.

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PROJECT SELECTION AND EVALUATION **9Hours**

Collection of ideas and purpose of project - Selection criteria - screening ideas for new products (evaluation techniques).

NEW PRODUCT DEVELOPMENT **9Hours**

Research and new product development - Patents - Patent search - Patent laws - International code for patents - Intellectual property rights (IPR).

NEW PRODUCT PLANNING **9Hours**

Design of prototype - testing - quality standards - marketing research - introducing new products.

LABORATORY **9Hours**

Creative design - Model Preparation - Testing - cost evaluation - Patent application

Total Hours : 45hours

REFERENCES

1 Harry Nystrom, “Creativity and innovation", John Wiley & Sons, 1979.

2 Brain Twiss, “Managing technological innovation", Pitman Publishing Ltd., 1992.

3 Harry B.Watton, “New Product Planning ", Prentice Hall Inc., 1992.

4 P.N.Khandwalla, "Fourth Eye (Excellence through Creativity) - Wheeler Publishing ", Allahabad, 1992.

5 I.P.R. Bulletins, TIFAC, New Delhi, 1997.

WEB LINKS

1 oro.open.ac.uk/28441/1/CaseStudiesOfCreativity2.pdf

2 mashable.com/2011/09/30/creative-problem-solving/

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		L	T	P	C
P15BTE403	**BIOREACTOR DESIGN**	**3**	**0**	**0**	**3**

Course Objective:

- To make the students to understand the concepts of bioreactors and their design

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Understand the concepts of bioreactor operation
CO2 **:** Learn the concepts of batch bioreactor design
CO3 **:** Understand the concepts of semi-continuous bioreactor design
CO4 **:** Learn the concepts of continuous bioreactor design
CO5 **:** Understand scale up process

Pre-requisite:

1 Chemical Process Engineering

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

BASICS OF BIOREACTORS **9hours**

verview of bioreactions, Elements in bioreactor design, Rate expression in biological systems, Basic concept of material and energy balances, Development and significance of bioreactors, Bioreactor configurations, Classification of bioreactors, Bioreactors for solid-state fermentation, plant and animal cell cultures

BIOREACTOR OPERATION **9hours**

Common operations of bioreactor, Identification of common factors for smooth operation of bioreactors, Spectrum of basic bioreactor operations, Bioreactor operation for immobilized systems, plant and animal cell cultures

BATCH AND SEMICONTINUOUS BIOREACTORS DESIGN **9hours**

Overview of bioreactor design, Batch and semi continuous bioreactors for submerged fermentation of microbes

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CONTINUOUS BIOREACTORS DESIGN **9hours**

Continuous flow stirred tank and plug flow tubular bioreactors for submerged fermentation of microbes, Recycle bioreactors, Multistage bioreactors, Bioreactors for enzyme reactions and immobilized systems

CASE STUDIES AND SCALE-UP **9hours**

Design of packed bed, fluidized bed, airlift, hollow fibre, plant cell, mammalian cell bioreactors for various applications, Scale=up – Criteria, Similarity criteria, Methods, Generalized approaches.

Total Hours :45

REFERENCES

1 Tapobrata Panda. "Bioreactors: Analysis and Design", Latest Edition, New Delhi: Tata McGraw Hill Education Private Limited. 2011

2 Moser, Anton. "Bioprocess Technology: Kinetics and Reactors", Latest Edition, New York: Springer Verlag. 1988

OTHER REFERENCES

1 Forment, G. F. "Chemical Reactor Analysis and Design", Latest Edition, New Delhi: Wiley India Pvt Ltd.1990

2 Rawlings, J. B. and Ekerdt, J. G. "Chemical Reactor Analysis and Design Fundamentals", Latest Edition, San Francisco: Nob Hill Publisher. 2002

3 Levenspiel, O. "Chemical Reaction Engineering", Latest Edition, New Delhi: John Wiley Eastern Ltd. 1998

WEB LINKS

1 www.itrcweb.org/GuidanceDocuments/ALT-3.pdf

2 d.umn.edu/~rdavis/courses/che4601/notes/BioreactorDesignForChEs.pdf

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P15BTE404

BIOPROCESS MODELING AND SIMULATION

L	T	P	C
3	0	0	3

Course Objective:

