BIOTECHNOLOGY

B. Tech (Biotechnology) - 2018 Batch

PROGRAMME STRUCTURE

S. No.	Category	Credits
1	Humanities and Social Sciences including Management courses	10
2	Basic Science Courses	30
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	23
4	Professional Core Courses	59
5	Project work, seminar and internship in industry or appropriate work place/ academic and research institutions in India/abroad	15/9
6	Professional Elective courses relevant to chosen specialization/branch	18/24
7	Open subjects – Electives from other technical and /or emerging Courses	9
8	Mandatory Courses [Environmental Studies, Induction Program, Indian Constitution, Value Education, etc.]	(non-credit)
	Total	**164**

COURSE COMPONENTS

Table 1

Category	S.No	Course Code	Name of the Course	Credits [L:T:P:C]
01.Humanities & Social Science	1	18EN1001	English	3:0:0:3
	2	18EN1002	English Language Lab	0:0:2:1
	3	18MS2004	Total Quality Management	3:0:0:3
	4	18MS2005	Managerial Skills	3:0:0:3
			Total credits	**10**

Table 2

Category	S.No	Course Code	Name of the Course	Credits [L:T:P:C]
2.Basic Science	1	18MA1010	Matrices and Calculus	3:1:0:4
	2	18MA1011	Differential Calculus, Complex Analysis and Laplace Transform	3:1:0:4
	3	18MA2010	Mathematical and Numerical Methods	3:1:0:4
	4	18MA2011	Probability, Statistics and Random Process	3:1:0:4
	5	18PH1009	Applied Physics and Properties of Matter	3:1:0:4
	6	18PH1010	Applied Physics and Properties of Matter Lab	0:0:3:1.5
	7	18CH1006	Applied Chemistry	3:1:0:4
	8	18CH1002	Applied Chemistry Laboratory	0:0:3:1.5
	9	18BT2001	Cell Biology	3:0:0:3
			Total credits	**30**

Table 3

Category	S.No	Course Code	Name of the Course	Credits [L:T:P:C]
3.Engineering science	1	18ME1002	Engineering Graphics (AutoCAD)	0:0:4:2
	2	18ME1004	Workshop / Manufacturing Practices Laboratory	0:0:3:1.5
	3	18EE1003	Basic Electrical and Electronics Engineering	3:0:0:3
	4	18EE1004	Basic Electrical and Electronics Engineering Laboratory	0:0:3:1.5
	5	18CS1004	Programming for Problem Solving	3:0:0:3
	6	18CS1002	Programming for Problem Solving Lab	0:0:3:1.5
	7	18BT2002	Basics of Industrial Biotechnology	3:0:0:3
	8	18BT2003	Bioprocess Calculations	3:0:0:3
	9	18BT2004	Bio-analytical Techniques	3:0:0:3
	10	18BT2005	Bio-analytical Techniques Lab	0:0:3:1.5
			Total credits	**23**

Table 4

Category	S.No	Course Code	Name of the Course	Credits [L:T:P:C]
4.Professional core	1	18BT2006	Biochemistry	3:1:0:4
	2	18BT2007	Biochemistry Lab	0:0:3:1.5
	3	18BT2008	Microbiology	3:0:0:3
	4	18BT2009	Microbiology Lab	0:0:3:1.5
	5	18BT2010	Fluid Mechanics	3:1:0:4
	6	18BT2011	Fluid Mechanics & Heat transfer Lab	0:0:3:1.5
	7	18BT2012	Bioprocess Principles	3:0:0:3
	8	18BT2013	Bioprocess Lab	0:0:3:1.5
	9	18BT2014	Molecular Biology	3:0:0:3
	10	18BT2015	Genetic Engineering and Bioethics	3:0:0:3
	11	18BT2016	Molecular biology & Genetic Engineering Lab	0:0:3:1.5
	12	18BT2017	Bioprocess Engineering	3:0:0:3
	13	18BT2018	Enzyme Engineering & Technology	3:0:0:3
	14	18BT2019	Heat & Mass transfer	3:1:0:4
	15	18BT2020	Downstream Processing	3:0:0:3
	16	18BT2021	Downstream Processing Lab	0:0:3:1.5
	17	18BT2022	Immunology	3:0:0:3
	18	18BT2023	Cell biology & Immunology Lab	0:0:3:1.5
	19	18BT2024	Chemical Reaction Engineering	3:1:0:4
	20	18BT2025	Mass transfer & Chemical Reaction Engineering Lab	0:0:3:1.5
	21	18BT2026	Biochemical Thermodynamics	3:1:0:4
	22	18BT2027	Basics of Bioinformatics	2:0:0:2
	23	18BT2028	Bioinformatics Lab	0:0:2:1
			Total credits	**59**

Table 5

Category	S.No	Course Code	Name of the Course	Credits
7. Project work, internship (15)	1	18BT2999 / 18BT2998	Project	12/6
	2	ISP2997 / ISP2991	Internship	6 / 2
	3	MP2951	Mini Project	2
	5	ITP2903	Industrial Training	1
			Total Credits	**15 / 9**

SEMESTERWISE CURRICULUM

Semester-1

S.No	Course Code	Name of the Course	Credits [L:T:P:C]
1	18EN1001	English	3:0:0:3
2	18MA1010	Matrices and Calculus	3:1:0:4
3	18PH1009	Applied Physics and Properties of Matter	3:1:0:4
4	18CH2001	Environmental Studies	3:0:0:0
5	18CH1006	Applied Chemistry	3:1:0:4
6	18EN1002	English Language Lab	0:0:2:1
7	18PH1010	Applied Physics and Properties of Matter Lab	0:0:3:1.5
8	18CH1002	Applied Chemistry Laboratory	0:0:3:1.5
Total			**19**

Semester-2

S.No	Course Code	Name of the Course	Credits [L:T:P:C]
1	18MA1011	Differential Calculus, Complex Analysis and Laplace Transform	3:1:0:4
2	18EE1003	Basic Electrical and Electronics Engineering	3:0:0:3
3	18CS1004	Programming for Problem Solving	3:0:0:3
4	18BT1001	Biology in everyday life	3:0:0:3
5	18EE1004	Basic Electrical and Electronics Engineering Laboratory	0:0:3:1.5
6	18CS1002	Programming for Problem Solving Lab	0:0:3:1.5
7	18ME1002	Engineering Graphics (AutoCAD)	0:0:4:2
8	18ME1004	Workshop / Manufacturing Practices Laboratory	0:0:3:1.5
Total			**19.5**

Semester-3

S.No	Course Code	Name of the Course	Credits [L:T:P:C]
1	18MA2010	Mathematical and Numerical Methods	3:1:0:4
2	18BT2002	Bioprocess Calculations	3:0:0:3
4	18BT2006	Biochemistry	3:1:0:4
5	18BT2008	Microbiology	3:0:0:3
6	18BT2011	Basics of Industrial Biotechnology	3:0:0:3
7	18BT2009	Microbiology Lab	0:0:3:1.5
9	18BT2007	Biochemistry Lab	0:0:3:1.5

Total	20

Semester-4

S.No	Course Code	Name of the Course	Credits [L:T:P:C]
1	18MA2011	Probability, Statistics and Random Process	3:1:0:4
2	18MS2005	Managerial Skills	3:0:0:3
3	18BT2001	Cell biology	3:0:0:3
4	18BT2003	Bio-analytical Techniques	3:0:0:3
5	18BT2005	Fluid Mechanics	3:1:0:4
6	18BT2025	Biochemical Thermodynamics	3:1:0:4
7	18BT2004	Bio-analytical Techniques Lab	0:0:3:1.5
8	18BT2010	Fluid mechanics & Heat transfer Lab	0:0:3:1.5
Total			**24**

Semester-5

S.No	Course Code	Name of the Course	Credits [L:T:P:C]
1	18BT2012	Bioprocess Principles	3:0:0:3
2	18BT2014	Molecular Biology	3:0:0:3
3	18BT2019	Heat and Mass Transfer	3:1:0:4
4	18BT2022	Immunology	3:0:0:3
5		Professional Elective-1	3:0:0:3
6		Professional Elective-2	3:0:0:3
7	18BT2013	Bioprocess Lab	0:0:3:1.5
8	18BT2023	Cell biology & Immunology Lab	0:0:3:1.5
Total			**22**

Semester-6

S.No	Course Code	Name of the Course	Credits [L:T:P:C]
1	18BT2015	Genetic Engineering and Bioethics	3:0:0:3
2	18BT2017	Bioprocess Engineering	3:0:0:3
3	18BT2018	Enzyme Engineering & Technology	3:0:0:3
4	18BT2024	Chemical Reaction Engineering	3:1:0:4
5		Professional Elective-3	3:0:0:3
6		Open Elective-1	3:0:0:3
7	18BT2016	Molecular biology & Genetic Engineering Lab	0:0:3:1.5
8	18BT2026	Mass transfer Lab & Chemical Reaction Engineering Lab	0:0:3:1.5
9	18BT2059	Entrepreneurship, IPR and Biosafety	3:0:0:0
Total			**22**

Semester-7

S.No	Course Code	Name of the Course	Credits [L:T:P:C]
1	18BT2020	Downstream processing	3:0:0:3
2	18MS2004	Total Quality Management	3:0:0:3
3		Professional Elective-4	3:0:0:3

4		Professional Elective-5	3:0:0:3
5		Open Elective-2	3:0:0:3
6	18BT2027	Basics of Bioinformatics	2:0:0:2
7	18BT2021	Downstream processing Lab	0:0:3:1.5
8	18BT2028	Bioinformatics Lab	0:0:2:1
9		Professional Elective-6	0:0:3:1.5
10		Professional Elective-7	0:0:3:1.5
Total			**22.5**

Semester-8

S.No	Course Code	Name of the Course	Credits [L:T:P:C]
1		Open Elective-3	3:0:0:3
2	18BT2999	Full Semester Project	0:0:12:12
		Total	**15**

M.Tech. (Biotechnology) 2018 Batch

PROGRAMME STRUCTURE

S. No.	Category	Credits
1	Professional Core courses	22
2	Professional Elective courses	15
3	Open Courses – Electives from other Technical and /or Emerging Courses	3
4	Mini Project / Industrial Training	2
5	Project – Phase I & II	26
6	Audit Courses 1 & 2	(non-credit)
	Total Credits	**68**

COURSE COMPONENTS

Table 1
PROFESSIONAL CORE COURSES

S. No.	Course Code	Course Name	Hours per Week			Credits
			L	T	P	
1	18MA3005	Foundations of Mathematics and Statistics	3	0	0	3
2	18BT3001	Advances in Biopolymer and Applications	3	0	0	3
3	18BT3002	Genetic Engineering and Recombinant Products	3	0	0	3
4	18BT3003	Bioprocess Modelling and Simulation	3	0	0	3
5	18BT3004	Lab - I Analytical Techniques in Biotechnology Lab	0	0	4	2
6	18BT3005	Lab – II Animal and Plant Tissue Culture Lab	0	0	4	2
7	18BT3006	Lab - III Advanced Process Equipment Design and Drawing Lab	0	0	4	2

8	18BT3007	Lab – IV Recombinant DNA Technology Lab	0	0	4	2
9	18MS3104	Research Methodology and IPR	2	0	0	2
		Total				**22**
10	ITP3901/ MP3951	Industrial Training/ Mini Project	0	0	4	2
11	18BT3998	Project – Phase I	0	0	20	10
12	18BT3999	Project – Phase II	0	0	32	16
		Grand Total				**50**

Table 2
PROFESSIONAL ELECTIVE COURSES

S. No.	Course Code	Course Name	Hours per Week			Credits
			L	T	P	
Elective - I						
1	18BT3009	Enzyme Technology and Industrial Applications	3	0	0	3
2	18BT3010	Microbial Biotechnology	3	0	0	3
3	18BT3011	Agriculture and Food Biotechnology	3	0	0	3
4	18BT3012	Big Data Analytics	3	0	0	3
5	18BT3013	Bioethics and Biosafety	3	0	0	3
Elective - II						
1	18BT3014	Chemical Process Technology	3	0	0	3
2	18BT3015	Immunotechnology	3	0	0	3
3	18BT3016	Computational Biology	3	0	0	3
4	18BT3017	Metabolic Regulation and Engineering	3	0	0	3
5	18BT3018	Clinical trials and Bioethics	3	0	0	3
Elective - III						
1	18BT3019	Sustainable Bioprocess Development	3	0	0	3
2	18BT3020	Advanced Animal Biotechnology & Tissue Culture	3	0	0	3
3	18BT3021	Molecular Diagnostics	3	0	0	3
4	18BT3022	Drug Design and Discovery	3	0	0	3
Elective - IV						
1	18BT3023	Transport Phenomena	3	0	0	3
2	18BT3024	Pharmaceutical Biotechnology	3	0	0	3
3	18BT3025	Bioreactor Engineering	3	0	0	3
4	18BT3026	Stem Cell Therapeutics	3	0	0	3
5	18BT3027	Nanobiotechnology	3	0	0	3
Elective - V						
1	18BT3028	Advanced Plant Biotechnology	3	0	0	3
2	18BT3029	Cancer Management Techniques	3	0	0	3
3	18BT3030	Genomics and Proteomics	3	0	0	3
4	18BT3031	Advanced Environmental Biotechnology	3	0	0	3

Table 3

OPEN ELECTIVE COURSES

S. No.	Course Code	Course Name	Hours per Week			Credits
			L	T	P	
1	18BT3032	Entrepreneurship and Management	3	0	0	3
2	18BT3033	Industrial Waste Management	3	0	0	3
3	18BT3034	Industrial Safety	3	0	0	3

Table 4

	Audit Course (Mandatory courses) – 2 Course					
Code	**Course Name**		**L**	**T**	**P**	**C**
1	18VE3001	Value Education	0	0	2	0
2	18EN3001	English for Research Paper Writing	2	0	0	0
3	18MS3105	Constitution of India	2	0	0	0
4	18CE3083	Disaster Management	2	0	0	0

SEMESTER WISE CURRICULUM

SEMESTER I

S. No.	Course type/code	Course Name	Hours/Week			Credits
			L	T	P	
1	18MA3005	Foundations of Mathematics and Statistics	3	0	0	3
2	18BT3001	Advances in Biopolymer and Applications	3	0	0	3
3	Professional Elective	Elective I	3	0	0	3
4	Professional Elective	Elective II	3	0	0	3
5	18BT3004	Lab - I Analytical Techniques in Biotechnology Lab	0	0	4	2
6	18BT3005	Lab – II Animal and Plant Tissue Culture Lab	0	0	4	2
7	18BT3008	Research Methodology and IPR	2	0	0	2
8		Audit course 1	2	0	0	0
		Total	**16**	**0**	**8**	**18**

SEMESTER II

S. No.	Course type/code	Course Name	Hours/Week			Credits
			L	T	P	
1	18BT3002	Genetic Engineering and Recombinant Products	3	0	0	3
2	18BT3003	Bioprocess Modelling and Simulation	3	0	0	3
3	Professional Elective	Elective III	3	0	0	3
4	Professional Elective	Elective IV	3	0	0	3

5	18BT3006	Lab - III Advanced Process Equipment Design and Drawing Lab	0	0	4	2
6	18BT3007	Lab – IV Recombinant DNA Technology Lab	0	0	4	2
7	ITP3901/ MP3951	Industrial Training/ Mini Project	0	0	4	2
8		Audit course 2	2	0	0	0
		Total	**14**	**0**	**12**	**18**

SEMESTER III

S. No.	Course type/code	Course Name	Hours/Week			Credits
			L	T	P	
1	Professional Elective	Elective V	3	0	0	3
2		Open Elective	3	0	0	3
3	18BT3998	Project – Phase I	-	-	20	10
		Total	**06**	**0**	**20**	**16**

SEMESTER IV

S. No.	Course type/code	Course Name	Hours/Week			Credits
			L	T	P	
1	18BT3999	Project – Phase II	-	-	32	16
		Total	**-**	**-**	**32**	**16**

LIST OF COURSES

Sl.No	Course Code	Name of the Course	Credits [L:T:P:C]
1.	18BT1001	Biology in Everyday Life	3:0:0:3
2.	18BT2001	Cell Biology	3:0:0:3
3.	18BT2002	Basics of Industrial Biotechnology	3:0:0:3
4.	18BT2003	Bioprocess Calculations	3:0:0:3
5.	18BT2004	Bio-analytical Techniques	3:0:0:3
6.	18BT2005	Bio-analytical Techniques Lab	0:0:3:1.5
7.	18BT2006	Biochemistry	3:1:0:4
8.	18BT2007	Biochemistry Lab	0:0:3:1.5
9.	18BT2008	Microbiology	3:0:0:3
10.	18BT2009	Microbiology Lab	0:0:3:1.5
11.	18BT2010	Fluid Mechanics	3:1:0:4
12.	18BT2011	Fluid Mechanics & Heat Transfer Lab	0:0:3:1.5
13.	18BT2012	Bioprocess Principles	3:0:0:3
14.	18BT2013	Bioprocess Lab	0:0:3:1.5
15.	18BT2014	Molecular Biology	3:0:0:3
16.	18BT2015	Genetic Engineering and Bioethics	3:0:0:3
17.	18BT2016	Molecular Biology & Genetic Engineering Lab	0:0:3:1.5
18.	18BT2017	Bioprocess Engineering	3:0:0:3
19.	18BT2018	Enzyme Engineering & Technology	3:0:0:3
20.	18BT2019	Heat & Mass Transfer	3:1:0:4

21.	18BT2020	Downstream Processing	3:0:0:3			
22.	18BT2021	Downstream Processing Lab	0:0:3:1.5			
23.	18BT2022	Immunology	3:0:0:3			
24.	18BT2023	Cellbiology & Immunology Lab	0:0:3:1.5			
25.	18BT2024	Chemical Reaction Engineering	3:1:0:4			
26.	18BT2025	Mass Transfer & Chemical Reaction Engineering Lab	0:0:3:1.5			
27.	18BT2026	Biochemical Thermodynamics	3:1:0:4			
28.	18BT2027	Basics of Bioinformatics	2:0:0:2			
29.	18BT2028	Bioinformatics Lab	0:0:2:1			
30.	18BT2029	Industrial safety & Hazard analysis	3:0:0:3			
31.	18BT2030	Environmental Pollution Control Engineering	3:0:0:3			
32.	18BT2031	Process Equipment Design & Economics	3:0:0:3			
33.	18BT2032	Process Dynamics & Control	3:0:0:3			
34.	18BT2033	Mechanical Operation	3:0:0:3			
35.	18BT2034	Mechanical Operation Lab	0:0:3:1.5			
36.	18BT2035	Biochemical Engineering	3:0:0:3			
37.	18BT2036	Biochemical Engineering Lab	0:0:3:1.5			
38.	18BT2037	Cancer Biology	3:0:0:3			
39.	18BT2038	Clinical Database Management	3:0:0:3			
40.	18BT2039	Clinical Database Management Lab	0:0:3:1.5			
41.	18BT2040	Plant & Animal Biotechnology	3:0:0:3			
42.	18BT2041	Stem Cell Technology	3:0:0:3			
43.	18BT2042	Biopharmaceutical Technology	3:0:0:3			
44.	18BT2043	Agricultural Biotechnology	3:0:0:3			
45.	18BT2044	Metabolic Engineering.	3:0:0:3			
46.	18BT2045	Research Methodology	3:0:0:3			
47.	18BT2046	Molecular Forensics	3:0:0:3			
48.	18BT2047	Protein Engineering	3:0:0:3			
49.	18BT2048	Plant Tissue Culture	3:0:0:3			
50.	18BT2049	Animal Biotechnology and Cell Culture	3:0:0:3			
51.	18BT2050	Plant and Animal Tissue Culture Lab	0:0:3:1.5			
52.	18BT2051	Role of Biotechnology in Environment	3:0:0:3			
53.	18BT2052	Industrial Pollution Control	3:0:0:3			
54.	18BT2053	Biomass& Bioenergy	3:0:0:3			
55.	18BT2054	Environmental Biotechnology	3:0:0:3			
56.	18BT2055	Matlab Programming	3:0:0:3			
57.	18BT2056	Fundamentals of Biochemistry	3:0:0:3			
58.	18BT2057	Pathology and Microbiology	3:0:0:3			
59.	18BT2058	Human Anatomy and Physiology	3:0:0:3			
60.	18BT2059	Entrepreneurship, IPR and Biosafety	3:0:0:3			
61.	18BT3001	Advances in Biopolymer and Applications	3	0	0	3
62.	18BT3002	Genetic Engineering and Recombinant Products	3	0	0	3
63.	18BT3003	Bioprocess Modelling and Simulation	3	0	0	3
64.	18BT3004	Analytical Techniques in Biotechnology Lab	0	0	4	2
65.	18BT3005	Animal and Plant Tissue Culture Lab	0	0	4	2