- To make the students to understand the applications of optimization, modelling and simulation in bioprocess industries

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Understand the applications of optimization in bioprocess industries
CO2 **:** Understand the applications of modelling
CO3 **:** Understand the applications of simulation in bioprocess industries
CO4 **:** Apply simulation techniques to bio chemical systems
CO4 **:** Work with various simulation packages

Pre-requisite:

1 Chemical Process Engineering

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

OPTIMIZATION **9hours**

Concepts of optimization, single variable optimization, Linear and Non Linear Programming Methods, Specialized Optimization techniques – Genetic Algorithm, Artificial Neural Network etc, Case Studies

MODELLING **9hours**

Concept of modelling, Unstructured and structured modelling, Meaning and interpretation through Deterministic and stochastic models, Segregated and unsegregated models, Shu's segregated models for Lactic acid fermentation, Details of Structured kinetic models: Compartmental models, Product formation, Unstructured and structured models, Genetically structured models

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CASE STUDIES IN MODELLING **9hours**

Stochastic model for thermal sterilization of the medium, Modelling for activated sludge process, Model for anaerobic digestion, Models for ethanol fermentation and antibiotic production, Case studies

SIMULATION **9hours**

Process simulation techniques, Equation oriented approach, Equation oriented simulators (SPEED UP, ASCEND, FLOWSIM, QUASILIN, DYNSIM), Simulation programs based on Euler's methods, Newton – Raphsen methods, Runga – Kutta methods, Simulation of biochemical system models

SIMULATION PACKAGES **9hours**

Simulation packages for bioprocess industries: Bio Process Simulator, Bio Pro Designer, Biotechnology Design Simulator, BATCHES, Intelligen Super Pro, Aspen Batch Plus and gepasi, Case studies

Total Hours :45

REFERENCES

1 Luyben, Michael L. and Luyben, William L. "Process Modeling, Simulation, and Control for Chemical Engineers", Latest Edition, New Delhi: Tata McGraw Hill Education Private Limited. 1989

2 Ramirez, W. "Computational Methods in Process Simulation", Latest Edition, Oxford: Butterworth Publisher. 1997

OTHER REFERENCES

1 Bailey, James E. and Ollis, David F. "Biochemical Engineering Fundamental", Latest Edition, McGraw Hill, Inc. 1986

2 Franks, R. G. E. "Mathematical Modelling in Chemical Engineering", Latest Edition, Hoboken/New Jersey: John Wiley & Sons. 1967

3 Harrison, Roger G., Todd, Paul W., Rudge, Scott R. and Petrides, Demetri,"Bioseparations Science and Engineering", Latest Edition, USA: Oxford Universities Press. 2002

4 Felder, R. M. and Rousseau, R. W., "Elementary Principles of Chemical Processes",Latest Edition, Hoboken/New Jersey:John Wiley & Sons. 2005

WEB LINKS

1 people.ufpr.br/~meleiro/graduacao/tq066/Bioproc_Design.pdf

2 www.doiserbia.nb.rs/ft.aspx?id=0367-598X0704263Z

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P15BTE405 **BIOMATERIAL AND TISSUE ENGINEERING**

L	T	P	C
3	0	0	3

Course Objective(s)

- To expose the students to various biomaterials for medical applications
- To learn basics of tissue engineering and application of various biomaterials for tissue engineering

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Understand properties of biomaterials

CO2 **:** Explain characterization methods for biomaterials

CO3 **:** Distinguish the different modes of tissue response to biomaterials

CO4 **:** Describe various applications of biomaterials in drug delivery and tissue engineering

CO5 **:** Comprehend various applications and regulatory issues related to biomaterials

Pre-requisite:

1 NIL

Course Assessment methods:			
Direct		**Indirect**	
1	Internal Test I	**1**	Course end survey
2	Internal Test II	**2**	Industry Survey
3	Internal Test III	**3**	Alumni survey
4	Assignments		
5	End semester examination		

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BIOMATERIALS **9Hours**

Biotechnology derived polymers and composites, Characterization of biomaterials, Bioceramics and composites, Biopolymers: Polymers as biomaterials. Polysaccharides: alginates, dextrans, chitosan, hyaluronic acids. Bacterial polyesters: poly(hydroxyl alkanoates), poly(hydroxybutyrates). Proteins: collagen, fibrin, gelatin, albumin. Smart biomaterial

CHARCTERIZATION AND TESTING BIOMATERIALS **9Hours**

Microstructure and mechanical properties, Electrochemical & Physiochemical, properties of biopolymers, Biocompatibility of polymers as biomaterials. Biodegradable polymers for medical application electrospinning, solvent casting, and melt molding, freeze drying, phase separation, Rapid prototyping, Sterilisation of implants and devices, gamma radiation, autoclaving. biocompatibility, blood compatibility and tissue compatibility, Toxicity tests, sensitization, carcinogenicity, mutagenicity and special tests, *in vitro* and i*n vivo* testing;

TISSUE ENGINEERING **9Hours**

Introduction, structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, Cell culture-Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction. Aspect of cell culture: decellurization, cell seeding, cell expansion, cell transfer, cell storage and cell characterization, Scaffold, and transplant- Engineering biomaterials, Three dimensional scaffolds.

TISSUE RESPONSES TO BIOMATERIALS **9Hours**

Interaction of cells and tissues with synthetic and natural biomaterials. Soft tissue response, Blood Compatibility, Materials Failure. Immunological consequences of polymeric implants and devices, Issues of biocompatibility and biodegradability.

BIOMEDICAL APPLICATIONS AND REGULATORY ISSUES **9Hours**

Biomedical application of materials obtained from natural sources. Cardiovascular Applications-Treatments of atherosclerosis; Stents, Heart Valves, Blood Substitutes; balloon angioplasty and pacemakers. Artificial skin, Artificial Organs. Case studies. Orthopedic Applications: Dental applications: Biodegradable polymers in drug delivery, Overview of biomaterials and implant

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regulatory issues, Tissue engineering: Ethical and regulatory aspects: Ethical FDA and regulatory issues.

Total Hours : 45

REFERENCES

1. Park JB and Lakes RS Biomaterials. Plenum,1992.
2. Bhat S. V., ***Biomaterials***, Springer, 2002.
3. Palsson B., S. Bhatia, ***Tissue Engineering,*** Pearson Prentice Hall, 2003.
4. Buddy D. Ratner et al. (Ed.) ***Biomaterials Science: An Introduction to Materials in Medicine, ,*** 2nd edn., Academic Press,2004**.**

WEB LINKS

1. **http://nptel.ac.in/courses/102106036/**

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P15BTE406 **STEM CELLS IN HUMAN DISEASES**

L	T	P	C
3	0	0	3

OBJECTIVES

- To learn about the biology of stem cells and their differentiation
- To understand the application of stem cell therapy in human diseases
- To learn the role of stem cell in regenerative medicine.

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 **:** Understand the basics concepts of stem cells and varieties

CO2 **:** Illustrate the mechanism of stem cell differentiation and molecular networks

CO3 **:** Enumerate the applications of stem cells and stem cell therapy in diseases

CO4 **:** Outline the application of stem cell therapy in human diseases

CO5 **:** Comprehend the role of stem cell treatment in regenerative medicine

Pre-requisite:

1 Immunology

2 Genetic Engineering and Genomics

Course Assessment methods:

	Direct		**Indirect**
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Faculty survey
3	Assignments	**3**	Industry
4	End semester examination	**4**	Alumni

BIOLOGY OF STEM CELLS **9Hours**

Concepts on stem cells and historical perspectives; Cellular and molecular features of stem cells Regulation of stem cells' self-renewal & molecular markers; Derivation, differentiation and propagation of stem cells; Cellular and molecular basis of stem cell differentiation; Varieties of stem cells : Embryonic stem cells & germ stem cells, Fetal-adults stem cells & cancer stem cells, New generation stem cells, Induced pluripotent stem cells & patient-specific stem cells,

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Genetically engineered stem cells.