66.	18BT3006	Advanced Process Equipment Design and Drawing Lab	0	0	4	2
67.	18BT3007	Recombinant DNA Technology Lab	0	0	4	2
68.	18BT3009	Enzyme Technology and Industrial Applications	3	0	0	3
69.	18BT3010	Microbial Biotechnology	3	0	0	3
70.	18BT3011	Agriculture and Food Biotechnology	3	0	0	3
71.	18BT3012	Big Data Analytics	3	0	0	3
72.	18BT3013	Bioethics and Biosafety	3	0	0	3
73.	18BT3014	Chemical Process Technology	3	0	0	3
74.	18BT3015	Immunotechnology	3	0	0	3
75.	18BT3016	Computational Biology	3	0	0	3
76.	18BT3017	Metabolic Regulation and Engineering	3	0	0	3
77.	18BT3018	Clinical trials and Bioethics	3	0	0	3
78.	18BT3019	Sustainable Bioprocess Development	3	0	0	3
79.	18BT3020	Advanced Animal Biotechnology & Tissue Culture	3	0	0	3
80.	18BT3021	Molecular Diagnostics	3	0	0	3
81.	18BT3022	Drug Design and Discovery	3	0	0	3
82.	18BT3023	Transport Phenomena	3	0	0	3
83.	18BT3024	Pharmaceutical Biotechnology	3	0	0	3
84.	18BT3025	Bioreactor Engineering	3	0	0	3
85.	18BT3026	Stem Cell Therapeutics	3	0	0	3
86.	18BT3027	Nanobiotechnology	3	0	0	3
87.	18BT3028	Advanced Plant Biotechnology	3	0	0	3
88.	18BT3029	Cancer Management Techniques	3	0	0	3
89.	18BT3030	Genomics and Proteomics	3	0	0	3
90.	18BT3031	Advanced Environmental Biotechnology	3	0	0	3
91.	18BT3032	Entrepreneurship and Management	3	0	0	3
92.	18BT3033	Industrial Waste Management	3	0	0	3
93.	18BT3034	Industrial Safety	3	0	0	3

18BT1001	BIOLOGY IN EVERYDAY LIFE	L	T	P	C
		3	0	0	3

Course Objective:

1. To comprehend the fundamental principles and concepts of human Health and Well-being.
2. To impart knowledge and implications of Biotechnology in daily Life.
3. To ensure knowledge transfer in applications of biomolecules and trends in biology.

Course Outcome:

1. Classify and Understand Life and Life forms.
2. Acquire knowledge towards Human health and welfare.
3. Assess the Significance of entrepreneurship and industry.
4. Analyze and engineer Molecules that define Life.
5. Rationalize the biological processes and their significance.
6. Understand and Apply Future trends in Biology.

Module I: LIFE AND LIFE-FORMS (9)

Brief Introduction about the Course. Classification of Life forms. Body plan and Design of Life Forms – Evolution. Nutrition in Humans – Macronutrients and Micronutrients. Blueprint of Life. Tree of Life. Case Study – Neanderthals to Homo-Sapiens.

Module II: HEALTH AND WELL-BEING AND STRESS MANAGEMENT (9)

The Human Body during Health and Disease – Example – Two Systems – Digestive and Excretory, their Diseases. Stress - Symptoms, Types, Causes and Treatment. Depression – Symptoms, Types, Causes and Treatment. Alcohol Abuse and Drug Abuse - Symptoms, Types, Causes and Treatment. Case Study – Substance Abuse and Social Responsibility.

Module III: BIOTECHNOLOGY AT HOME AND IN INDUSTRY (9)

Microorganisms – An overview The Good, the Bad and the Ugly Microbes. Bread, Beer and Batter. The Fermentation Industry – Principles, Processes and Products. Antibiotics –Mechanism Immunotherapeutics, Microbes as Fertilizer, Organisms as Pesticides, Biofuels.

Module IV: MOLECULES THAT MAKE US (9)

Biomolecules (Carbohydrates, Proteins, Lipids, and Nucleic Acids) – Types and Properties. Common diseases in Biomolecules. Flow of Genetic information. Genes to Function. Case Study - Crime Scene Investigation (FBI and CBI).

Module V: TRENDS IN BIOLOGY – THE FUTURE (4)

Genetically Modified Organisms (GMO) – Plants, Animals and Microbes (Two Examples Each). Human Cloning. Stem Cells Depot. Drug Resistance.

Module VI: MODERN AND RECENT TRENDS IN MEDICINE (5)

Drug Resistant Pathogens. Biosafety and Ethics. Nobel Prizes in Medicine and Physiology (Current Affairs). Careers in Biosciences – Survey and Interdisciplinary research.

Total Hours:45

Text Books

1. Pelczar MJ, Chan ECS & Krein NR, "Microbiology", Tata McGraw Hill Edition, NewDelhi, India, 2007
2. Prescott LM, Harley JP, Klein DA, "Microbiology", Wm. C. Brown Publishers,3rd edition,2001.
3. Owen J, Punt J, Stanford S, "Kuby Immunology", WH Freeman & Co., 2013.

References Books

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
2. Arthur C Guyton, "A Textbook of Human Physiology", Elsivier Saunders, International Edition, 11th Edition, 2006.
3. Bruce Alberts, Molecular Biology of the Cell. "Essential of Molecular Biology" by David Frielder, 2010.
4. Peter Raven et al "Biology", McGraw-Hill Education; 10 edition, January 9, 2013.

18BT2001	CELL BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To acquaint students with the concepts in Cell Biology.
2. To understand structure and function of the organelles of cells
3. To learn the cell-cell interactions, transport mechanism and signaling pathways of cell

Course Outcome:

1. Acquire knowledge on the structure and function of cellular organelles and components
2. Analyze the behavior of cells in their microenvironment in multicellular organisms (i.e. a cell within its social context) with emphasis on cell-cell interactions, cell-extra cellular matrix interactions
3. Illustrate specific processes and proteins involved in membrane transport.
4. Understand receptor subclasses and their possible uses in cell signaling
5. Determine the Mode of action and regulation of signaling molecules for signal transduction
6. Outline the mechanisms by which different messenger-receptor interactions bring about long or short-term changes in cell state.

Module I: FEATURES OF CELL AND ITS ORGANELLES (9)

Brief history of cytology and cell theory, Prokaryotes and Eukaryotes (plant cell and animal cell), Membranes of the cell: Plasma membrane, Nuclear membranes, Organelle membranes. Brief outline of organelles; Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgi apparatus, peroxisome, glyoxisome, lysosome, centriole, cilia and flagella.

Module II: CELL CYCLE AND ITS REGULATION (4)

Cell cycle and molecules that control cell cycle, Regulation of cell cycle.

Module III: CYTOSKELETON AND CELLS IN THEIR SOCIAL CONTEXT (5)

Microtubules, microfilaments, intermediate filaments and their binding proteins. Cell- cell communication: Cell junction, Cell adhesion, Extra Cellular Matrix, Basal Lamina.

Module IV: CELL TRANSPORT AND TRAFFIC (9)

Passive and active transport, permeases, osmosis, pumps and gated channels, co transport: symport, antiport. Vesicular transport: Endocytosis, Exocytosis, Protein glycosylation in eukaryotes and protein sorting. Transport in prokaryotic cells, entry of viruses and toxins into the cell.

Module V: SIGNALING MOLECULES AND THEIR RECEPTORS (9)

Signaling molecules: autocrine, paracrine and endocrine and its mode of action in cell signaling. Cytosolic, nuclear and membrane bound receptors: G-protein coupled receptor, protein tyrosine kinases receptor and cytokine receptors for cell signaling.

Module VI: SIGNAL TRANSDUCTION (9)

Signal amplification, different models of signal amplifications: role of cyclic AMP, cyclic GMP and G proteins in signal transduction, phosphorylation and regulation in signaling: serine – threonine kinases in signaling. Role of Inositol triphosphate (IP_3) in signal transduction, calcium ion flux and its role in cell signaling.

Total Hours:45

Text Books

1. Geoffrey M. Cooper and Robert E. Hausman, The Cell: A Molecular Approach, Fifth Edition, ASM Press and Sinauer Associates, Inc., USA, 2015.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, Molecular Biology of the cell, fifth edition, Taylor and Francis group, 2012.

Reference Books

1. De Robertis & De Robertis, Cell Biology, 4th Edition, 2010.
2. Lodish, H. and D. Baltimore, Cell Biology, W.H. Freeman publishers, 2012.
3. Gerald Karp, Cell and Molecular Biology, John Wiley and sons Inc, 2013.

18BT2002	BASICS OF INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To ensure students to have a base on the History of Biotechnology and its source of origin and the analysis on the different kinds of microorganisms this could be deployed for industrial biotechnology.
2. The paper elaborates on the industrial side of biotechnology and being in the engineering side the students will have a strong foundation on the aspects of fermentation and microbial engineering for better bio products.
3. The paper facilitates the need for knowing the various production strategies of bio products employed for better sustainable bioprocess development

Course Outcome:

1. Acquire fundamental knowledge on the history of biotechnology, reactors and microscopes. They will also having a base on modelling and simulation in Bioprocessing.
2. Acquire knowledge on the various types of Reactors and the base of fermentation technology.

3. The students will be aware of all the technical issues related with dealing microorganisms and microbial culture and to select the microorganisms for the kind of bio products they will be able to produce.
4. Help them to analyze industrial-market value of these bio products and relate them with the scope of biotechnology
5. Justify the clinical and biological significance of these bio products for sustainable bioprocess engineering,
6. The paper will enable students to understand the difference in manufacturing commercial bio products and all the ethical issues involved in it. In whole the paper will be very useful for them to scale up their own bio products with respect to entrepreneurial aspects.

Module I: INTRODUCTION TO INDUSTRIAL BIOPROCESS (9)

Introduction on the Historical overview of industrial fermentation processes on that of reactors and microscopes. The Traditional and modern biotechnology and the future perspectives in Industrial Biotechnology. Brief survey of organisms, processes, products related with modern biotechnology.

Module II: PRODUCTION OF PRIMARY METABOLITES (9)

The understanding of process flow sheeting, modelling and simulation in bioprocessing Pictorial representation of the need to know on Hypothesis and pictorial representation on the developmental process concerning upstream and downstream processing. The production of primary metabolites such as organic acids like citric acid, Lysine. Alcohols: Beer and Wine production.

Module III: PRODUCTION OF SECONDARY METABOLITES (9)

The production of secondary metabolites of high commercial value like Antibiotics: Penicillin V, Streptomycin and Ampicillin sodium salt. Production of commercial vitamins like Vitamin B12, Vitamin E, Vitamin B. Production of Bioethanol.

Module IV: PRODUCTION OF INDUSTRIAL ENZYMES AND OTHER PRODUCTS (9)

Introduction on Enzymes and the need for the Michaelis –Menten Kinetics in modelling enzyme reactions. Production of Industrial Enzymes like Amylase, Bromelain. Production of Bio fertilizers, Production of Bio preservatives: Nissin.

Module V: PRODUCTION OF MODERN BIOTECHNOLOGICAL PRODUCTS (5)

Production of Biopolymers like lignocellulose, Xanthan Gum, Poly Hydroxy Butyrate (PHB).

Module VI: PRODUCTION OF TARGET SPECIFIC FINE BIOPRODUCTS: (4)

Single Cell Proteins and fine bio products for pharmaceutical applications like monoclonal antibodies.

Total Hours: 45

Text Books

1. Prescott and Dunn, Industrial Biotechnology, Agro bios (India).
2. P.F. Stanbury and Whitaker, Fermentation Technology, Second Edition.

References Books

1. Elmar Heinzle,Sustainable Bioprocess Development, 2008.
2. Robert H. Perry, Handbook of Chemical Engineering.

18BT2003	BIOPROCESS CALCULATIONS	L	T	P	C
		3	0	0	3

Course Objective:

1. To develop skills of students in principles and basic calculations
2. To familiarize in material balance for non-reactive systems and simple reactive systems
3. To conceptualize energy balance for non-reactive systems and simple reactive systems in chemical process engineering.

Course Outcome:

The students will be able to

1. Understand the importance and inter conversion of different units

2. Apply concept of mass balance approach in unit operations
3. Adapt appropriate system boundary to resolve multiunit chemical process
4. Demonstrate vapor-liquid equilibrium calculations for ideal multi component system.
5. Apply concepts of liquid-vapour equilibrium in two phase systems
6. Classify different form of energy and their implication
7. Enable to assess energy expenditure on chemical process system

Module I ModuleS SYSTEMS (9)

Units systems, basic units, derived units, dimension analysis, force, pressure, work, heat, conversion to SI units, Mass and volumetric flux, Avogadro number, molarity, molality and normality, molecular weight, equivalent weight, mass fraction, mole fraction.

Module II MATERIAL BALANCE (9)

Fundamental of material balance, Basics of calculation, approach of solving material balance problems, Mixing, Crystallization, Evaporator, Distillation, Absorption Column, Drier, Liquid - Liquid and Solid - Liquid Extraction

Module III STOICHIOMETRY (9)

Stoichiometry, limiting & excess reactants, fractional conversion, yield, Material balance in sequential multi-unit and recycle Systems, Material Balance of Unsteady State Reaction systems

Module IV GAS LAWS (9)

Ideal Gases, Standard temperature and pressure, partial pressure, Gas laws: Amagat's law and Daltons law, Single component two phase system, vapor pressure, vapor liquid equilibrium, saturation, condensation, relative humidity

Module V ENERGY BALANCE (6)

Elements of energy balance calculations, types of Energy, Internal energy, Enthalpy changes, Heat capacities, Procedure for energy balance calculations.

Module VI SYSTEM BOUNDARIES (3)

Closed/open unsteady state system, closed/open steady state systems.

Total Hours: 45

Text Book

1. David Mautner Himmelblau, James B. Riggs., 'Basic Principles and Calculations in Chemical Engineering' Prentice Hall of India, 4th editon. 2004

Reference Books

1. Felder, R.M., Rousseau R.W., "Elementary Principle of Chemical Processes", John Wiley and Sons Publication 3rd edition, 2000.
2. BI Bhatt & SM Vora "Stoichiometry", Tata Mcgraw- Hill, 4th edition, 2004.
3. Venkataramani.V and Anantharaman.A., "Process Calculations", PHI learning Pvt. Ltd, 2003.

18BT2004	BIO-ANALYTICAL TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide the students an ability to understand the principles of instrumentation
2. To impart the knowledge of different techniques and methods in biotechnology
3. To improve the understanding of applications of techniques in the field of biotechnology

Course Outcomes:

1. To understand the basic techniques of drug extraction
2. Illustrate the different methods of spectroscopy
3. Classify the various techniques of Chromatography
4. Elaborate the importance of electrophoresis and thermal analysis techniques
5. Analyze the methods of structural elucidation of different drugs
6. Evaluate the importance of detection of radioactive isotopes

Module I EXTRACTION METHODS (9)

Buffers, pH – pH meter and applications, Solvent extraction –introduction and principle; Extraction techniques–batch, stripping or back, continuous and counter-current; Principle of solid extraction (Soxhlet); Types -Temperature assisted, pressurized hot water and supercritical fluids based extraction.

Module II SPECTROSCOPY TECHNIQUES (9)

Basic principle of Spectroscopy -Beer-Lambert's law, Principle, Instrumentation and applications of Colorimeter, Flame photometry, spectrofluorimetry and Spectrophotometer: types– UV – visible – Raman spectroscopy.

Module III CHROMATOGRAPHY TECHNIQUES (9)

Principle, types and applications of Chromatography- Thin layer, Adsorption, Ion-exchange, Affinity, Gelfiltration, GC and HPLC.

Module IV ELECTROPHORESIS & THERMAL METHOD (9)

Principle, Types and applications of Electrophoresis– agarose gel, polyacrylamidegel (PAGE), SDS-PAGE–principle, instrumentation and applications; isoelectric focusing–principle and applications; Thermo gravimetricanalysis (TGA)-Principle, instrumentation and applications

Module V STRUCTURAL ELUCIDATION TECHNIQUES (5)

Mass spectrometry–principle, instrumentation (electron spray ionization [ESI] & chemical ionization [CI]) and applicationns; nuclear magnetic resonance (NMR) –principle, instrumentation and applications;

Module VI RADIOISOTOPE METHODS (4)

Radioactive isotopes, radioactive decay and their types, radioactive techniques - RIA, GM counter, Scintillation counter, Applications in Medicine & Diagnosis.

Total Hours:45

Text Book

1. Willard and Merrit, Instrumental Methods and Analysis. VI Edition, CBS Publishers & Distributors; 2002.

Reference Books

1. Gurdeep R. Chatwal and Sham K. Anand. Instrumental Methods of Chemical Analysis. 5th Edition. Himalaya Publishing House, India. (2012).
2. 2 B.K.Sharma. Instrumental Methods of Chemical Analysis. 24th revised and enlarged edition. GOEL Publishing House, India. (2014).
3. 3 Keith Wilson and John WalkerPrinciples and Techniques of Practical Biochemistry and Molecular Biology. 7th Edition. Cambridge University Press, U.K. (2010).
4. 4 Douglas A. Skoog, F.James Holler and Stanley R. Crough. Instrumental Analysis. 6th Edition. Brooks Cole Publishing Company. USA, (2007).
5. 5 Avinash Upadhyay, Kakoli Upadhyay and Nirmalendu Nath. Biophysical Chemistry: Principles and Techniques. Himalaya Publsihing House Pvt. Ltd. India, (2014).

18BT2005	BIO ANALYTICAL TECHNIQUES LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To impart technical knowledge about the working principle and applications of different equipments related to biotechnology experiments.
2. To enable the students to understand the principles of instrumentation
3. To impart the knowledge of different techniques and methods in biotechnology

Course Outcome:

1. Understand the basic measurement methods and its applications in biotechnology
2. Describe the instrumentation and applications of different spectroscopic techniques
3. Demonstrate the principles, techniques and applications of chromatography.
4. Explain the determination of pH and their applications in buffer preparations
5. Understand different purification techniques of primary and secondary metabolites
6. Examine the applications of equipments involved in experimental biotechnology

List of Experiments

1. Estimation of Polyphenol by Colorimetric Method
2. Verification of Beers Law and Construction of Beers Law plot
3. Preparation of buffer solution with Henderson-Hasselbach equation and its verification with pH meter
4. Titration curves of Acetic acid and Citric Acid using pH meter
5. Precision and Validity of an experiment
6. Determination of analytical wavelength for given sample
7. Estimation of sugars by ascending paper chromatography
8. Identification of amino acids by ascending paper chromatography
9. Determination of turbidity by nephelometry
10. Conductivity measurement in titration
11. Gas Chromatography
12. High Performance Liquid Chromatography

18BT2006	BIOCHEMISTRY	L	T	P	C
		3	1	0	3

Course Objective:

1. To ensure students will have strong foundation in structure, properties and function of various biomolecules.
2. To introduce them to the basic structure of biomolecules which are involved in metabolic pathways
3. To understand the industrial-market value and significance of these biomolecules and to apply these in the fundamentals of biotechnology

Course Outcome:

1. Acquire knowledge on structure, properties and biological functions of carbohydrates, lipids and proteins which help them to understand the significance of biomolecules in bioprocesses and biotechnology
2. Acquire knowledge on nucleic acids structure, properties and functions of nucleic acids
3. Assess the significance of Vitamins and mineral functions
4. Help them to analyze industrial-market value of these biomolecules and relate them with the scope of biotechnology
5. Justify the clinical and biological significance of these biomolecules
6. Understand the complexes of different biomolecules and their biomedical significance

Module-I CARBOHYDRATES (9)

Classification, structure, properties and functions of carbohydrates: Monosaccharides, Disaccharides, Oligosaccharides-examples; Polysaccharide – classes- homo and hetero polysaccharides,conjugated carbohydtares, glycolysis, gluconeogenesis ,TCA cycle, Pentose Phosphate Pathway,glycogenesis, Glycogen Storage Disease, Respiratory chain and ATP synthesis

Module-II FATTY ACIDS AND LIPIDS (9)

Fatty acids- basic structure, types, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid-fat and wax, Compound lipid-Phospholipid, sphingolipid, ether lipid and glycolipid, Derived lipid – cholesterol biosynthesis, fatty acid biosythesis and degradation, Inborn errors of lipid metabolism.

Module-III AMINO ACIDS, PEPTIDES AND PROTEINS (9)

Amino acids- classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides –examples; Proteins- structure / conformation levels-primary, secondary, tertiary and quaternary, Ramachandran plot, classification, Biosynthesis of aromatic amino acids-tyr,trp,phe, biodegradation of proteins and urea cycle, Review on amino acid metabolic disorders.

Module-IV NUCLEOTIDES AND NUCLEIC ACIDS (9)

Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-Chargaff's rule on DNA base composition, unusual forms of DNA, RNA types, structure and functions, biosynthesis of purines and pyrimidines and its degradation, Inborn errors of nucleic acid metabolism - Review.

Module-V VITAMINS (4)

Vitamins: classification (A, D, E, K, and B-complex members), basic structure, source, daily requirement, functions and deficiency symptoms,

Module-VI MINERALS – FUNCTIONS AND DISORDERS (5)

Minerals: classification- macro elements and microelements, specific function and deficiency disorders, review on vitamins and mineral supplementations.

Total Hours: 45

Text Books

1. Jain and Jain "Biochemistry", Chand publication, 2008.
2. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.

References Books

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.
2. Lubert Stryer, "Biochemistry", WH Freeman & Co., 4th edition, 2000.
3. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.

18BT2007	BIOCHEMISTRY LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 14BT2006-Biochemistry

Course Objective:

1. To understand the basic units and measurements of biochemical solutions
2. To develop the skills in identifying the various biomolecules
3. To develop the skills of quantifying the various biomolecules

Course Outcome:

1. Know the basic units, calculations and different measurements tools used in biomolecule evaluations
2. Develop the basic lab skill in preparing different solutions of different concentrations and their measurement tools with representing units
3. Acquire knowledge in estimation of different carbohydrates using suitable method
4. Analyze through tests and identify the different carbohydrate, amino acid and lipid molecules present in the given sample solution.
5. Apply the reaction principle to quantify the proteins, amino acids, cholesterol and nucleic acids using colorimeter
6. Apply basic knowledge on the properties of biomolecules for the extraction of minerals and vitamins from food sources and quantify them.

List of Experiments:

1. Study of biochemical solutions, units and measurements
2. Estimation of total carbohydrate by Anthrone method
3. Qualitative analysis of carbohydrates
4. Estimation of reducing sugars by Di Nitro Salicylic acid method
5. Tests for lipids: - Fats and cholesterol
6. Estimation of cholesterol by Zak's method
7. Estimation of protein by Lowry's method

8. Qualitative analysis of amino acids
9. Estimation of amino acid by Ninhydrin method
10. Estimation of DNA by diphenylamine method
11. Dry ashing of food materials and colorimetric estimation of phosphorus
12. Estimation of ascorbic acid content in foods

18BT2008	MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To highlight the functions and characteristics of microorganisms
2. To study the growth of microorganisms and the impact of environment on their growth
3. To evaluate explicitly, the metabolic pathways, role of microbes in public health; insight into the physical and chemical control of microorganisms

Course Outcome:

1. Acquire basic knowledge on the history and development of microbiology
2. Recognize the fundamental concepts in the structure and functions of microbes
3. Understand the classification and nomenclature of microorganism, microscopic, staining and sterilization techniques
4. Identify the appropriate physical and chemical methods to control the growth of microbes
5. Demonstrate the nutritional requirements for microbial growth and their metabolism
6. Explain the dynamics of commensal, opportunistic and pathological relationships between microbes and humans

Module I: INTRODUCTION TO MICROBIOLOGY (9)

An overview of microbiology including a historical perspective of microbiology-classification, and nomenclature of microorganisms-Basics of Microscopy – light, phase, fluorescent and electron microscopy (SEM and TEM)- principles of different staining techniques like gram staining, acid fast, capsular staining, flagellar staining, spore staining

Module II: MICROBIAL STRUCTURE AND MULTIPLICATION (9)

Morphology, Structure and Functions of Prokaryotic- and Eukaryotic Cells, Multiplication of bacteria, viruses, algae, protozoa, fungi, yeast with appropriate examples, Life history of actinomycetes and bacteriophage

Module III: MICROBIAL NUTRITON AND METABOLISM (9)

Nutritional requirements of bacteria: Growth curve and Different methods to quantitative bacterial growth, Mathematics of growth generation time and growth rate constant, factors affecting growth. Aerobic and Anaerobic respiration, Microbial metabolism- Entner– Doudoroff and Phosphoketolase pathway

Module IV: CONTROL OF MICROORGANISMS (9)

Physical and chemical control of microorganisms – sterilization: Moist heat, dry heat, radiation and filtration. Disinfection: phenol, alcohol and detergents; Chemotherapy and antibiotics- antibacterial, anti-fungal agents, anti-viral agents

Module V: ENVIRONMENTAL MICROBIOLOGY (4)

Interaction between Microorganisms – Commensalism, Synergism, Mutualism (symbiosis), Lichen symbiosis, Normal flora of human healthy host, importance of nosocomial infections (hospital borne), mode of transmission of airborne pathogens,

Module VI: FOOD AND INDUSTRIAL MICROBIOLOGY (5)

food and water borne infections caused by bacteria and virus, Significance of microbes in food; Industrially important microbial products and processes

Total Hours:45

Text Books

1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.2007
2. Prasad B.N., "A Text Book of Biotechnology", Budha Academic Enterprises, G.P.O., Box 20195, Kathmandu, Nepal. 2003.

Reference Books

1. Talaron K, Talaron A, Casida, Pelczar and Reid. Foundations in Microbiology, W.C.Brown Publishers, 2001.
2. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001.
3. Lim D, "Microbiology", Second Edition, WCB-Mc Graw Hill, 2001.

18BT2009	MICROBIOLOGY LAB	L	T	P	C
		0	0	1.5	1.5

Co-requisite: 18BT2008- Microbiology

Course Objective:

1. To enable the students to understand the basic principles involved in the isolation of different kinds of microorganisms and gain accurate handling of microorganisms
2. Students will be taught about the different parts of microscopes and their functions
3. The students will learn to identify the microorganisms using various staining techniques and biochemical tests

Course Outcome:

1. Acquire basic knowledge on microbiological lab safety guidelines
2. Demonstrate proper handling, identify the parts/functions of microscopes
3. Experiment with transfer of living microbes using aseptic technique
4. Demonstrate proficiency and use of microbial isolation and staining techniques
5. Build skill to prepare media for microbial growth and cultivation techniques of microorganisms
6. Culture, identify, and explain different kinds of microorganisms present in environmental samples

List of Experiments:

1. Lab safety method and Regulations, Principles and methods of sterilization and Study of instruments: Compound microscope, Autoclave, Hot air oven, Laminar Airflow
2. Media preparation- Nutrient broth, Nutrient agar, slants, soft agar
3. Culturing of microorganisms– in broth and plates (pour plate, streak plate)
4. Enumeration of microorganisms from Soil
5. Enumeration of microorganisms from Water
6. Measurement of microbial Size – Micrometry
7. Anaerobic Cultivation – Fluid Thioglycolate broth
8. Staining Techniques -Simple, Gram staining and spore staining
9. Staining of fungus – Lacto phenol cotton blue staining
10. Motility test by Hanging drop method and soft agar inoculation
11. Biochemical Characterization of Bacteria: IMViC test, Catalase, Casein and Starch Hydrolysis
12. Antibiotic sensitivity assay – Disc and Well diffusion method

18BT2010	FLUID MECHANICS	L	T	P	C
		3	1	0	4

Course Objective:

1. To develop skills of students related to the fundamental calculations involved to measure the properties of fluids, measurement of fluid flow
2. To ensure students to have a strong knowledge related to types of fluids, instrument used in fluid flow mechanism

3. To make student understand the fluid flow processes involved in different sections in industrial operations

Course Outcomes

1. On completion of this subject students will be able to know the nature of fluids, kinematics of fluid flow
2. Students will able to know how to do measurement of flow and transportation of fluids in the problems related to the chemical engineering.
3. Students will be having enough basic theoretical knowledge to do an industrial training
4. Students will be having enough theoretical knowledge to work in industry
5. Students will able to face the complex situations during the malfunction of any fluid flow instrument
6. Students learn to deal with the theoretical knowledge on flow around solids

Module I BASICS OF FLUID STATICS AND DYNAMICS (12)

Nature of fluids, properties; Types of fluids, fluid statics: density, pressure-height relationship; pressure measurements-U tube, differential, simple, inverted and inclined manometers, solving problems for pressure measurements, continuity and mechanical energy equations.

Module II FLUID FLOW MEASUREMENT AND CONTROLS (12)

Measurements of fluid flow – orifice meter, venturimeter, pitot tube, rota meter, wires and notchs. Solving problems for venturi meter and orifice meter, Flow controls - gate valve, needle valve, check valve, globe and ball valve. Industrial application of flow measurements and flow controls.

Module III FLUID FLOW THROUGH SOLIDS (12)

Flow around solids and through packed beds; Drag curves for regular and irregular solids. Pressure drop, flooding and loading, friction factor for packed bed, Ergun's equation. Fluidization: mechanism. Types-fluidized bed. General properties
of fluidized beds.

Module IV MIXING AND AGITATION (12)

Mixing of solids and paste, Agitation and mixing of solids, liquids, mixers for pastes, power requirements, mixer effectiveness, mixer for dry powers, mixing index in blending granular solids. Agitation and mixing of liquids-equipments, flow pattern and power consumption in agitated vessels, blending and mixing scale, agitator design.

Module V TRANSPORTATION OF FLUID (8)

Introduction to fluid transfer, fluids moving machinery performance, Selection and specification, reciprocating pumps, centrifugal pumps, pump characteristics.

Module VI TRANSPORTATION EQUIPMENTS(4)

Concepts of compressors, fans and blowers.

Total Hours:60

Text Books

1. Dr.Bansal.R.K, "A text book of fluid mechanics", Laxmi Publication(P) Ltd, New Delhi, 1st edition, 2008
2. Bernard Massy, John ward and Smith, "Mechanics of fluids", Taylor & Francis Publishers, USA 8th edition, 2006.

Reference Books

1. Mc Cabe W.L and Smith J.C, "Unit operations in chemical engineering", McGraw Hill, 6th edition 2006.
2. Perry R.H., Green D.W. and Maloney J.O. "Perry's Chemical Engineers Handbook", McGraw-Hill, 7th edition 1997.

18BT2011	FLUID MECHANICS & HEAT TRANSFER LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To provide extensive knowledge on various unit operations in bioprocess industries
2. To ensure students to have a strong knowledge on various flow measuring equipments involved in bioprocess industries
3. To make student understand the fluid flow processes involved in different sections in industrial operations

Course Outcome:

The students will be able to

1. Understand the heat transfer concept and its applications.
2. Understand the important of fluid mechanics applications.
3. Analyze various flow meters for wide range of applications in industrial biotechnology
4. Demonstrate the friction factor for wide range of applications in industrial biotechnology
5. Demonstrate the thermal conductivity of materials for wide range of applications in heat exchangers
6. Experiment with annular pipe for wide range of applications in industry.

List of Experiments

1. Calibration of Flow Meter (Venturimeter)
2. Determination of pressure head loss in Annular Pipe
3. Thermal Conductivity for Insulating Medium
4. Determination of friction factor in Helical Coil
5. Determination of Darcy's Friction Factor
6. Determine the overall heat transfer coefficient in Double pipe Heat Exchanger (Parallel and Counter Flow)
7. Determine the coefficient of discharge in Orifice Meter
8. Determine the overall heat transfer coefficient in Shell and Tube Heat Exchanger
9. Determinations of Minor Losses in Pipes (Sudden Expansion and Contraction)
10. Determine the flow rate of Rota meters
11. Pressure Drop in a Fluidized Bed Column
12. Pressure Drop across Packed Column

18BT2012	BIOPROCESS PRINCIPLES	L	T	P	C
		3	0	0	3

Course Objective:

1. To understand the principles of bioprocessing and appreciate its applications in Bioprocess Technology
2. To ensure students to have a strong knowledge on the importance of medium formulations and optimization
3. To provide extensive knowledge on sterilization kinetics

Course Outcome:

The students will be able to

1. Review the fermentation processes and sampling
2. Summarize media formulation and medium optimization for fermentation process
3. Analyze Thermal death kinetics of microbes, sterilization time and filter sterilization of medium and air
4. Demonstrate isolation and storage of industrially important microbes
5. Assess inoculum development for fermentation process
6. Examine stoichiometry of cell growth and product formation

Module – I OVERVIEW OF FERMENTATION PROCESS (6)

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter and ancillaries, aseptic condition and containment, Sampling

Module – II MEDIUM FORMULATION AND OPTIMIZATION (9)

Criteria for good medium, medium requirements for fermentation processes, carbon, nitrogen,minerals, vitamins and other complex nutrients, oxygen requirements, medium formulation of optimal growth and product formation, examples of simple and complex media, design of various commercial media for industrial fermentations – medium optimization by Plackett burmann method

Module – III STERILIZATION KINETICS (12)

Thermal death kinetics of microorganisms, batch and continuous heat sterilization of liquid media, filter sterilization of liquid media, air sterilization and design of depth filters, design of sterilization equipment - batch and continuous.

Module – IV INOCULUM DEVELOPMENT (8)

Isolation of industrially important microbes, preservation and storage of industrially important microbes, Quality control of preserved stock cultures and development of inoculum for industrial fermentation

Module – V STOICHIOMETRY OF CELL GROWTH AND PRODUCT FORMATION (8)

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances.

Module –VI YIELD CALCULATIONS (4)

Knowing the Priciples of product yield and calculations of yield coefficients of biomass and product formation.

Total Hours:45

Text Book

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.

Reference Book

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2002

18BT2013	BIOPROCESS LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 18BT2012- Bioprocess Principles

Course Objective:

1. To learn the culturing of microbes and quantifying biomass production
2. To provide extensive knowledge on enzyme kinetics
3. To learn immobilization techniques

Course Outcome:

The students will be able to

1. Acquire knowledge in the cultivation of microorganisms and estimating its dry weight.
2. Demonstrate enzyme assay qualitatively and quantitatively
3. Examine factors affecting enzyme activity.
4. Devise methods to produce fermented products
5. Utilize solid state fermentation for production of fermented products
6. Assess the effect of substrate concentration on growth of microbes.

List of Experiments:

1. Culturing of Different Types of Microorganism
2. Estimation of Biomass Production
3. Effect of Substrate Concentration on Growth of E-coli
4. Effect of pH on Enzyme Activity
5. Effect of Temperature on Enzyme Activity
6. Immobilization of ∝ - Amylase Enzyme by entrapment method
7. Components of Fermentor
8. Citric acid production by Solid State Fermentation
9. Enzyme Assay- Starch Plate Assay

10. Quantitative Enzyme Assay
11. Production of Wine
12. Production of Amylase from Bacillus subtilis and Assaying for its Activity

18BT2014	MOLECULAR BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To understand the basics of molecular biology and gene expression.
2. To understand DNA damage and repair systems
3. To get an overview on the regulation of gene expression

Course Outcome:

The students will be able to

1. Understand the fundamental concepts of the organization of genome and central dogma
2. Summarize the fundamental mechanism on the process of replication, transcription and translation in the gene expression
3. Recognize common mutations, their natural repair systems and the natural gene expression regulation systems in prokaryotes and eukaryotes
4. Discuss and distinguish the replication of prokaryotic and eukaryotic DNA
5. Explain the synthesis of RNA and post-transcriptional modifications
6. Comprehend the role of operons and cis/trans elements in gene regulation

Module I CHROMOSOME ORGANIZATION (9)

Chromosome organization in prokaryotes and eukaryotes, Different forms of DNA, Classical experiments : Grifith, Hershey and chase; Avery McLeod & McCarty. Bacterial Recombination: Transformation, Transduction, Sexduction and Conjugation. Lytic and lysogeny.

Module II DNA REPLICATION – PROKARYOTES (4)

DNA replication- Semi conservative replication, Meselson stahl experiment, Enzymes in replication, Replication in prokaryotes, D-loop and rolling circle mode of replication, regulation of replication, replication of linear viral DNA.

Module III DNA REPLICATION – EUKARYOTES AND MUTATIONS (5)

Replication in eukaryotes and telomere replication. Mutation : types, DNA repair - methylation, mismatch, SOS, recombination.

Module IV TRANSCRIPTION (9)

RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, inhibitors, post-transcriptional modification - RNA splicing and RNA editing. Transcription in virus : RNA replicase, Reverse transcriptase.

Module V TRANSLATION (9)

Elucidation of genetic code-salient features, Process of translation in prokaryotes and eukaryotes, Post-translational modifications, Inhibitors.