STEM CELL DIFFERENTIATION **9Hours**

Stem cells, progenitors and their differentiation; Molecular net-works to induce stem cell differentiation; Stem cell differentiation-specific culture systems; Molecular phenotyping & cell propagation-enrichment strategies and functional integration of differentiated cell types in vivo

BIOTECHNOLOGY OF STEM CELLS **9Hours**

Stem cells: model system for cell-developmental biology; Biopharmaceutical need for stem cells; Medical (therapeutic) need for stem cells; Stem cells and progenitors for drug testing; Genetically engineered stem cells for drug discovery & gene therapy

STEM CELLS FOR HUMAN DISEASES **9Hours**

Stem cell therapy for diseases – neurodegenerative disorders, cardiovascular disorders, metabolic/diabetic/systemic disorders, hematopoietic and autoimmune disorders; stem cell preservation in cancer patients

STEM CELLS AND REGENERATIVE MEDICINE **9Hours**

Current stem cell therapies; Use of stem cells to study cancer; correlation between stem cells and cancer; Stem cells and aging; Clinical applications of hematopoietic stem cells from cord blood – Fanconi Anemia **(case study)** ; hematopoietic therapy – bone marrow transplantation ; autologous and heterologous transplantation; repair of damaged organs – liver, pancreas

Total Hours :45

REFERENCES

1. Robert Lanza, *Handbook of Stem Cells Volumes -I & -II*, Elsevier Academic Press, San Diego, California, USA, 2004
2. Slack,J.M.W., *Essential Developmental Biology*, Blackwell Publishing Company, Carlton, Victoria, Australia, 2006.
3. Knipe D.M.,Howley P.M eds., *Fields Virology*., Philadelphia ., P.A., Lippincott., Williams and Wilkins., 2001
4. Hackett, N.R., Crystal R.G., *Adenovectors for gene therapy*. In: *Gene Therapy*. Eds Templeton., N.S., Lassic, D.D., New York., Marcel Dekker, 2000

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WEB LINKS

1. http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/G/GeneTherapy.html
2. http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/G/GeneTherapy2.html
3. http://users.rcn.com/jkimball.ma.ultranet/BiologyPages/A/AntigenPresentation.html#Exogenous_antigens

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BIOENTREPRENEURSHIP

P15BTE407

L	T	P	C
3	0	0	3

Course Objective(s)

- To learn about the factors, attributes and indicators of bioenterpreneurship
- To understand the components of biotech company
- To learn the business strategies and technology transfer in biotech. companies

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 : Understand the basics concepts of bioentrepreneurship

CO2 : Illustrate the components of biotechnology companies

CO3 : Enumerate the models in biotech business

CO4 : Outline the biotechnology plan

CO5 : Comprehend the business strategies and technology transfer

Pre-requisite course:

1 Enterpreneurship

Course Assessment methods:

Direct		Indirect	
1	Internal Tests	**1**	Course end survey
2	Model Examination	**2**	Industry
3	Assignments	**3**	Alumni
4	End semester examination		

INTRODUCTION **9Hours**

Entrepreneurship, Definition; Factors necessary for Entrepreneurship, Attributes in an Entrepreneur, Bioentrepreneurship, Indicators of Bioentrepreneurship Case study: Building of a Bioentrepreneur

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COMPONENTS OF BIOTECH COMPANY **9Hours**

Paths for starting new Biotech ventures, History of establishment of pioneer biotechnology companies, Key for success, Mission and Strategy, product selection for new Biotech venture. Successful Bioentrepreneurs in India.

BIOTECH BUSINESS MODELS **9Hours**

Vertical model, , Platform Business Model, Hybrid Model, Service Business Model from Genomics based companies

Case study: Product Model

BUSINESS PLAN **9Hours**

General considerations, Business plan - Do's and don'ts, How to write Business proposal, Checklist for Business proposal writing, Deficiencies in start up business plan

BUSINESS STRATEGIES AND TECHNOLOGY TRANSFER **9Hours**

Intellectual property in biotech - Licensing, Accessing University technology, Licensing of Biotechnological invention, Funding agencies in India

Total Hours :45

Laboratory Components:

1. Lateral thinking, 2. Six thinking hats, & 3. Business plan

REFERENCES

1 Jogdand, S.N., *Entrepreneurship and Business of Biotechnology,* Himalaya Publishing Home, 2007.

2 Gupta, C.B. and S. S. Khanka, S.S., *Entrepreneurship and Small Business Management,* 1996.

3 R Oliver, R. *The coming biotech age: The business of biomaterials*. New York: McGraw Hill, 2000.

4 S. Shaleesha, S.., Bioethics, *Wisdom educational service*, Chennai, 2008

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WEB LINKS

1 http://www.birac.nic.in/webcontent/jk.pdf

2 https://books.google.co.in/books?id=0UoM48fo6_IC&pg=PA1&lpg=PA1&dq=bioentrepreneurship&source=bl&ots=W1fvPn3lbB&sig=wNo14uxLigEtmWpFrPBJyCmHJt0&hl=en&sa=X&ei=4KJRVfbZL4nauQS-n4CICg&ved=0CCwQ6AEwAzg U#v=onepage&q=bioentrepreneurship&f=false

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ONE CREDIT INDUSTRY COURSES

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P15BTIN001 DAIRY TECHNOLOGY

Objectives:

- To understand and learn about various aspects of milk.
- To learn in detail about milk processing techniques and products.

Course Outcomes (COs):

CO1: Understand the basics of milk.

CO2: Learn about various processing techniques of milk.

CO3: Explain the different dairy products.

Prerequisite courses: Nil

Course Assessment methods:			
Direct		**Indirect**	
1	Internal Tests	1	Course end survey
		2	Industry survey

COMPONENTS AND PROPERTIES OF MILK 3 Hours

Milk: Composition – factors affecting milk composition – nutritive value of milk – physicochemical properties of milk & milk constituents – microbiology of milk.

MILK PROCESSING 3 Hours

Milk Processing – collection storage – receptor (platform tests) – pasteurization – sterilization – homozenization – centrifugation – membrane separation – cooling – packing .

EQUIPMENTS USED IN DAIRY INDUSTRY 3 Hours

Coolers, pasteurizers, sterilizers – homogenizes – centrifuges – membrane separation unit – packaging equipments, FFS machine, Vacuum packaging, dryers.

QUALITY CONTROL IN MILK 3 Hours

Judging and grading of milk – plat form tests (smell, appearance, sediment, temperature, acidity,

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lactometer) sampling – testing – Clean-in-place (CIP) – (HACCP)Hazard Analysis and Critical Control Point – Good Manufacturing Practices(GMP), National & International standards of milk & Milk Products.

MILK PRODUCTS **3 Hours**

Milk Products Butter – Cheese – Ice Cream, Ghee etc. Waste Management – Whey, Whey Proteins – Solids -New Product Development. Visit to Sakthi dairy- Testing milk and products.

Total Hours :15

References

1 Sukumar De, Outlines of dairy technology,1st Edition,Oxford University Press, 1980.

2 EIRI ,Hand book of milk processing, dairy products and packaging technology, Engineers India Research In, 2007.

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P15BTIN002 MUSHROOM TECHNOLOGY

Objectives:

- To understand and learn about various edible mushrooms that are commonly cultivated and consumed.
- To learn in detail on cultivations steps and practices for edible mushrooms and their beneficial effects on human health.
-

Course Outcomes (COs):

CO1: Understand biology of edible mushrooms

CO2: Cultivation techniques of button, oyster,milky and paddy straw mushrooms.

CO3: Explain the various nutritive value and their therapeutic effects

Prerequisite Courses: Nil

Course assessment methods:			
Direct		**Indirect**	
1	Internal Tests	1	Course end survey
		2	Industry survey

2 Hours

BIOLOGY OF MUSHROOMS

Classification fungi, life cycle of fungi, parts of a typical mushroom , properties of edible mushrooms, differentiating edible mushroom from poisonous mushrooms. Different types of Button, Oyster, Milky and Paddy straw mushrooms- General morphology.

MUSHROOM CULTIVATION TECHNIQUES 8 Hours

Cultivation systems- Button mushroom, Oyster mushroom, Milky mushroom and Paddy straw mushroom.Problems and remedial measure in edible mushroom cultivation.