Module VI REGULATION OF GENE EXPRESSION (9)

Regulation of gene expression: In prokaryotes - lac and trp operons. Regulation in eukaryotes – cis and trans elements, chromatin in gene regulation.

Total Hours: 45

Text book

1. David Friefelder, "Molecular Biology", Narosa Publ. House. 6th edition 2003.

Reference books

1. David R. Hyde, "Genetic and Molecular Biology", Tata McGraw Publications, New Delhi, 4th edition, 2010.
2. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.
3. Gardner, Simmons and Snustad, "Principles of Genetics", John Wiley, 8th edition, 2000.

18BT2015	GENETIC ENGINEERING AND BIOETHICS	L	T	P	C
		3	0	0	3

Course Objective:

1. Helps the student to understand the tools and steps in Genetic engineering.
2. Trains students on the strategy employed in genetic engineering.
3. Helps the student understand the application in genetic engineering and the social implications and the ethics to be followed.

Course Outcome:

The students will be able to

1. Learn the basics of genetic engineering
2. Understand the basic tools employed in genetic engineering.
3. Understand the use of cloning vectors in genetic engineering.
4. Gain knowledge about polymerase chain reaction and its variations and applications.
5. Learn the strategy of gene cloning.
6. Understand the implications of ethical issues pertaining to genetic engineering.

Module I RESTRICTION ENZYMES (9)

Restriction enzymes- Classification-nomenclature; Ligases- Modifying enzymes; Probe preparation and the methods of labeling them; Southern hybridization-Northern hybridization; Western blotting, Autoradiography; DNA finger printing-RFLP Analysis-chromosome walking.

Module II IDEAL VECTORS PLASMIDS (9)

Properties of ideal vectors Plasmids as vectors- PBR322- pUC vectors--M13-Lambda phage vectors ,Cosmid vectors, Phagemids-Cloning vectors in Gram positive bacteria- streptomycetes, Shuttle vectors, Expression vectors, YAC, BAC, Mammlian cells-SV40 & CMV vectors.

Module III POLYMERASE CHAIN REACTION (9)

Mechanism of Polymerase chain reaction, types of PCR, Inverse PCR, Nested PCR, Molecular beacons, RACE PCR, RAPD, RFLP.

Module IV CONSTRUCTION OF RECOMBINANT DNA (9)

Construction of recombinant DNA: Preparation of competent cell-Transformation (Physical, chemical and biological methods of Transformation), transfection- Recombinant selection and screening of Recombinant DNA, Genomic Library, cDNA library.

Module V BIOETHICS (5)

Definitions, history & views on ethics and bioethics. Ethical issues pertaining to biology and biotechnology. Special procedures for r-DNA based product production.

Module VI BIOSAFETY GUIDELINES (4)

Biosafety regulations, r-DNA guidelines- National and international, levels of containment.

Total Hours: 45

Text Books

1. Desmond S. T. Nicholl, "An Introduction to Genetic Engineering", 3rd Edition Cambridge University Press; South Asian edition , 2010.
2. Monika Jain "Recombinant DNA Techniques", Narosa Publishing House, 2012.
3. Barry R. Schaller "Understanding Bioethics and the Law: The Promises and Perils of the Brave New World of Biotechnology" Praeger Publishers Inc, 2007.

Reference Books

1. Sandy B. Primrose, Richard Twyman "Principles of Gene Manipulation and Genomics" Backwell Scientific Publications 2010.
2. Sandhya Mitra, "Genetic Engineering Principles and Practice", Macmillan Publications, 2008.
3. Dubey R. C, "Text book of Biotechnology", S. Chand & Co. Publications, 2006.
4. Richard Sherlock, John D. Morrey "Ethical Issues in Biotechnology" Rowman & Littlefield Publishers, 2002.

18BT2016	MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. The objective of the course the student will learn various basic techniques in molecular biology and genetic engineering.
2. The student will learn how to isolate DNA from various sources.
3. The student will learn to manipulate DNA.

Course Outcome:

The students will be able to

1. The student knows how to isolate DNA from Plant source.
2. The student knows how to isolate DNA from Animal source.
3. The student knows how to isolate DNA from bacterial source.
4. The student knows how to carry out qualitative and quantitative measurements on nucleic acids.
5. The student knows how to manipulate DNA using restriction and ligation techniques.
6. The student knows how to transfer DNA into bacteria by the transformation technique.

List of Experiments

1. Isolation of genomic DNA from plant tissue
2. Isolation of genomic DNA from animal liver
3. Isolation of genomic DNA from microorganism (E-coli)
4. Isolation of plasmid DNA from microorganism
5. Quantitative and qualitative analysis of isolated genomic DNA using spectrophotometer
6. Agarose gel electrophoresis of DNA and analysis of their molecular weights by gel documentation
7. Extraction of proteins from plant or animal tissue and confirmation with qualitative tests
8. Separation and identification of proteins by SDS-PAGE using Coomassie Brilliant Blue stain
9. Restriction enzyme digestion of DNA samples confirmation through agarose gel electrophoresis
10. Ligation of DNA fragments and confirmation through agarose gel electrophoresis
11. Competent bacterial cell preparation
12. Transformation of DNA into competent cells

14BT2017	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. This course aims at making the students understand the fundamental principles and concepts of Bioreactor engineering.
2. This will help the student understand stoichiometric calculations, models of growth and product formation
3. To understand the basics of oxygen transfer in microbial bioreactors

Course Outcome:

The students will be able to

1. Acquire knowledge on principles of stoichiometry and concepts of bioreactor engineering.
2. Assess elemental balance equations and models of growth and product formation.
3. Classify growth kinetics and product formation kinetics using models
4. Devise methods to calculate volumetric mass transfer coefficient and determination methods.
5. Analyze bioreactors for free cell and immobilized cell reactions
6. Discuss parameters to be monitored and controlled in Fermentation processes

Module I STOICHIOMETRY OF CELL GROWTH AND PRODUCT FORMATION(9)

Stoichiometry of cell growth and product formation, elemental balances, degrees of reduction of substrate and biomass, available electron balances, various yield coefficients of biomass and product formation, oxygen consumption and heat evolution in aerobic cultures

Module II SIMPLE UNSTRUCTURED KINETIC MODELS (9)

Simple unstructured kinetic models for microbial growth, Monod model, Substrate uptake kinetics and maintenance coefficient, growth of filamentous organisms, product formation kinetics - Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Determination of kinetic parameters for monod equation.

Module III OXYGEN TRANSFER IN MICROBIAL BIOREACTORS (9)

Oxygen transfer in microbial bioreactors; oxygen uptake rates and determination of oxygen transfer coefficients (k_La) by correlations and experimental methods; Mass transfer in heterogeneous biochemical reaction system, role of aeration and agitation in oxygen transfer and types of aerators and agitators.

Module IV BIOREACTORS FOR FREE AND IMMOBILIZED CELLS (9)

Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift and loop reactor, Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors. Basics of solid state fermentation, various scale- up criteria for bioreactors.

Module V PARAMETERS TO BE MONITORED AND CONTROLLED IN FERMENTATION PROCESSES (5)

Basic configuration of fermenter and ancillaries, main parameters to be monitored and controlled in Fermentation processes- Temperature, pressure, flow measurement, rate of stirring, shaft power, weight, Dissolved Oxygen, pH, inlet and exit gas analysis.

Module VI ANALYZING PROCESS PARAMENTERS (4)

Online data analysis of chemical parameter measurements for biochemical processes.

Total Hours: 45

Text Books

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.

Reference Books

1. Lee, J.M, "Biochemical Engineering", 1st Edition, Prentice Hall, 2001.
2. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997.

18BT2018	ENZYME ENGINEERING AND TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives

1. To learn the significance of enzyme, classification, application
2. To provide knowledge on kinetics based on different models and theories,
3. To learn on extraction and purification of enzymes, and their immobilization.

Course outcome

Upon successful completion of this course, students will be able to

1. Do the Classification and nomenclature of enzymes.
2. Explain applications in food, pharmaceutical and other industries
3. Evaluate kinetic parameters and understand their usage for research.
4. Explain various enzyme immobilization techniques.
5. Explain the steps involved in the extraction and purification of enzymes.
6. To model different inhibition types.

Module I CLASSIFICATION AND NOMENCLATURE (9)

Brief introduction to enzymes, nomenclature and classification of enzymes, mechanisms of enzyme action, specificity of enzyme action, the structure–functionality relationships, concept and determination of enzyme activity, Effect of physical and chemical factors on enzyme activity, applications in food, pharmaceutical and other industries

Module II ENZYME KINETICS AND INHIBITION (9)

Kinetics of enzyme catalysed reactions. Importance and estimation of kinetic constants, Kinetics of bi substrate enzymes, Enzyme inhibition types and models- Competitive, Noncompetitive and un competitive inhibitions. Inhibition kinetics- substrate, product and toxic compound.

Module III EXTRACTION AND PURIFICATION OF ENZYMES (9)

Extraction and purification of enzymes from plant, animal and microbial sources, Extraction of soluble and membrane bound enzymes. Nature of extraction medium. Purification of enzymes. Criteria of purity. Determination of molecular weight of enzymes.

Module IV IMMOBILIZATION OF ENZYMES (9)

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, Encapsulation, cross-linking, covalent binding etc., - examples, advantages and disadvantages of Different immobilization techniques. Design of immobilized enzyme reactors – Packed bed, Fluidized bed and Membrane bioreactors

Module V ENZYME BIOSENSORS (5)

Applications of enzymes in analysis; Design of enzyme electrodes and their working and experimentation.

Module VI APPLICATIONS (4)

Case studies on their Application as biosensors in industry, healthcare and environment.

Total Hours:45

Text Book

1. T Palmer, "Enzymes", Horwood Publishing Series, 2001. 6th edition, 2006

Reference Books

1. Martin Chaplin and Christopher Bucke, "Text book on Enzyme Technology", Cambridge University Press, 4th edition, 2004.
2. Shuler, M.L. and Kargi,F, " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd., 2nd edition, 2002.

18BT2019	HEAT AND MASS TRANSFER	L	T	P	C
		3	1	0	4

Course Objective:

1. To ensure students to having strong fundamental knowledge about heat transfer operations
2. To introduce them to the heat and mass transfer calculations for bioprocess and biochemical industries
3. To understand the industrial application and significance of these equipment in biotechnology

Course Outcome:

At the end of the course the students could be able to

1. Recognize the basic doctrine of heat transmits
2. Recognize and work out conduction effort
3. Recognize and work out convection effort and analyze heat exchangers
4. Solve the problems related to diffusion, leaching and adsorption
5. Estimate the number of stages for Distillation and absorption
6. Propose and analyze the vertical of evaporators

Module-I – CONDUCTION (12)

Introduction - Modes of heat transfer - Thermal conductance and resistance - Temperature field and temperature gradient - mechanism of heat transfer. Conduction - Heat transfer by conduction - General heat conduction equation - Thermal diffusivity and equivalent thermal conductivity -

Linear one-dimensional steady state conduction through plane, cylinders, spheres and composite walls - Heat conduction with internal heat generation - Systems with variable thermal conductivity .

Module-II CONVECTION AND RADIATION (12)

Convection – Types of convection - Individual and overall heat transfer coefficient - Reynolds's analogy - Natural convection – Forced convection , Radiation -Thermal radiation - Spectrum of electromagnetic radiation - Monochromatic Emissive Power of black body - Planck's Distribution Law - Kirchoff's Law - Total Emissive Power, problems on Stefan- Boltzmann's law and Wien's displacement law - Configuration factor determination, typical examples.

Module-III HEAT EXCHANGER AND EVAPORATORS (12)

Heat exchanger-Types of heat exchange equipment and design of heat exchangers-effectiveness of heat exchangers – Logarithmic mean temperature difference –solving problems. Concept of evaporation-types - single effect evaporator -mass and energy balances, capacity, steam economics and effectiveness. Industrial evaporators.

Module –IV DIFFUSION AND INTER PHASE MASS TRANSFER (12)

Diffusion concept – types- mechanism, equimolar and non- equimolar counter diffusion- calculation and measurements, interface theory concept, mass transfer coefficient.

Module-V DISTILLATION AND ABSORPTION (8)

Raoult's law and VLE diagram and methods distillation, methods and types of distillation, calculation of number theoretical plates by McCabe –Thiele methods. Theories of absorption and design.Types of packing and merit and demerits.

Module –VI HEAT TRANSFER APPLICATIONS (4)

Concept of HTU, NTU and total height of column. Industrial application of these equipments.

Total Hours:60

Text Book

1. Holman, J. P., Heat Transfer, 9th Edition, Mc Graw Hill, Singapore, 2002
2. Donald Q. Kern, Process Heat Transfer, Tata McGraw Hill, New Delhi, 1997
3. Heat and mass Transfer solved problems by GK Ray, Tata McGraw Hill, new Delhi.

Reference Book

1. Mccabe, W. L., Smith, J. C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 6th Edition,2004
2. Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003

18BT2020	DOWNSTREAM PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the characteristics of biomolecules and types of cell disruption methods.
2. To study the principles of solid liquid separation processes, isolation of bioproducts
3. To study the principles of purification and polishing of bioproducts.

Course Outcome:

1. Strategies of downstream processing based on characteristics of biomolecules.
2. Various cell disruption techniques for product recovery.
3. Solid liquid separation processes for large scale operations.
4. Techniques of bulk product isolation and purification.
5. To design purification strategy based on product characteristics.
6. To identify finishing operations.

Module I OVERVIEW OF BIOSEPARATIONS (9)

Broad classification of bioproducts, characteristics of fermentation broths and bioproducts. Cell disruption and pretreatment: Analysis of various physical, chemical, enzymatic and mechanical methods for release of intracellular products, Flocculation: electrical double layer concept, mechanisms of charge dependent flocculation.

Module II PRODUCT RECOVERY (9)

Gravity sedimentation: Mechanisms of sedimentation, thickeners, classifiers, applications in downstream processing. Centrifugal bioseparations: Theory of centrifugal settling- basic equations, centrifuge selection-RCF, scale up of centrifuges- sigma analysis, equivalent time.

Filtration: Equipments for conventional filtration- filter media, pretreatment methods, general filtration theory- Darcy's law, compressible and incompressible filter cakes, filtration cycle, scale up and design of filtration.

Module III ISOLATION OF BIOPRODUCT (9)

Adsorption, Extraction, aqueous two phase extraction, Precipitation, Membrane separation processes: reverse osmosis, dialysis, electrodialysis, pervaporation.

Module IV PURIFICATION (9)

Chromatographic separations: Classification of techniques, elution chromatography- retention theory -Gas and liquid chromatography- Ion exchange chromatography, gel permeation chromatography, affinity chromatography

Module V FINISHING OPERATION (5)

Product crystallization: Basic principles- nucleation and crystal growth- supersaturation theory- commercial crystallizers- Recrystallization.

Module VI HEAT AND MASS TRANSFER IN DRYERS (4)

Product drying: Heat and mass transfer in drying- types of commercial dryers- vacuum dryers, freeze dryers, spray dryers. Lyophilization

Total Hours:45

Text Books

1. Paul A Belter, EL Cussler, Wei-shou Hu, Bioseparations: Downstream Processing for Biotechnology - Wiley Interscience, 1988.
2. Sivasankar B, Bioseparations: Principles and Techniques, Prentice-Hall of India Pvt. Ltd., 2008.

Reference Books

1. Roger g. Harrision; paul w. Todd; scott r. Rudge, "bioseparations science and engineering" oxford university press, 2015
2. Don w. Green; nooralabettu krishna prasad "downstream process technology : a new horizon in biotechnology" phi learning private limited, 2010
3. Richardson j.f.;harker j.h.;backhurst j.r. "coulson and richardsons chemical engineering volume 2 : particle technology and separation processes" butterworth-heinemann, 2006
4. Christie john geankoplis "transport processes and separation process principles : includes unit operations" prentice hall of india private limited, 2006

18BT2021	DOWNSTREAM PROCESSING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To strengthen principles of the unit operations involved in the separation and purification of a biological product
2. To learn on cell disruption techniques, solid liquid separation
3. To learn about product isolation, purification and polishing

Course Outcome

After successful completion of the course, the students would have learnt

1. Strategies of downstream processing based on characteristics of biomolecules.
2. Cell disruption techniques for intracellular product recovery.
3. Separate microbial cells from aqueous suspensions

4. Techniques of bulk product isolation and purification.
5. To design purification strategy based on product characteristics.
6. To identify finishing operations.

List of Experiments

1. Batch Sedimentation
2. Flocculation
3. Cell disruption by homogenizer
4. Isoelectric precipitation
5. Salting out
6. Solvent Extraction
7. Aqueous two phase extraction
8. Leaching
9. Drying
10. Column Chromatography
11. Adsorption
12. Distillation

Text Books

1. Paul A Belter, EL Cussler, Wei-shou Hu, Bioseparations: Downstream Processing for Biotechnology - Wiley Interscience, 1988.
2. Sivasankar B, Bioseparations: Principles and Techniques, Prentice-Hall of India Pvt. Ltd., 2008.

Reference Books

1. Roger g. Harrision; paul w. Todd; scott r. Rudge, "bioseparations science and engineering" oxford university press, 2015
2. Don w. Green; nooralabettu krishna prasad "downstream process technology : a new horizon in biotechnology" phi learning private limited, 2010
3. Richardson j.f.;harker j.h.;backhurst j.r. "coulson and richardsons chemical engineering volume 2 : particle technology and separation processes" butterworth-heinemann, 2006

18BT2022	IMMUNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. This course aims to impart basic knowledge in Immunology,
2. To help the students familiarize with the organs and cells of the immune system, the immune response and molecular interactions involved in immune response.
3. To make the students aware of the applications of immunology such as, immunodiagonosis and immunotherapy.

Course Outcome:

1. Student learns the history and development of the field of immunology.
2. Student understands the types of immunity, the basic plan of the immune of the immune system and the organs of the immune system.
3. The students learn about the cells of the immune system and their functions.
4. Students understand the humoral immune system
5. Students understand the physiology and the pathology of the immune system.
6. Students aware of the applications of immunology in diagnosis and treatment of diseases.

Module I IMMUNE SYSTEM (9)

Introduction and an overview of immunology, History of immunology, Types of Immunity - Innate and acquired immunity, Cell mediated and humoral immunity; Organs of the immune system: Lymphoid organs - primary and secondary.

Module II IMMUNE RESPONSE (9)

Granulocytes and Agranulocytes, haematopoiesis, extravasation, phagocytosis. T and B Lymphocytes & NK cells. Major histocompatibility complex; antigen processing and presentation, T-Cell activation and the cellular immune response.

Module III ANTIGEN ANTIBODY REACTIONS (9)

Antigens- chemical and their molecular nature; Haptens; Adjuvants. Antibody – structure, Classes, Genes and Antibody diversity. Antigen Antibody reactions; Neutralization, Opsonization. Complement, Cytokines. Vaccines.

Module IV IMMUNE RESPONSES (4)

Injury and inflammation; immune responses to infections: immunity to bacteria, and virus; Transplantation: laws, consequences and genetics of transplantation,

Module IV CANCER IMMUNOLOGY AND AIDS (5)

Cancer immunology – Tumour Associated Antigens and Tumour Specific Antigens; Autoimmunity; Autoimmune disorders, Allergy and hypersensitivity, Tolerance, Immunosuppression and AIDS.

Module V IMMUNOTECHNOLOGY (9)

Diagnostics; immunodiffusion, Haemagglutination, RIA, ELISA, Western Blotting, Immunofluorescence Assay, Immunohistochemistry. Therapeutics and prophylactics; Abzymes, Monoclonal Antibody production, Chimeric & humanized antibodies. Vaccines.

Total Hours:45

Text Book

1. Roitt I, Male, Brostoff, "Immunology", Mosby Publishers, 2002.

Reference Books

1. Tizard, "Immunology", Saunders college publication, 5th Edition. 2004.
2. Kuby J, "Immunology", WH Freeman & Co., 2000.
3. Ashim K. Chakravarthy, "Immunology", TataMcGraw-Hill, 2001

18BT2023	CELL BIOLOGY AND IMMUNOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To acquaint the students with basic laboratory techniques involved in cell
2. This course aims to impart basic knowledge in Immunology,
3. To make the students aware of the applications of immunology such as, immunodiagonosis and immunotherapy

Course Outcome:

1. Student understands the types of immunity, the basic plan of the immune of the immune system and the organs of the immune system.
2. The students learn about the cells of the immune system and their functions.
3. Students understand the humoral immune system
4. Students understand the physiology and the pathology of the immune system.
5. Students aware of the applications of immunology in diagnosis and treatment of diseases.

List of Experiments

1. Study of Microscopy
2. Microscopically Identification of Cells in Permanent Fixed Slides
3. Staining for Various Stages of Mitosis in Allium cepa (Onion)
4. Osmosis and Tonicity Studies Using Red Blood Corpuscles
5. Differentiation of Blood Cells Using Giemsa Staining
6. Separation of Peripheral Blood Mononuclear Cells and Trypan Blue Assay for Live Cell
7. Blood Grouping and Rh typing
8. Preparation of Plasma and Serum
9. Single Radial Immunodiffusion
10. Double Immunodiffusion – Ouchterlony Method
11. Immunoelectrophoresis

12. Counter Current Immunoelectrophoresis

18BT2024	CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	1	0	4

Course Objectives

1. To provide knowledge on estimation of kinetic parameter
2. To derive design equations for various reactors.
3. To make the students aware of Non-ideal reactors

Course Outcomes:

The students will be able to

1. Describe the kinetics of reactions
2. Design equations to determine the performance of ideal reactors
3. Create various models for describing non- ideal behavior of reactors
4. Analyze performance of combined reactors
5. Explain adsorption and desorption phenomena in heterogeneous systems.
6. Create design of various fermentor / bioreactors

Module I HOMOGENEOUS REACTIONS (12)

Principles of Homogeneous reactions – and rate equations-estimation of rate constants using constant volume and constant pressure Batch reactor-data for typical reactions – Arrherius equation-Non elementary reaction kinetics-Multiple reactions-yield Concepts.

Module II PERFORMANCE OF BIOREACTORS (12)

Performance equations for single batch reactor, ideal CSTR, ideal PFR-Application to design.

Module III MULTIPLE REACTOR SYSTEMS (12)

Multiple reactor systems – selection of suitable reactor systems for multiple reactions-recycle reactor-Principles in non isothermal reaction and reactors.

Module IV NON IDEAL REACTORS (12)

Non Ideal reactors- Non Ideal Flow-Tracer experiments and application-TIS model, Axial Dispersion model-for tubular reactors. Exchange volume and By Pass and dead volume models for CSTRS.

Module V GAS-LIQUID REACTIONS (8)

Gas-Liquid Reactions-kinetics-G-L reactor design Principles-Principle of Catalysis-types of catalytic reactors.

Module VI CATALYTIC REACTIONS (4)

Concept of effectiveness factor in Catalytic reactions-G-L-S-reactors – slurry reactor.

Total Hours: 60

Text Books

1. Levenspiel, Octave "Chemical Reaction Engineering", 3rd Edition, John – WileySons, 2002.
2. Fogler, H.S. "Elements of Chemical Reaction Engineering", 2nd Edition, Prentice Hall, 2002.

Reference Books

1. Missen, R.W. etal., "Chemical Reaction Engineering and Kinetics", John – Wiley, 1999.
2. Davis, Mark E and Robert J. Davis "Fundamentals of Chemical Reaction Engineering" McGraw – Hill, 2005.
3. Harri ot, Peter "Chemical Reactor Design" Marcel Dekker, 2003.
4. Sila, Harry "Chemical Process Engineering : Design and Economics" Marcel Dekker, 2003
5. Nauman, E. Bruce "Chemical Reactor Design, Optimization, and Scaleup", McGraw – Hill, 2002.
6. Richardson, J.E. and D.G. Peacock "Coul son & Richardson' s Chemical Engineering", Vol.3 (Chemical & Biochemical Reactors & Process control) 3rd Edition, Butterworth Heinemann/ Elsevier, 2006.

18BT2025	MASS TRANSFER AND CHEMICAL REACTION ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To learn chemical engineering principles
2. To provide knowledge on practical applications in the areas of mass transfer
3. To provide knowledge on reaction engineering and particle mechanics.

Course Outcome:

1. Ability to plan experiments and present the experimental data meaningfully
2. Ability to apply theoretical concepts for data analysis and interpretation
3. Capability to visualize and understand chemical engineering unit operations related to fluid and particle mechanics
4. Understand the experimental techniques related to chemical reaction engineering
5. Understand the basic laws of mass transfer.
6. Learn to operate various reactors

List of Experiments

1. Batch reactor
2. Semi batch reactor
3. Continuous stirred tank reactor
4. Plug flow reactor
5. Tank in series
6. Residence time distribution
7. Simple distillation
8. Single effect evaporator
9. Absorption column
10. Extraction

18BT2026	BIOCHEMICAL THERMODYNAMICS	L	T	P	C
		3	1	0	4

Course Objective:

1. To have strong foundation on the thermodynamic laws and concepts relevant to biochemical process.
2. To understand fundamental concepts such as enthalpy, entropy, fugacity, free energy, and chemical potential in biological system
3. To introduce behavior of pure fluid, partial molar properties

Course Outcome:

1. Use fundamentals of biochemical thermodynamics to evaluate real world biological systems.
2. Apply the concept of entropy to assess reversibility or feasibility of biochemical process
3. Demonstrate role biochemical thermodynamics in the reactor designs, vapor-liquid equilibrium and industrial applications
4. Apply fundamentals to assess biochemical reaction equilibrium and its dependency on pressure and temperature
5. Students will be able to analyze energetic problems in biochemical reaction
6. Solve problems dealing with multi-phase biochemical systems.

Module – I: BASIC CONCEPTS & LAWS OF THERMODYNAMICS (12)

System, Surrounding & Processes, Closed and Open systems, State Properties, Intensive & Extensive Properties, State and Path functions, work, enthalpy, internal energy, specific heat, First law for Cyclic Process, Energy Balance for Closed Systems, open systems, Steady flow or non-flow energy equations, Heat reservoir and Heat engines, Heat pump, Carnot cycle, The Reversible Process, General statements of

the second law, Concept of entropy, Calculation of entropy changes, Clausius inequality, Entropy and Irreversibility.

Module II: PVT BEHAVIOR AND THERMODYNAMIC EQUILIBRIUM (12)

PVT behavior of pure fluids, equations of state and ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure constant temperature, adiabatic and polytrophic processes. Equations of state for real gases: Van-der Waals equation, virial equation. Coupled reactions and energy rise compounds, reaction stoichiometry, standard heat of reaction, heat of combustion, Hess's Law of Constant Heat Summation, criteria of biochemical Reaction equilibrium, equilibrium constant and standard free energy change, effect of Temperature, pressure on equilibrium constants.

Module III: THERMODYNAMIC FUNCTIONS (12)

Energy properties, Derived properties, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy heat capacity relations, Gibbs- Helmholtz equation, Thermodynamic square, Joule-Thomson expansion.

Module IV: THERMODYNAMICS IN BIOCHEMICAL REACTIONS (12)

Thermodynamic energy function to standard state, Molar enthalpy of formation, Entropy change and Gibbs Energy change in chemical reaction. Fugacity: Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, Fugacity of solids and liquids, Activity: Effect of temperature and pressure on activity. Departure functions and generalized charts, thermodynamic diagrams – types of diagrams and construction of thermodynamic diagrams. Partial molar properties - Partial molar properties of solutions, determination of partial molar properties, chemical potential – effect of temperature and pressure, Gibbs-Duhem equation.

Module V: PHASE EQUILIBRIUM IN SOLUTION (6)

Criteria of phase equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibria, VLE in ideal solutions, Non-Ideal solutions - azeotropes, VLE at low pressures – activity co –efficient equation, bubble point and dew point equilibria, Liquid-Liquid Equilibrium diagrams – binary liquid Equilibrium diagrams.

Module –VI CHEMICAL EQUILIBRIUM REACTIONS(6)

Introduction to Chemical Reaction Equilibrium, Equilibrium criteria for homogeneous chemical reactions; Evaluation of equilibrium constant and effect of pressure and temperature on equilibrium constant; Calculation of equilibrium conversions and yields for single and multiple chemical reactions.

Total Hours: 60

Text Books

1. Introduction to Chemical Engineering thermodynamics - Joseph Mauk Smith, Hendrick C. Van Ness, Michael M. Abbott, McGraw-Hill, 2005
2. Thermodynamics of Biochemical Reactions - Robert A. Alberty, Wiley Inderscience, 2003.

References Books

1. Chemical And Engineering Thermodynamics, Stanley I Sandler, 4th Ed., John Wiley & Sons, Inc. 2006.
2. Chemical Engineering Thermodynamics By Y.V.C. Rao, New Age International.
3. Biological Thermodynamics, Donald T. Haynie, Cambridge University Press.

18BT2027	BASICS OF BIOINFORMATICS	L	T	P	C
		2	0	0	2

Course Objective:

1. To learn and understand specific databases and perform effective database searches.
2. To learn and perform various Insilco analysis for gene and protein structure and function identification
3. To learn and perform target identification for drug-designing and to have a platform for interchange and exchange of knowledge with academia and industry.

Course Outcome:

1. Acquire knowledge on structure, properties and biological functions of carbohydrates, lipids and proteins which help them to understand the significance of biomolecules in bioprocesses and biotechnology
2. Apply the knowledge of science and technology to solve the biological problems related to biosciences.
3. Design the solution for biological knowledge based problems and design process the specified needs to solve human problems
4. Help them to analyze biomolecules using appropriate techniques, software resources and modern engineering tools.
5. Understand and exhibit the knowledge vital role for new drug design by various methodologies to save the human health
6. Recognize the need for indeipetend and lifelong learning experience in bimolecular analysis and application

Module I: INTRODUCTION TO BIOINFORMATICS (6)

Definition - Importance and uses of Bioinformatics- Information Technology- Systems Biology, Scope of Bioinformatics. Elementary Commands and Protocols, ftp, telnet, various file formats for biological sequences

Module II: BIOLOGICAL DATABASES (6)

Introduction to Biological databases, organization and management of databases, searching and retrieval of information from World Wide Web. -Primary sequence databases Composite sequence databases- Secondary databases- nucleic acid sequence databases - Protein sequence data bases.

Module III: SEQUENCING ALIGNMENT AND DYNAMIC PROGRAMMING (6)

Alignment-Local, Global alignment, pairwise and multiple sequence alignments. Concept of gap penalty and e-value. Alignment algorithms. Dynamic programming in sequence alignment: Needleman-Wunsch Algorithm and Smith Waterman Algorithm, Aminoacid Substitution matrices (PAM, BLOSUM).Sequence similarity search with database: BLAST and FASTA

Module IV: COMPUTATIONAL GENOMICS AND PROTEOMICS (6)

Large-scale genome sequencing strategies; Comparative genomics; Understanding DNA microarrays and protein arrays, Gene and protein prediction strategies, phylogenetic analysis, primer design, sequence submission, Automated Genome Comparison and its Implication, Automated Gene Prediction, Gene Signaling Pathways and Pathway Regulation

Module V: MOLECULAR MODELING AND DRUG DISCOVERY (3)

Basic concepts of Homology, threading, abinition protein structural modeling, Molecular simulation,

Module VI: DRUG DISCOVERY (3)

Virtual ligands library preparation, target identification and validation, optimization of ligand, docking studies, Industrial application of CADD.

Total Hours: 30

Text Books

1. T K Attwood, D J parry-Smith," Introduction to Bioinformatics", Pearson Education, 1st Edition, 11th Reprint 2005
2. Gusfields G, "Algorithms on strings, trees and sequences- Computer Science and Computational Biology", Cambridge University Press, 1997.

References Books

1. S.C. Rastogi & others, "Bioinformatics- Concepts, Skills, and Applications", CBS Publishing, 2003.
2. David W.Mount "Bioinformatics sequence and genome analysis", Cold spring harbor laboratory press, 2004.
3. Neil C. Jones and Pavel A. Pevzner, "An Introduction to Bioinformatics Algorithms", MIT Press, First Indian Reprint 2005.

18BT2028	BIOINFORMATICS LAB	L	T	P	C
		0	0	1	1

Co-requisite: 14BT2027-Basics of Bioinformatics

Course Objective:

1. To understand the basic methods for sequence retrieving and analysis.
2. To develop the skills in developing knowledge of sequence analysis.
3. To develop the skills of recognition of biomolecule for various application

Course Outcome:

1. Apply the knowledge of internet source to use of biological science
2. Formulate an analytical skill to understand the mathematical principle to solve biological principles.
3. Acquire knowledge in estimation of different biomolecule and their function
4. Characterize the molecular components in biomolecules.
5. Apply the mathematical algorithms to predict function characteristic biomolecule prediction
6. Apply basic knowledge on the properties of biomolecules for important functional modification.

List of experiments:

1. Biological Databases with Reference to Expasy and NCBI
2. Queries based on Biological databases
3. Sequence similarity searching using BLAST
4. Pairwise sequence alignment
5. Multiple Sequence and Phylogenetic Analysis
6. Gene Prediction
7. Protein Familes –SCOP,Pfam and CATH
8. Secondary Structure prediction
9. Tertiary Structure Predicition
10. Analysing the geometry of protein and visuavalize the protein using protein databank and swiss-pdb viewer.
11. Homology Modeling Using Modeller Protein
12. Ligand docking using Glide protocol

18BT2029	INDUSTRIAL SAFETY AND HAZARD ANALYSIS	L	T	P	C
		3	0	0	3

Course Objective:

1. Students learn about implementation of safety procedures
2. To understand the risk analysis and assessment
3. To learn and understand hazard identification

Course Outcome:

The students will be able to

1. Demonstrate the awareness of plant safety in selection and layout of chemical plants and the usage of safety codes.
2. Exhibit the skill in classifying chemical, fire, explosion hazards
3. Understand the occupational diseases
4. Analyze the bio medical and engineering response to health hazards
5. Implement the effective process control and instrumentation
6. Create awareness the usage of safety codes

Module I NEED FOR SAFETY (9)

Need for safety in industries; Safety Programmes – components and realization; Potential hazards – extreme operating conditions, toxic chemicals; safe handling

Module II SAFETY PROCEDURES (9)
Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety
Module III PLANNING AND RISK ASSESSMENT (4)
Over all risk analysis-emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies.
Module IV QUANTITATIVE RISK ASSESSMENT (5)
Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.
Module IV SAFETY AUDITS (9)
Hazard identification safety audits, checklist, what if analysis, vulnerability models event tree analysis fault tree analysis, Hazan past accident analysis Fixborough-Mexico-Madras-Vizag Bopal analysis
Module V CASE STUDIES (9)
Hazop-guide words, parameters, derivation-causes-consequences-recommendation-coarse Hazop study-case studies-pumping system-reactor-mass transfer system.

Total Hours: 45

Text Books
1. Chemical Process Safety: Fundamentals with Applications, Daniel A. Crowl, J.F. Louvar, Prantice Hall, NJ, 1990.
2. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.

References
1. Handley, W., "Industrial Safety Hand Book ", 2nd Edn., McGraw-Hill Book Company, 1969.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., " Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Taylor, J.R., Risk analysis for process plant, pipelines and transport, Chapman and Hall, London, 1994.

18BT2030	ENVIRONMENTAL POLLUTION CONTROL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:
1. To give an exposure to various control acts
2. To study the advantages and disadvantages of impact assessment methods
3. To study the methods of reducing the waste and reusing it.

Course Outcome:
The students will be able to
1. Gain basic knowledge on pollution, its types
2. Outline Pollution control acts and regulations.
3. Employ collected raw data on pollution caused by industries.
4. Evaluate audit reports on pollution is finally controlled.
5. Create various approaches for material reuse
6. Integrate various recycling methods

Module I: WATER POLLUTION CONTROL (9)
The water (prevention and control of pollution) act 1974 and rules 1975- CPCB-form XIII,XIV,XV,The air (prevention and control of pollution) act 1981 and rules 1982,CPCB-form I,VI. National ambient air quality standards.
Module II: ENVIRONMENT PROTECTION ACT (9)
The environment (protection) act 1986, rules 1986-definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous, standards of emission or discharge of environmental pollutants. Form V

Module III: ENVIRONMENTAL IMPACT ASSESSMENT (9)

Environmental impact assessment notification, 2006-environmental clearance, list of projects, form I, general structure of EIA documents, content of summary EIA

Module IV: BIOSAFETY (9)

The manufacture, use, import, export and storage of hazardous microorganisms genetically engineered organisms or cells rules, 1989-definitions, competent authorities, animal and human pathogens

Module V: BIOMEDICAL WASTE DISPOSAL (4)

Biomedical waste (management and handling) 1998,-categories of biomedical waste, colour coding and type of container for disposal of biomedical wastes.

Module VI: TRANSFER WASTE EQUIPMENT DISPOSAL (5)

Transport of biomedical waste containers/bags (schedule IV), standards for treatment and disposal of biomedical wastes (schedule V),waste management facilities like incinerator/autoclave/microwave system, form-I,II,III.

Total Hours: 45

Text book:

1. C. S. Rao Environmental Pollution Control Engineering, New Age International, 2007

Reference Books

1. Peter Wathern, "Environmental Impact Assessment theory and practice", Unwin Hyman Ltd. Routledge, 1990,
2. L. Lee Harrison , "Environmental Health and Safety Auditing Handbook", 2nd edition, McGraw Hill, Inc., New York, 1995
3. Kirkwood, R. C. and Longley, A. J., "Clean Technology and Environment", Chapman Hall, 1995.

18BT2031	PROCESS EQUIPMENT DESIGN & ECONOMICS	L	T	P	C
		3	0	0	3

Course Objective:

1. To design safe and dependable processing facilities.
2. This course focus on plant layout and design of piping systems
3. This will provide the basic knowledge to carryout design process cost effectively.

Course Outcome:

The students will be able to

1. Utilize principles of process equipment design, the mechanical aspects of the design
2. Design various unit operation equipments, including safety considerations
3. Develop flow measurement devices
4. Design safe and dependable processing facilities
5. Describe the Scale up criteria of bioreactors
6. Analyze the plant layout.