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NUTRITIONAL STATISTICS AND BENEFICIAL EFFECTS OF EDIBLE MUSHROOMS 5 Hours

Carbohydrate, protein, essential aminoacids, fats, vitamins, polyphenols and antioxidants calorific values, of edible mushroom fruiting bodies. Antiviral , antibacterial effect, antifungal effect, anti-tumour effect, therapeutic properties of edible mushrooms.

Total Hours :15

References

1 Mushroom Production and Processing Technology, Pathak Yadav Gour (2010) Published by Agrobios (India).

2 Mushroom Cultivation, Tripathi, D.P.(2005) Oxford & IBH Publishing Co. PVT.LTD, New Delhi.

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P15BTIN003

PILOT-PLANT AND INDUSTRIAL FERMENTORS

Objective(s):

- To learn about ancillaries of pilot-plant and industrial fermentors
- To understand the need of pilot-plant fermentors
- To learn the applications of pilot-plant fermentors

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 : Understand the basic components of pilot-plant fermentors

CO2 : Outline the importance of pilot-plant fermentor in biotech. industries

CO3 : Learn about components of industrial fermenter

Course assessment methods:			
Direct		**Indirect**	
1	Internal Tests	1	Course end survey
		2	Industry survey
		3	Alumni survey

PILOT-PLANT FERMENTER:

Advantages and types of pilot-plant fermenters, Design and operation of pilot-plant fermentors; Material of construction, aeration and agitation, temperature control, automatic antifoam control, automatic pH control, and facilities for air sterilization; Scale-up parameters in fermenters; Development of products using pilot-plant fermenter; Control of a fermenter by digital controllers interfaced with computers for continuous acquisition of online data and for process control;

INDUSTRIAL FERMENTER:

Temperature and pH control, aeration and agitation, Fermenter Accesories, Product recovery

Total Hours :15

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References

1 Fermentation and Biochemical Engineering Handbook ftp://ftp.feq.ufu.br/Luis/Books/E-Books/Engineering/Fermentation%20And%20Biochemical%20Engineering%20Handbook/14077_01a.pdf

2 James M. Lee, Biochemical Engineering, http://jmlee.org/documents/ebiochesample.pdf

3 Pauline M. Duran , Bioprocess Engineering Principles, Elsevier 2009

4 Shuler, M.L. and F. Kargi, Bioprocess Engineering Basic Concepts 2Ed, PHI Learning Pvt Ltd., 2008

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P15BTIN004 BIOETHANOL TECHNOLOGY

Objectives:

- To learn about the feedstocks, fermentation and purification of bioethanol

Course Outcomes (COs):

After successful completion of this course, the students should be able to

CO1 : Describe the economic, social and environmental aspects of bioethanol

CO2 : Illustrate the feedstocks for bioethanol

CO3 : Demonstrate the fermentation routes for bioethanol production

CO4 : Outline the purification steps involved in bioethanol fermentation

CO5 : Understand the future prospects of bioethanol

Course assessment methods:			
Direct		**Indirect**	
1	Internal Tests	1	Course end survey
		2	Faculty survey
		3	Industry survey
		4	Alumni survey

BIOETHANOL 5 Hours

Introduction: Economic aspects, energy balance, main drivers; Global production: statistics, international and national directives, current and emerging status. First generation (sugars and starch), second generation (lignocelluloses), third generation(algae), feedstocks with future potential, feedstock processing, alternative routes to bioethanol

FERMENTATION AND PURIFICATION 5 Hours

Ethanologenic microorganisms, theoretical and applied aspects, ethanol fermentation from sucrose, starch hydrolysate, lignocelluloses hydrolysate and algae hydrolysate. Distillation: Theoretical and applied aspects; Adsorption: Theoretical and applied aspects; Quality control: Quality parameters (process and product), alcohol specifications.

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ENVIRONMENTAL ASPECTS AND FUTURE PROSPECTS 5 Hours

Environmental aspects: Sustanability and climate change, energy and water conservation, co-products: generation and utilization, effluent treatment and control; Future prospects: Global trends and issues, future challenges.

Total Hours : 15

References:

1 Walker, G.M., Bioethanol: Science and technology and fuel alcohol, , Graeme M. alker & Ventus Publishing ApS, 2010

Other references:

1 www.ethanol.net

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