Module I STANDARD CODES (9)

Design of the equipments as per ASME, ISI codes, drawing according to scale

Module II HEAT EXCHANGERS (9)

Shell and tube heat exchanger , double pipe heat exchanger , Single effect evaporator and vertical tube evaporation

Module III DISTILLATION COLUMNS (9)

Design & Construction details and assembly drawing of distillation column; absorption Towers

Module IV FLOW MEASURING DEVICES (9)

Design of flow measurements -their material of construction.

Module V ECONOMICS (4)

Economics, cost estimation.

Module VI APPLICATIONS (5)

The use of equipments designed for biotechnology industry for different purposes: Reactors,

Airlift, Fluidized Bed , Packed bed reactor.

Total Hours: 45

Text Books

1. Joshi, M.V, "Process Equipment Design", MacMillan, 3rd edition, 2004.

Reference Books

1. Brownbell I.E., Young E.H.. "Chemical Plant Design" 1985.
2. Kern D.Q. "Heat Transfer". McGraw Hill, 1985.
3. McCabe, W.L., J.C. Smith and P. Harriott "Unit Operations of Chemical Engineering", 6th edition, McGraw-Hill, 2001.
4. Wnell, L.E, & Young, E.H.: Process Equipment Design, Wiley Eastern, New Delhi, 2000.
5. Ludwig, E.E.: Applied Process Design for Chemical & Petrochemical Plants, Vols. I, II & III, (2nd Ed.), Gulf Publishing Company, Texas, 1977, 1979, 1983.
6. Perry, R.H. & Green, D.W.: Perry's Chemical Engineers' Handbook, (7th Ed.),McGraw Hill (ISE), 2000.

18BT2032	PROCESS DYNAMICS & CONTROL	L	T	P	C
		3	0	0	3

Course Objective

1. To control and measure the processing facilities in a cost effective manner.
2. To focus on plant layout control and piping systems
3. To provide in-depth knowledge on control systems

Course Outcomes:

The students will be able to

1. Analyze open-loop systems
2. Analyze and apply the knowledge of linear closed loop systems
3. Develop working knowledge of control system by frequency response
4. Analyze Frequency response and apply it to advanced control systems
5. Develop working and design knowledge of Digital controllers
6. Compare different control modes for dstillation and heat exchanger.

Module-I OPEN LOOP SYSTEMS (9)

Laplace Transforms - Standard functions, Open loop systems, first order systems and their transient response for standard input functions, first order systems in series, linearization and its application in process control, second order systems and their dynamics

Module –II CLOSED LOOP SYSTEMS (9)

Closed loop control systems, development of block diagram for feed-back control systems, servo and regulatory problems, transfer function for controllers and final control element

Module-III FREQUENCY RESPONSE (9)

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram

Module –IV ADVANCED CONTROL SYSTEMS (9)

Introduction to advanced control systems, cascade control, feed forward control, model predictive control, control of distillation Column and heat exchanger

Module –V DIGITAL CONTROLLERS (5)

Introduction to Computer control loops, Digital computer, computer process Interface.

Module –VI DIGITAL CONVERTERS (4)

Digital to analog and analog to digital converters, sampling continuous signal.

Total Hours: 45

Text Books

1. Coughnowr, D. R., Process Systems Analysis and Control, Mc Graw Hill, New York, 2nd Edition,1991.
2. George Stephanopolous, Chemical Process Control, Prentice-Hall of India Pvt-Ltd., New Delhi, 1990.

Reference Books

1. Doeblin Er n e s t , Measurement Systems, Mc Graw Hill, New York , 2005
2. A.Suryanarayanan, "Chemical instrumentation and process control", Khanna Publishers, 2nd edition, New Delhi , 1995
3. George Stephanopolous, Chemical Process Control, Prentice-Hall of India Pvt-Ltd., New Delhi, 1990.

18BT2033	MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3

Course Objective:

1. To ensure students to having strong fundamental knowledge about various unit operations
2. To introduce them to the Characterize particles and perform size reduction and size analysis of particles
3. To understand the industrial application and significance of these equipment in biotechnology

Course outcome:

At the end of the course the students would be able to

1. Characterize particles and perform size reduction and size analysis of particles
2. Identify conveyors & storage vessels for particular applications
3. Explain the principle, construction and operation of various classification equipments
4. Apply the principles of agitation and mixing
5. Evaluate the parameters of filtration
6. Compare different separation process

Module- I SIZE REDUCTION AND SOLID PARTICLES (13)

Introduction to unit operations and their role in bio chemical Engineering industries - Characteristics of particulate solids - Sampling techniques - Specifications - Screen analysis - Particle size distribution, particle size measurement - Surface area measurements - Relevant equations and problems. Principles of size reduction - Specific properties of solids for size reduction - Energy required for size reduction - Crushing and grinding efficiency - Laws of crushing - Classification of crushing and grinding equipment , Scope and applications - Size enlargement techniques

Module –II TRANSPORTATION AND CONVEYING (9)

Conveying of bulk solids: Classification of conveyors - Selection of conveyors - Storage of solids in bulk protected and unprotected piles - Bins - Silos - Hoppers - Mass flow and funnel flow bins - Flow assisting devices - Feeders - Weighing of bulk solids - Batch and continuous weighing techniques

Module –III CLASSIFICATION OF SOLID PARTICLES (9)

Classification of separation methods for different type of mixtures like solid-solid, solid-gas - solid-liquid - Screening - Classification of screening equipments - Mechanical classification and classifiers - Rare and dense medium separation - Magnetic separation - Electrostatic separation - Floatation and Elutriation - Phase separation - Centrifugal separation - Electrostatic precipitators - Impingement separators - Gas solids separation - Gravity settling - Cyclone separators - Bag filters scrubbers.

Module-IV MIXING BLENDING (5)

Mixing of solids, solid- liquid mixing, blending, kneading , impeller -Design of agitator- power of agitation - Correlations for power consumption

Module-V FILTRATION (4)

Filtration - Batch and continuous filtration, compressible and incompressible filter cakes.

Module –VI FILTRATION DEVICES (5)

Calculations for specific cake resistance, filter medium resistance - Industrial filters - Centrifugal filtration

Total Hours: 45

Text Books

1. Mccabe, W. L., Smith, J. C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 6th Edition, 2004
2. Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003

Reference Books

1. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson and Richardson's Chemical Engineering, Volume I, Butterworth Heinemann, Oxford, 5th Edition, 2002
2. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson and Richardson's Chemical Engineering, Volume II, Butterworth Heinemann, Oxford, 5th Edition, 2002

18BT2034	MECHANICAL OPERATIONS LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To ensure students to having strong fundamental knowledge about various unit operations
2. To introduce them to the Characterize particles and perform size reduction and size analysis of particles
3. To understand the industrial application and significance of these equipment in biotechnology

Course Outcome:

At the end of the course the students would be able to

1. Characterize particles and perform size analysis
2. Evaluate the power consumption for Particle size reduction and size enlargement.
3. Evaluate the constants for crushing
4. Design and operate filtration equipments
5. Analyze Solid liquid separation in industrial equipment based on settling, density and centrifugal force.
6. Evaluation of filtration effect medium and cake resistance.

List of experiments

1. Studies in an agitated vessel
2. Drag studies
3. Particle size distribution
4. Screening Efficiency
5. Determination of specific surface area by air elutriation
6. Determination of area of a thickener by batch sedimentation test
7. Size reduction using Jaw Crusher and Verification of crushing laws
8. Size reduction using Ball Mill and determination of specific surface area
9. Drop weight crushing and verification of crushing laws
10. Determination of specific cake resistance and filter medium resistance for leaf filtration
11. Determination of specific cake resistance and filter medium resistance for rotary vacuum filtration
12. Determination of specific cake resistance and filter medium resistance for filtration in a plate and frame filter press.

Text Books

1. Mccabe, W. L., Smith, J. C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw Hill, New York, 6th Edition, 2004.
2. Geankoplis, C. J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003.

Reference Books

1. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson and Richardson's Chemical Engineering, Volume I, Butterworth Heinemann, Oxford, 5th Edition, 2002
2. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., Coulson and Richardson's Chemical Engineering, Volume II, Butterworth Heinemann, Oxford, 5th Edition, 2002

18BT2035	BIOCHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. To provide the idea to determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
2. To provide knowledge regarding cell growth patterns and design of various bioreactors.
3. To study the enzyme kinetics and inhibition models

Course Outcome:

The students will be able to

1. Classify chemical and biochemical processes
2. Acquire knowledge on growth kinetics and growth inhibitor models
3. Examine various enzyme kinetics and enzyme inhibition models
4. Assess the role of aeration and agitation in fermenter design
5. Design batch and continuous sterilization Process
6. Develop various novel bioreactors

Module I CHEMICAL AND BIOCHEMICAL PROCESSES (6)

Comparison of chemical and biochemical processes, industrially important microbial strains, preservation and storage of industrially important microbes, Quality control of preserved stock cultures

Module II ENZYME KINETICS (9)

Kinetics of single substrate reactions without inhibition- Michelis – Menten parameters, Estimation of MM parameters, Enzyme Inhibition – Substrate, Product and Toxic compound inhibition, types and derivation.

Module III UNSTRUCTURED KINETIC MODELS FOR GROWTH (12)

Simple unstructured kinetic models for microbial growth, Monod model, Substrate uptake kinetics and maintenance coefficient, growth of filamentous organisms, product formation kinetics - Leudeking-Piret models, substrate and product inhibition on cell growth and product formation. Determination of kinetic parameters for monod equation

Module IV OXYGEN TRANSFER IN MICROBIAL BIOREACTORS (9)

Oxygen transfer in microbial bioreactors; oxygen uptake rates and determination of oxygen transfer coefficients (k_La) by correlations and experimental methods; Mass transfer in heterogeneous biochemical reaction system, role of aeration and agitation in oxygen transfer and types of aerators and agitators.

Module V BIOREACTORS FOR FREE AND IMMOBILIZED CELLS (5)

Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift and loop reactor,

Module VI BIOREACTOR EQUIPMENT (4)

Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors.

Total Hours: 45

Text books

1. Shuler M.L and Kargi F, "Bioprocess Engineering Basic Concepts" Prentice Hall of India 4th edition, 2002.

Reference books

1. Lee, J.M, "Biochemical Engineering", Prentice Hall, 2nd Edition, 2001.
2. Blanch, H.W and Clark, D.S, "Biochemical engineering", Marcel Dekker, 1997.

18BT2036	BIOCHEMICAL ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

1. To provide the idea to determine the rates of enzyme catalyzed reactions and to provide knowledge on the immobilization of enzymes.
2. To provide knowledge regarding cell growth pattern and bioreactors.
3. To study the enzyme kinetics and inhibition models

Course Outcome:

The students will be able to

1. Classify chemical and biochemical processes
2. Acquire knowledge on growth kinetics models
3. Examine various enzyme kinetics and enzyme inhibition models
4. Assess the rate constant and Darcy's friction factor for pipeline and helical coil
5. Design batch and continuous sterilization Process
6. Develop various novel bioreactors

List of Experiments:

1. Production of citric acid
2. Comparative study between Free & Immobilized Enzyme
3. Determine the enzyme specificity using α-Amylase
4. Growth kinetics of Baker's Yeast
5. Determination of MM Parameters
6. Batch Reactor –I [Equimolar Concentration]
7. Batch Reactor – II [Non – Equimolar Concentration]
8. Semi batch Reactor
9. Mixed Flow Reactor
10. Determine the rate constant for second order reaction using Batch reactor
11. Darcy's Friction factor for straight pipe line & helical coil.
12. Determine the Thermal conductivity of Composite wall

18BT2037	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To educate students the complexity and regulatory networks involved in cancer development process
2. To learn the mechanism involved at cellular and molecular level so as to develop new strategies of therapy.
3. To understand the current strategies of cancer detection, prevention and treatment.

Course Outcome:

Upon completion of the course, the students will be able to

1. Understand the epidemiology of carcinogenesis
2. Know different forms of cancer and the principles of their development
3. Understand the complex pathways and molecular switches involved in the transformation of a normal cell to a cancer cell.

4. Understand the regulatory imbalance between cell growth and programmed death
5. Recognize the molecular mechanism of cancer spread and its clinical implications.
6. Summarize the importance of understanding the biology of cancer, the current strategies of cancer diagnosis, prevention and treatment.

Module I: FUNDAMENTALS OF CANCER BIOLOGY (9)

Epidemiology of cancer: Environmental factors, Viruses, Life style habits - dietary factors, Mutations and DNA repair; Regulation of cell cycle , Modulation of cell cycle in cancer- pRb, p53; Forms and hallmarks of cancers.

Module II: PRINCIPLES OF CARCINOGENESIS (9)

Theory of carcinogenesis- Chemical carcinogenesis, Physical carcinogenesis; X-ray radiation-mechanisms of radiation carcinogenesis; Epigenetics of cancer.

Module III: MOLECULAR CELL BIOLOGY OF CANCER (9)

Cyclin dependent kinases; Tumor suppressor genes, Oncogenes, Virus and cancers- DNA viruses, Retroviruses; Growth factors related to transformation, Telomerases, Apoptosis – p53.

Module IV: PRINCIPLES OF CANCER METASTASIS (9)

Clinical significances of invasion - Three step theory of invasion and metastasis cascade- Role of cell adhesion molecules, Proteinases and tumour cell invasion - Angiogenesis: VEGF signaling

Module V: CANCER DETECTION TECHNIQUES (4)

Cancer screening, clinical interpretation and early detection - Detection using biochemical assays, Tumor markers; Advances in cancer detection,

Module VI: CANCER THERAPY (5)

Different forms of therapy: Chemotherapy, Radiation therapy, Immunotherapy, Molecular therapy, Use of signal targets towards therapy of cancer, Gene therapy, Cancer prevention strategies.

Total Hours: 45

Text Books

1. Stella Pelengaris, Michael Khan, The molecular Biology of Cancer, Blackwell Publishing, 1st edition, 2006.
2. Robert A. Weinberg, The Biology of Cancer, Garland Science, 2nd edition, 2014

References Books

1. Dunmock N.J and Primrose S.B, "Introduction To Modern Virology‘‘, Blackwell Scientific Publications, Oxford, 1988.
2. Franks L. M, Teich N. M, "An Introduction To Cellular and Molecular Biology of Cancer‘‘,Oxford Univ. Press,Oxford Medical Publications, 1992.
3. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
4. Robert G, Mckinnell, Ralph E. Parchment, Alan.O. Perantoni, G. Barry Pierce, "The Biological Basis of Cancer", Cambridge University Press, New York. 2003.

18BT2038	CLINICAL DATABASE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objective:

1. To learn and understand clinical data management and its role in clinical research.
2. To impart clear understanding on various essential elements of Clinical Research and Clinical Data Management.
3. To train you on different aspects and activities involved: CRF Designing, Data entry, Data Collection, AE Management, and Report Creation etc.

Course Outcome:

The students will be able to,

1. Acquire knowledge on clinical trials ,data management and preparation
2. Describe analytics and decision support, including the capabilities of dashboards and data capture tools.

3. Utilize enterprise-wide information assets in support of organizational strategies and objectives.
4. Explain concepts of database architecture and design.
5. Differentiate the roles and responsibilities of various providers and disciplines, to support documentation requirements, throughout the continuum of healthcare.
6. Validate the reliability and accuracy of secondary data sources.

Module I: INTRODUCTION OF CLINICAL TRIALS (9)

Basic statistics for clinical trials, Roles & Responsibilities of Key Stakeholders, Preparations & Planning for Clinical Trials, Essential Documentation in Clinical Research & Regulatory Submissions, Clinical Trials Project Planning & Management, Study Start Up Process, Clinical Monitoring Essentials, Compliance, Auditing & Quality Control in Clinical Research

Module II : CLINICAL DATA MANAGEMENT (9)

Introduction to Data Management, Data Definition & Types, Study Set Up, CRF Design Considerations, Data Entry, Remote Data Entry, Identifying and Managing Discrepancies, Medical Coding, Database Closure, Data Management Plan, Electronic Data Capture, Tracking CRF Data, Managing Lab Data, Collecting Adverse Event Data, Creating Reports and Transferring Data, Enterprise Clinical Data Management Tools.

Module III: CLINICAL DATA ANALYSIS AND MANAGEMENT (9)

Study set-up, Introduction to Clinical Database , Documents, guidelines used in CDM, Data Entry, Data Review/Data Validation, Query Management, Data management plan, Project management for the clinical data manager, Vendor selection and management, Data management standards in clinical research, Design and development of data collection, Edit check design principles

Module IV: CLINICAL CASE REPORT FORMS (9)

CRF Completion Guidelines, CRF printing and vendor selection, Data validation, programming and standards, Laboratory data handling, External data transfer, Patient –reported outcomes, CDM presentation at investigator meetings, Metrics for clinical trials, Systems Software Validation Issues Clinical Trials Database Environment

Module V: CLINICAL QUALITY AUDIT (4)

Audit –Definition, types & procedures, Audit standards, Audit trail & its role in authenticity of data, Audit plan, Audit by regulatory authorities,

Module VI: CLINICAL LOGISTICS AND REGULATIONS (5)

GMP, GDP & logistics, Preparing and delivering audit reports, What makes a good audit, New product development & GxP Regulations

Total Hours: 45

Text Book

1. Susanne Prokscha (2011), Practical Guide to Clinical Data Management, Third Edition, CRC Press; 3 edition (18 November 2011), ISBN -13:978-1439848296
2. Richard K Rondel (2000) Clinical Data Management, Second Edition. Wiley Publishing House. ISBN: 978-0-470-85335-1

Reference Book

1. Rondel, R.K., Varley, S.A. and Webb, C.F. eds., Clinical data management. New York: Wiley, 2000
2. Smith, Jonathan A., ed. Qualitative psychology: A practical guide to research methods. Sage, 2015.
3. Machin, D., Day, S. and Green, S. eds., Textbook of clinical trials. John Wiley & Sons, 2007.

18BT2039	CLINICAL DATABASE MANAGEMENT LAB	L	T	P	C
		0	0	1.5	1.5

Co-requisite: 18BT2038- Clinical Database Management

Course Objective:

1. To understand the types of clinical data, samples, and software

2. To develop the skills to analyze the clinical trial data management
3. To develop the skills to evaluate clinical data management

Course Outcome:

1. The student shall apply medical terminology, clinical data management learnt to projects to develop databases for health care
2. The student will practice clinical data submission and interpret the clinical results
3. The student will demonstrate skills to analyze clinical data
4. The student will demonstrate skills to validate data
5. The student will develop Case Report Forms to store clinical data
6. The student will gain skillful knowledge of the management of clinical data used in clinical trials

List of experiments:

1. Contribute to the design of protocols, forms, and data collection process Queries based on Biological databases
2. comprehensive database programming
3. Create data validation checks
4. Issue and resolve data queries
5. Create and maintain data management plans
6. Full data integration (eCRF, images, laboratories, other instrumentation)
7. Manage and document study specific change control process
8. EDC and other data management systems
9. SAE reconciliation
10. Medical term coding (i.e. adverse events, medications)
11. Serious adverse Event Management
12. Data Extract and SAS Extract Locking and Freezing

18BT2040	PLANT AND ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To create awareness in Plant and Animal biotechnology.
2. To impart knowledge in micromanipulation techniques in cell culture.
3. To understand the principles of transgenic plants and animals.

Course Outcome:

The students will be able to

1. Acquire knowledge in plant biotechnology and its applications.
2. Gain the knowledge about to increase the production in agriculture products.
3. Prepare them to work in the Agriculture industries.
4. Understand about *In vitro* fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness
5. Study the development of transgenic animals will make the students to know more about breed development and choosing of the breeds for milk production
6. Assess about the scope and applications in this subject

Module I PLANT CELL AND TISSUE CULTURE (4)

Plant cell and Tissue culture: Tissue Culture media, Callus and suspension culture, Somoclonal Variation,

Module II MICROPROPAGATION AND OTHER TECHNIQUES (5)

Micropropagation, Organogenesis, Somatic embryogenesis, transfer and establishment of whole plants in soil, green house technology, Artificial seeds, Protoplast fusion and somatic hybridization, cybrids; anther, pollen and ovary culture for production of haploid plants.

Module II PLANT GENETIC TRANSFORMATION (9)

Plant Genetic Transformation Methods: Features of Ti and Ri Plasmids and its use as vectors,

Use of reporter genes and marker genes, gene transfer methods in plants: direct and indirect DNA transfer, Chloroplast transformation and its advantages.

Module III APPLICATION OF PLANT GENETIC TRANSFORMATION (9)

Application of Plant Genetic transformation: Herbicide resistance: Insect resistance, Disease resistance antifungal proteins, PR proteins, nematode resistance.

Module IV INTRODUCTION TO CELL CULTURE (9)

In Vitro fertilization, Embryo transfer- Micromanipulation technology, germ cell manipulation, sperm and embryo sexing

Module V TRANSGENIC ANIMALS (9)

Transgenic Animals and their significance. Ethical issues in Animal Biotechnology

Total Hours: 45

Text Books

1. Introduction. R. Ian Freshney. Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.
2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005
3. H.S. Chawala. Introduction to plant Biotechnology, Oxford and IBH Publishing Co. Pvt. LTD.New Delhi 2002.

Reference Books

1. Bojwani, S.S. "Plant Tissue Culture: Applications and Limitations", Elsevier science publishers, 1990.
2. Ian Freshney, "Culture of Animal Cells", Wiley-Liss, 5th edition, 2005
3. Grierson,D. "Plant Biotechnology in Agriculture Prospects for the 21st Century", Academic press, 2012
4. Doyle, A.R. Hay and B.E. Kirsop, "Living Resources for bio technology", Cambridge University press, Cambridge, 1990
5. Ed. John R.W. Masters, "Animal Cell Culture - Practical Approach", Oxford University Press, 3rd edition, 2000.
6. Dunmock N.J and Primrose S.B., "Introduction to Modern Virology", Blackwell Scientific Publications, 2002

18BT2041	STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. This course will take students on a journey into the stem cell biology and biotech revolution.
2. This course will provide details regarding social implications associated with stem cell technology.
3. The course offers an opportunity to understand the basics of stem cells, embryonic stem cells, adult stem cells and genetic engineering of stem cells and their applications.

Course Outcome:

1. To student gain knowledge in Stem cell basics, growing of ES cells in lab, differentiation of stem cells and application of stem cells.
2. They understand recent advancements in the biotechnological applications using both adult and embryonic stem cells.

Module I: INTRODUCTION (4)

Overview of Stem cell technology; Introduction to Cell Culture; Pros & Cons of Cell culture; Primary and Secondary cultures & Hayflicks limit, telomerase;

Module II: TECHNIQUES (5)

Aseptic Technique and Cell culture Lab equipments & etiquette.

Module III: TYPES OF STEMS CELLS (9)

Totipotency, Pleuripotency**,** Types of Stems Cells; Embryonic stem cells; Pleuripotent Stem Cells; Adult Stem cells; Induced Pleuripotent Stem Cells

Module IV: ISOLATION OF STEM CELLS (9)

Growth factors; chord cells; Derivation & differentiation of ES Cells; Derivation & differentiation of Pleuripotent Cells; Induced Pluripotent cell-Methods; Genetic & epigenetic reprogramming.

Module V: APPLICATIONS OF STEM CELL TECHNOLOGY (9)

Neurogenesis; Use of stem cells in Vascular biology; Use of stem cells in cardiac disease; Use of stem cells in Cancer; Stem cells of Liver, Gut and pancreas; Use of stem cells in tissue engineering & Gene therapy.

Module VI: ETHICAL CONCERNS OF STEM CELL TECHNOLOGY (9)

Problems and perspectives in stem cell technology; Alternatives to stem cells; Deeper concerns in stem cell technology-Immortality, longevity, ageing.

Total Hours: 45

Text Book

1. Handbook of Stem Cells edited by Anthony Atala, Robert Lanza. (Vol-1) Second edition. Academic press, 2013.

References Books:

1. Stem Cell Biology - edited by Daniel R Marshak, Richard L Gardener, David Gottlieab, Cold Spring Harbor Press.
2. Kursad and Turksen, "Embryonic Stem cells", Humana Press, 2002.

18BT2042	BIOPHARMACEUTICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To demonstrate the basics of biopharmaceutical technology to the undergraduate students.
2. To motivate the undergraduate students in analyzing the drug metabolism and mode of action.
3. To elaborate basic of formulations of drugs and to apply them in clinical trials.

Course Outcome:

The students will be able to

1. Acquire knowledge on drug development, principles, mechanism of actions of drug.
2. Outline on preparation of biotechnology oriented pharmaceutical products.
3. Demonstrate various testing and quality assurance in drug preparation.
4. Help them to analyze the pharmaceutical products available in the market.
5. Evaluate the recent advances in drug manufacturing.
6. Relate the regulations in clinical trial and management.

Module I DRUGS (9)

Introduction - Development of Drugs and Pharmaceutical Industry. Drug Metabolism and Pharmacokinetics - Drug Metabolism – Physico-Chemical Principles –Pharmacodynamics – Action of drugs in humans.

Module II MANUFACTURING PRINCIPLES (9)

Manufacturing Principles - Compressed tablets – wet granulation, – Dry granulation – Direct compression – Tablet presses formulation – Coating – Pills – Capsules sustained, action dosage forms. Quality control tests for tablets and capsules. Packaging of solid dosage forms.

Module III FORMULATIONS (9)

Manufacturing Principles – Parental, solutions – Oral liquids – injections – Ointments. Quality control tests for semisolid and liquid dosage forms. Packaging of semisolid and liquid dosage forms.

Module IV PHARMACEUTICAL PRODUCTS – VITAMINS AND ANTISEPTICS (4)

Pharmaceutical Products - Vitamins – Cold remedies – Laxatives –Analgesics –External Antiseptics – Antacids.

Module IV ANTIBIOTICS AND rDNA PRODUCTS(5)

Antibiotics – Biologicals – Hormones. Recent advances in the manufacture of drugs using r-DNA technology.

Module V TRIALS & REGULATIONS (9)

Clinical Trials & Regulations - Clinical Trials – Design, double blind studies, placebo effects. FDA regulations (General) and Indian Drug regulations- highlight. Good Laboratory Practice, Good manufacturing practice.

Total Hours: 45

Text Books

1. DM Brahmankar, Sunil B Jaiswal, "Biopharmaceutics and Pharmacokinetics-A Treatise", Vallabh prakashan, 2005.
2. Ansel, H., Allen, L., Popovich, N, "Pharmaceutical Dosage Forms and Drug Delivery Systems", Williams & Wilkins, 1999.

Reference Books

1. Lippin cott, "Remington's Science and Practice of Pharmacy", Williams & Wilkins publishers, 2005.
2. Goodman & Gilman's, "The pharmacological basis of therapeutics" by Joel Griffith Hardman, Lee E. Limbird, Alfred G. Gilman.2005
3. Tripathi KD, "Essential of Medical pharmacology", Jaypee Brothers Medical Publishers 2003.

18BT2043	AGRICULTURAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To demonstrate the basics of genes, genomes and breeding principles to the undergraduate students.
2. To motivate the undergraduate students in analyzing the tools and techniques in genetic engineering .
3. To elaborate the understanding of biodiversity and IPR issues in agricultural crops.

Course Outcome:

The students will be able to

1. Acquire knowledge on gene and genome organization.
2. Outline the principles of breeding.
3. Demonstrate various tools involved in genetic engineering.
4. Illustrate the pest management strategies
5. Relate various molecular mapping techniques
6. Help them to analyze the biodiversity and IPR.

Module I GENOMES AND GENES (9)

Chromatin structure, Karyotype analysis, Genome organization – C-Value para, dox, Cot curves & significance, Chromosome behaviour

Module II AGRICULTURE AND PLANT BREEDING (9)

Breeding of crops, Heterosis , Apomixis, Mutations , Polyploidy in crop improvement, Principles of integrated Pest Management

Module III TOOLS AND TECHNIQUES OF GENETIC ENGINEERING (9)

Recombinant DNA technology, Concept of Genetic makers; gene interaction, multiple allelism, pleiotropism and multiple factor inheritance. Genetic, Chromosomal and Molecular map, Techniques in genetic engineering

Module IV BIODIVERSITY (6)

Genetic diversity Molecular diversity; Species and Population biodiversity, Collection and conservation of biodiversity, endangered plants, endemism and Red Data Book, Biodiversity and centers of origins of plants; Biodiversity hot spots,

Module V INTELLECTUAL PROPERTY RIGHTS (3)

IPR in relation to Indian Flora- Basmati Rice, Turmeric and Neem

Module VI GENOME ANALYSIS (9)

Genome projects, Genome Annotation, Biological Data Bases, Data base search engines, Sequence Analysis and Molecular Phylogeny

Total Hours: 45

Text Books

1. Principles of Gene Manipulation S. B. Primorose, RM Twyman and R.W. old sixth edition (2001) Blackwell science
2. Induction of Bioinformatics – T.K. Attwood & D.J. Parry-Smith 2002, Pealson Education Singapore Pvt. Ltd Indian, Indian Branch, Delhi. ISBN 817808

Reference Book:

1. Gene Cloning and DNA analysis, an introduction, Fourth edition TA Brown (2001) Blackwell science.
2. From Genes to clones, Introduction to gene Technology. (Erist L innacker (2003) Panima Publishing Corporation.
3. Kothari, A., 1997: "Understanding Biodiversity Life sustainability and Equity Orient".
4. Lewin's Genes XII Hardcover – (2017) by Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick

18BT2044	METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. To develop skills of the students in the area of metabolic engineering to alter the existing metabolic pathway
2. To introduce novel metabolic pathways in microorganisms using r-DNA technology
3. To learn molecular techniques in order to enhance the product yield

Course Outcome:

1. Ability to integrate modern biology with engineering principles
2. Acquire knowledge on the principles and regulation of metabolic pathways
3. Analyze different methods to obtain improved production strains
4. Categorize the synthesis of primary and secondary metabolites and bioconversion process
5. Practical applications of metabolic engineering in chemical, medical, and environmental fields
6. Develop a good appreciation of the multidisciplinary aspects of biotechnology

Module I: BASICS IN METABOLIC FLUX ANALYSIS (9)

Analysis of metabolic control in glycolysis, metabolic flux analysis and its applications in aminoacid production by glutamic acid bacterium

Module II: REGULATION OF PRIMARY METABOLIC PATHWAYS (9)

Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites: glutamic acid, Mutants which do not produce feedback inhibitors or repressors- auxotrophs-lysine, isoleucine, arginine, purine nucleotides.

Module III: REGULATION OF SECONDARY METABOLIC PATHWAYS (9)

Producers of secondary metabolites, Precursor effects, trophophase- idiophase relationship, applications of secondary metabolites

Module IV: IMPROVED PRODUCTION OF SECONDARY METABOLITES (9)

Antibiotics, vitamins, Mycotoxins- maintenance of genetic stability; Bioconversions

Module V: APPLICATIONS OF METABOLIC ENGINEERING (5)

Product over production examples: amino acids, polyhydroxyalkanoic acids, By-product minimization of acetate in recombinant *E. coli*, Extension of substrate utilization range for organisms such as *S. cerevisae* and *Z. mobilis* for ethanol production,

Module VI: CELL METABOLIC ENGINEERING (4)

Improvement of cellular properties, Altering transport of nutrients including carbon and nitrogen

Total Hours: 45

Textbooks

1. Gregory N. Stephanopoulos, Aristos A. Aristidou & Jens Nielsen, "Metabolic Engineering: Principles and Methodologies", Academic Press, An Imprint of Elsevier India Pvt.Ltd., 1st edition, 1998.
2. S. Cortassa, M.A.Aon, A.A.Iglesias and D.Llyod, " An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co. Pte. Ltd, 2002.

Reference Books

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005
2. W.Crueger and A. Crueger, "A Text Book of Industrial Microbiology", Panima Publishing Corporation, 2005
3. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.

18BT2045	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To intend the students with the knowledge about the basic research methods, applications in conducting research, various data collection and analysis techniques.
2. To gain insights into scientific research.
3. To help in critical review of literature and assessing the research trends, quality and extension potential of research and equip students to undertake research.

Course Outcome:

1. To understand the basic principles of research
2. Illustrate the different methods of sample design
3. Classify the various techniques of data collection and analysis
4. Elaborate the steps involved in thesis and report writing
5. Analyze the importance of biosafety in research
6. Evaluate the importance of ethics in research

Module I: RESEARCH PROBLEMS (5)

Definition and characteristics of research, Basic Concepts- Validity, reliability, Variables- Dependent, Independent and Intervening, Types-Basic and applied- Interdisciplinary - formulation of research problem,

Module II: RESEARCH DESIGN AND EXPERIMENTAL DESIGN (4)

research design -Hypothesis: formulation- Types: Descriptive,relational and explanatory- Methods of Research: descriptive, comparative, experimental- clinical research- controlled clinical trials

Module III: SAMPLE DESIGN, MEASUREMENT AND SCALING TECHNIQUES (9)

Steps in sample design, Criteria for selecting a sample procedure, Characteristics of Good sampling Procedure, Types of Sample Design, Selecting Random Samples, Complex random sampling Design, Measurement Scales, Sources of Errors in measurement, Tests of Second measurement, Technique of developing Measurement Tools, Scaling-Classification and design.

Module IV: COLLECTION, PROCESSING AND ANALYSIS OF DATA (9)

Data collection: methods and types- Processing Operations-Editing, coding, tabulation, Data Analysis, Statistics in Research, Measures of Central Tendency, Dispersion, Asymmetry, relationship. Regression Analysis, Correlation Analysis, Software for statistical analysis- SPSS- features

Module V: MANUSCRIPT/THESIS WRITING (9)

Research report - Types of Research reports, steps of manuscript, thesis and review of literature, Literature citation, Impact factor of journals, Citation index of journals, H-factor, Bibliography and References, Methods of presentation of report, significance of report writing

Module VI: ETHICS AND BIOSAFETY (9)

Introduction- Scientific conduct and misconduct – Authorship issues- basic principles of human and animal research ethics- international regulation- Laboratory safety, biosafety, recombinant material safety, Standard operation protocol

Total Hours: 45

Text Book

1. C.R. Kothari, "Research methodology, Methods and techniques", New Age International (P) Ltd, Publishers, 2nd edition, 2000.

Reference Books

1. Jerrod H. Zar, "Biostatistical analysis", Prentice Hall International, Inc. Press, 1999.
2. Donald H. McBurney, "Research methods", Thomson Asia Pvt. Ltd. 2002
3. Ranjit Kumar, "Research methodology", Sage Publications, London, 2006.
4. Raymond – Alain, "Doing Management research", Sage publications, 2001.

18BT2046	MOLECULAR FORENSICS	L	T	P	C
		3	0	0	3

Course Objective:

1. The molecular forensics provides students with experiences and information that will broaden their understanding of the field of Forensic Science and crime scene investigations.
2. To ensure students in having foundation Forensics and molecular techniques in forensics.
3. A concurrent goal of the subject is to develop observational, organizational and cognitive skills so to be able to integrate their experiences and knowledge so to solve problems.

Course Outcome:

1. The student will understand the history and current state of forensic biological testing and the role of a forensic biologist in a forensic investigation
2. The student will learn the proper methods for the handling of biological evidence.
3. The students understand the application of molecular based techniques in forensics science.
4. The students learn the methods used to identify suspects and parental disputes.
5. The students will gain knowledge in paleo biology and anthropology and its importance in Forensics
6. The student will observe the case studies and will understand the complete details of investigation.

Module I: INTRODUCTION TO FORENSIC SCIENCE (9)

Introduction to Crime Laboratories, Responsibilities of the Forensic Scientist, Securing and Searching the Crime Scene, Recording and Collection of Crime Scene Evidence,Document Examination, Ethics and Integrity

Module II DISCOVERY AND RECOVERY OF HUMAN REMAINS (9)

The Autopsy and Handling of a Dead Body, The Stages and Factors of Decomposition, Determining the Age and Provenance of Remains, Asphyxia, Gunshot Wounds, Bite Marks

Module III PATTERN ANALYSIS (9)

Human Tissues, Body Fluids and Waste Products, Fingerprints, Hair, Teeth, Blood, Detecting the Presence of Blood, Bloodstain Pattern Analysis , Forensic anthropology, Paleontology, Toxicology

Module IV FINGER PRINTING (5)

Mitochondrial, DNA, DNA Finger Printing- RFLP. STR Genotyping issues, VNTRS and STR, mt DNA analysis, Identification of suspects.

Module V RAPD IN FORENSICS (4)

RAPD in Forensics, Study of Kinnship by DNA Profilig.

Module VI FORENSIC CASE STUDIES (9)

Forensic Case studies by molecular identification, PCR directed Y chromosome sequences, PCR Amelogenein Gene, Types of sequencing; forensic significance of polymorphic enzymes, forensics in paternity disputes.

Text Book

1. Lincoln PJ & Thomson J, "Forensic DNA Profiling Protocols", Humana Press. 2011.

References Book

1. Rudin N & Inman K. "An Introduction to Forensic DNA Analysis", 2nd Ed. CRC Press. 2002.

18BT2047	PROTEIN ENGINEERING	L	T	P	C
		3	0	0	3

Course objectives

1. To ensure the strong knowledge in protein architecture through a detailed study of protein structure.
2. To realize the structure-functional relationships of proteins
3. To impart advance knowledge the characteristic properties of proteins and their significance in biological systems

Course Outcome:

1. To analyze the various interactions in protein makeup.
2. To be familiar with different levels of protein structure.
3. To gain knowledge in analyzing the protein structures at various levels
4. To know the role of functional proteins in various field of study.
5. To apply the knowledge in improving the functions of proteins
6. To practice the latest application of protein science in their research.

Module-I BONDS, ENERGIES, BUILDING BLOCKS OF PROTEINS (9)

Covalent, Ionic, Hydrogen, Coordinate, hydrophobic and Vander walls interactions in protein structure. Interaction with electromagnetic radiation (radio, micro, infrared, visible, ultraviolet, X-ray) and elucidation of protein structure. Amino acids (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).

Module II PROTEIN ARCHITECTURE (9)

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-turnalpha, beta-turn- beta (hairpin), beta-sheets, alpha-beta-alpha, topology diagrams, up and down & TIM barrel structures nucleotide binding folds.

Module III TERTIARY STRUCTURE (9)

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, protein-protein interactions and methods to study it

Module IV STRUCTURE-FUNCTION RELATIONSHIPS (4)

DNA-binding proteins: prokaryotic transcription factors, Helix-turn-Helix motif in DNA binding, Trp repressor, Eukaryotic 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

Module V IMMUNOGLOBULINS AND ENZYMES (5)

Immunoglobulins: IgG Light chain and heavy chain architecture, abzymes and Enzymes: Serine proteases, understanding catalytic design by engineering trypsin, chymotrypsin and elastase, substrate-assisted catalysis other commercial applications

Module VI PROTEIN ENGINEERING AND PROTEIN DESIGN (9)

Protein data base analysis–methods to alter primary structure of proteins –Examples of engineered proteins –Protein design, principles and examples. Methods in Proteins engineering; Immunotoxins; mechanism and its applications; Drug designing; structure based approach, receptor based approach.

Total Hours: 45

Text Books

1. Branden C. and Tooze J., "Introduction to Protein Structure", 2nd Edition, Garlan Publishing, 1999.
2. Creighton T.E. "Proteins: Structures and Molecular properties", 2nd Edition. W.H. Freeman, 1992.

References Books

1. Kristian M. Müller and Katja M. Arndt―Protein Engineering Protocols;, Third Edn. Humana Press, 2007
2. Gregory A. Petsko and Dagmar Ringe―Protein Structure and Function, First Edition, Oxford University Press USA, 2003
3. Moody PCE, and AJ Wilkinson, Protein Engineering, IRL Press, Oxford. 1990

18BT2048	PLANT TISSUE CULTURE	L	T	P	C
		3	0	0	3

Course Objective:

1. To create awareness in plant biotechnology.
2. To impart knowledge in micromanipulation techniques in cell culture.
3. To understand the principles of transgenic plants.

Course Outcome:

The students will be able to

1. Acquire knowledge in cell and tissue culture techniques.
2. Gain the knowledge about to plant genetic engineering tools.
3. Learn the various applications of plant tissue culture.
4. Understand the molecular concepts of disease resistance factors in plants.
5. Study the development of transgenic plants on abiotic and biotic factors
6. Assess about the scope and applications in plant biotechnology

Module I CELL AND TISSUE CULTURE (9)

Definition and need; Types of Methods in plant Biotechnology; Cell and Tissue Culture; Micro propagation; Callus Culture; Somatic Embryogenesis; Hairy Root Culture; Culture Medias.

Module II PLANT GENETIC ENGINEERING TOOLS (9)

Vectors and Genetic Engineering; Agro bacterium mediated gene transfer and cloning; Agro bacterium types; Plant viruses and Genetic Engineered viruses as a tool of deliver foreign DNA; major plant viruses, Camv, TMV, BBTV, Gemim viruses etc.

Module III APPLICATION OF PLANT BIOTECHNOLOGY (9)

Hairy Root Cultures and Secondary Metabolite production; Plant as Bioreactors- edible Vaccines; Germplasm conservation; Gene Banks; Crop improvement; legume symbiosis, N_2 Fixation; Regulation of NIF and NOD Genes.

Module IV MOLECULAR ASPECTS OF DISEASE SUSCEPTIBILITY AND RESISTANCE (9)

Transposable elements, factors influencing disease resistance and susceptibility RFLP

Module V: **TRANSGENICS – ABIOTIC FACTORS (4)**

Stress tolerance-Biotic and abiotic temperature, salinity, drought etc;

Module VI: **TRANSGENICS – BIOTIC FACTORS (5)**

Pests and insects resistance- viral resistance- development of disease resistance plants by introducing *Bacillus thuringiensis* genes.

Total Hours: 45

Text Books

1. Mantal S.H., Mathew J.A.,Mickee R.A., Principles of Plant Biotechnology. An Introduction to Genetic Engineering in Plants, Blackwell Scientific Publication, 1985.
2. Marx J.L., Revolution in Biotechnology, Cambridge University Press, 1989.

Reference Books

1. Dodds J.H., Plant Genetic Engineering, Cambridge University Press, 1985.
2. Grieson, Plant Biotechnology.
3. Glick and Pasternak, Molecular Biotechnology.
4. R.K.Gupta., Introduction to Biotechnology.
5. R.C. Dubay and Maheswari. Introduction to Microbiology, 2002, S.CHAND.
6. Walker and Raplery, Molecular Biology and Biotechnology, Panima.2003.

18BT2049	ANIMAL BIOTECHNOLOGY AND CELL CULTURE	L	T	P	C
		3	0	0	3

Course Objective:

1. To develop skills of the students in the area of animal biotechnology
2. To learn the protocols involved in cell culture techniques
3. To understand the applications in Cell culture and Tissue engineering

Course Outcome:

The students will be able to

1. Acquire knowledge in primary cell culture techniques, maintenance of cell line
2. Understanding the use of scaling up of cell culture and the production of products from cell cultures
3. Gaining knowledge in the latest field of Tissue engineering and to culture cells in 3D methods and its applications
4. Understand about *In vitro* fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness
5. Study the development of transgenic animals will make the students to know more about breed development and choosing of the breeds for milk production
6. Assess about the scope and applications in this subject

Module I INTRODUCTION TO CELL CULTURE (9)

Layout of cell culture laboratory chemically defined and serum free media. Primary cell culture, Establishment of cell line, Maintenance and Preservation of cell line.

Module II SCALING UP OF CELL CULTURES (9)

Suspension cultures, Continuous flow cultures, Immobilized cultures, Cell culture as a source of various products – Vaccine Production

Module III TISSUE ENGINEERING (9)

3D culturing, Different stages of tissue engineering, Protocols for 3D culturing of cells, Different types of cells in matrices for tissue engineering.

Module IV MICROMANIPULATION OF EMBRYOS (9)

Micromanipulation technology, Enrichment of X and Y bearing sperms from semen samples of animals: Artificial insemination and germ cell manipulation, *In Vitro* fertilization and Embryo transfer technology.

Module V: TRANSGENIC ANIMALS (5)

Concepts of Transgenic Animal technology: Stratergies for the production of Transgenic animals and their importance in Biotechnology,

Module VI: STEM CELL TECHNOLOGY AND ETHICS (4)

Stem cell cultures in the production of Transgenic animals, Ethical issues in Animal Biotechnology

Total Hours: 45

Text Books

1. R. *Ian Freshney*. *Introduction to Culture* of Animal *Cells*: A Manual of Basic Technique and Specialized Applications, Sixth Edition. *Publisher*, John Wiley & Sons, 2011.

2. Animal cell culture 3rd ed., by John R.W. Masters A Practical Approach Oxford University press New York 2005

Reference Books

1. Ramadass P, Meera Rani S. "Text Book of Animal Biotechnology", Akshara Printers, 2000.
2. Ranga M.M. "Animal Biotechnology", Agrobios India Limited, 2002
3. Methods in Biotechnology, Animal cell Biotechnology. Methods and Protocols. 2nd Ed., Edited by Rolf Portner. Humana Press. 2007.

18BT2050	PLANT AND ANIMAL TISSUE CULTURE LAB	L	T	P	C
		0	0	1.5	1.5

Course Objective:

1. To learn the basic techniques of animal cell culture
2. To impart the technical skills of plant tissue culture
3. To develop the knowledge of preservation and conservation techniques in cell culture

Course Outcome:

The students will be able to

1. Gain knowledge in Animal cell culture technique
2. Understand the sterilization techniques and its importance
3. Analyze and determine the growth of cells in *In vitro* conditions
4. Evaluate the viability cells in animal cell culture
5. Apply the propagation methods for commercially important plants
6. Understand various in vitro techniques in animal and plant cell culture system

List of Experiments

1. Basics of tissue culture laboratory design and maintenance.
2. Packing and Sterilization of glass and plastic wares for cell culture.
3. Preparation of reagents and media for Animal cell culture.
4. Quantification and cell viability test using Tryphan blue.
5. Culturing of Spleenocytes from Spleen.
6. Isolation and culturing of Thymus cells.
7. Introduction to Plant Cell & tissue Culture.
8. Types of Sterilization in Plant Tissue Culture
9. Preparation and sterilization of different culture media.
10. Sterilization and inoculation of explants for micropropagation.
11. Sterilization and inoculation of explants for callus culture.
12. Preparation of synthetic seeds.

18BT2051	ROLE OF BIOTECHNOLOGY IN ENVIRONMENT	L	T	P	C
		3	0	0	3

Course Objective:

1. To learn the importance of biotechnology
2. To learn the importance of environment
3. To understand the significance of conservation

Course Outcome:

The students will be able to

1. Acquire knowledge on the scope of biotechnology
2. Dramatize the health hazards of various pollutants
3. Explain the importance of waste water treatment
4. Understand the significance of waste management
5. Outline the various bioremediation techniques
6. Dramatize the conservation of biodiversity

Module I SCOPE OF ENVIRONMENTAL BIOTECHNOLOGY (9)

Environmental Pollution; Types, Causes and Effects of Soil, air, water, oil and heavy metal. Pollution, control measures. Social Issues- Green House Gases, Global Warming, Acid Rain, Ozone depletion, nuclear accidents and holocaust.

Module II INDUSTRIAL WASTE WATER MANAGEMENT (9)

Purification of waste water; Aerobic and anaerobic treatments; Management of radioactive pollutants in water, VOC, COD BOD and BOD sensors.

Module III BIOMASS, ENERGY AND SOLID WASTE MANAGEMENT (9)

Biomass waste as renewable source of energy; Methods of energy production; Conversion of Solid Waste to Methane; Biogas production; Biofuels, Management of Sludge and Solid waste treatment- Land filling, lagooning, Composting and Vermi Composting.

Module IV BIODIVERSITY TYPES (5)

Definition, Types, Genetic, Species, Ecosystem; Biodiversity at Global Levels; Values of Biodiversity; Hotspots in Biodiversity; Loss of Biodiversity and its causes threats to Biodiversity;

Module V BIODIVERSITY CONSERVATION (4)

Biodiversity and its Conservation- In situ and Ex situ

Module VI BIOREMEDIATION AND BIODEGRADATION (9)

Types- Ex situ and In situ Bioremediation; genetically Engineered Microbes for Bioremediation.

Total Hours: 45

Text Book:

1. Dubey, R.C. "Text Book of Biotechnology", S. Chand & Co, 2nd edition, 2004.
2. Chatterjee, Introduction to Environmental Biotechnology, PHI Learning pvt ltd,3rd Edition 2011
3. Indu Shekhar Thakur Environmental Biotechnology: Basic Concepts and Applications, IK International Publishing House pvt Ltd, 2011

Reference Books

1. Foster C.F; Johnware D.A, "Environmental Biotechnlogy", Ellis Harwood Ltd.3rd edition, 1987
2. Gupta P.K. "Elements of Biotechnology", Rastogi Publications, 2004.

18BT2052	INDUSTRIAL POLLUTION CONTROL	L	T	P	C
		3	0	0	3

Course Objective:

1. To give an exposure to various control acts
2. To study the advantages and disadvantages of impact assessment methods
3. To study the methods of reducing the waste and reusing it.

Course Outcome:

The students will be able to

1. Gain basic knowledge on pollution, its types
2. Summarize Pollution control acts and regulations.
3. Employ preparation EIA report
4. Evaluate audit reports on pollution is finally controlled.
5. Understand the methods of material reuse
6. Understand recycling methods

Module I: PREVENTION AND CONTROL OF WATER POLLUTION (9)

The water (prevention and control of pollution) act 1974 and rules 1975- definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous. Prevention and control of water pollution.

Module II: PREVENTION AND CONTROL OF AIR POLLUTION (9)

The air (prevention and control of pollution) act 1981 and rules 1982,definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous National ambient air quality standards.

Module III: ENVIRONMENT PROTECTION ACT (9)

The environment (protection) act 1986,rules 1986-definitions, constitution, function and fund of central & state boards. Penalties and procedure, miscellaneous, standards of emission or discharge of environmental pollutants.

Module IV: ENVIRONMENTAL IMPACT ASSESSMENT (4)

Environmental impact assessment notification,2006-environmental clearance, list of projects, form I, general structure of EIA documents, content of summary EIA,

Module V: PLASTIC USAGE RULES (5)

The plastics manufacture, sale and usage rules,1999-defination,restriction on manufacture, sale.

Module VI: RECYLCED PLASTICS (4)

Distribution and use of virgin and recycled plastics carry bag and recycled plastic containers.

Total Hours: 45

Text book:

1. C. S. Rao Environmental Pollution Control Engineering, New Age International, 2007

Reference Books

1. Peter Wathern, "Environmental Impact Assessment theory and practice", Unwin Hyman Ltd. Routledge, 1990.
2. L. Lee Harrison , "Environmental Health and Safety Auditing Handbook", 2nd edition, McGraw Hill, Inc., New York, 1995.
3. Kirkwood, R. C. and Longley, A. J., "Clean Technology and Environment", Chapman & Hall, 1995.

18BT2053	BIOMASS & BIOENERGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To provide a understanding of various renewable feedstocks of importance to undergraduate students
2. To provide a understanding on the concept of biofuel production from biomass and other agri-residues

Course Outcome:

The students will be able to

1. Understand the fundamental principles
2. Know principles underlying the design and operation of waste and biomass to energy
3. Be aware of the techniques and limitations of Biomass preprocessing
4. Be able to compare Biomass conversion processes
5. Be familiar with current research issues in biodiesel production
6. To be familiar with the Environmental impacts of biofueld

Module I ENERGY (9)

Current energy consumption, Energy sources, overview of biofuel/bioenergy, concepts in understanding biofuel/bioenergy production, Renewable feedstocks

Module II BIOMASS (9)

Biomass preprocessing: drying, size reduction, and densification , Various biofuels/bioenergy from biomass

Module III BIOCONVERSION PROCESS (9)

Biomass conversion: gasification, anaerobic digestion, Biochemical conversion to ethanol, enzyme hydrolysis

Module IV BIODIESEL (9)

Carbon capture and sequestration, Biodiesel production from oil seeds, Environmental impacts of biofuel production

Module V WASTE AND ENERGY (5)

Waste composition/arisings: municipal waste, clinical waste, sewage sludge, agricultural waste, Waste & biomass materials handling.

Module VI POLICIES AND LEGISLATION(4)

Pollutants arising from waste/biomass to energy plants, Energy from waste/biomass, policies & legislation

Total Hours: 45

Text Book

1. Robert C. Brown, Biorenewable Resources**:** Engineering New Products from Agriculture.. Wiley-Black well Publishing , 2003.

18BT2054	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To acquire the knowledge of environmental problems and develop technologies
2. To develop skills in bioreactors and biotreatment methods of industrial wastewater
3. To find solution to create green and clean environment

Course Outcome:

1. Learn an awareness of professional responsibility towards protecting the environment.
2. Acquaint oneself with the pertinent legislation and methodology.
3. Study environmental issues involved engineering and resources projects.
4. Acquire the natural and engineered biotreatment methods to remediate the pollutants
5. Investigate the opportunities for incorporating environmental quality into products, processes and projects.
6. Develop novel technologies for bioremediation of environmental pollution

Module I: WATER QUALITY AND WATER TREATMENT (9)

Environmental monitoring – sampling, physical,chemical and biological analysis, Water purification processes in natural and engineered systems – coagulation, flocculation, UV radiation, electrodialysis, Reverse osmosis and capacitance deionizer (CDi). Treatment of groundwater for hardness removal by chemical means and ion exchange. Removal of toxicants from contaminated groundwater by adsorption techniques.

Module II: WASTEWATER TREATMENT (9)

Characteristics of wastewater, Primary treatment by sedimentation, Secondary treatment by suspended growth reactors - Activated sludge process, Aerobic – digestion, Anaerobic processes and Lagoons. Attached growth reactors - Trickling filter, Rotating Biological Contactor, Fluidized bed biological reactors, Upflow anaerobic sludge blanket reactor and Sequential batch reactor. Tertiary treatment: Removal of nitrogen and phosphorus. Polishing operations: Sand filtration, adsorption by activated carbon and chlorination. Treatment of wastewater from dye, food and pharmaceutical industries.

Module III: AIR POLLUTION AND CONTROL TECHNOLOGY (9)

Air Quality: Definitions, Characteristics and Perspectives; Classification of pollutants, Effects of air pollution, Control devices for particulate and gaseous contaminants: Settling chambers, Cyclone separator, Venturi scrubber, Biofiltration, Fabric filters, Electrostatic precipitators, absorption, adsorption, condensation and flaring; Legal and administrative systems for air pollution control.

Module IV: SOLID WASTE TREATMENT AND MANAGEMENT (9)

Types, sources and properties of solid waste, Collection of solid wastes, Transfer and transport, solid waste treatment methods: incineration, composting, land filling ,conversion of solid waste into useful products: Land farming, prepared beds, soil piles, bioventing and biosparging, Reuse, Recycle and Recovering (3Rs), Legal and administrative systems for waste control.

Module V: HAZARDOUS WASTE TREATMENT AND MANAGEMENT (6)

Types of hazardous waste, Xenobiotic compounds, recalcitrance, biodegradation of xenobiotics and oil spills, biological detoxification.

Module VI: BIOWASTE MANAGEMENT (3)
Overview of biodegradable and ecofriendly products.

Total Hours: 45

Text Books

1. Jogdand, S.N. Environmental Biotechnology (2012) Himalaya Publishing House, New Delhi.
2. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2014.

Reference Books

1. Karnely D. Chakrabarty K. Ovnen G.S. Biotechnology and Biodegradation, Advances in Applied Biotechnology series, Vol. Gulf Publications Co. London, 2009.
2. Graty. C.P.L., Daigger, G and Lim, H.C, Biological Wastewater Treatment. 3rd Edition, Marcel Dekker, 2008
3. Piasecki, B.W., Fletcher, K. A. and Mendelson, F. J. (2010). Environmental Management and Business Strategy John Wiley & Sons.

18BT2055	MATLAB PROGRAMMING	L	T	P	C
		3	0	0	3

Course Objective:

1. To ensure students to having strong foundation in matlab installation, configuration and basic syntax.
2. To introduce them to various string operations, functions and advanced matlab modules for plotting and graphics.
3. To understand the applications of Matlab modules for various biological applications.

Course Outcome:

1. Acquire knowledge on installation, configuration and environmental setup of Matlab and Matlab modules, which help them to understand the customization of any matlab modules.
2. Acquire knowledge on basic syntax and fundamentals of matlab, which help them to understand structure of matlab program and to apply in scripting.
3. Acquire knowledge on data types, operators and control structures, which aids them define data and operate on data.
4. Ability to plot and generate different types of graphs for any given experimental data.
5. Ability to import and export data from matlab to external environments.
6. Proficient in various biological applications such as sequence processing, retrieval, and sequence analysis.

Module-I FUNDAMENTALS (9)
Matlab Local Environment Setup - Set up GNU Octave, Basic Syntax - Commonly used Operators and Special Characters, Variables, Naming Variables, Multiple Assignments - Long Assignments, Creating Vectors - Creating Matrices.

Module-II MATLAB COMMANDS (9)
Commands for Managing a Session - Commands for Working with the System-Input and Output Commands-Vector, Matrix and Array Commands - Plotting Commands, M-Files - Creating and Running Script File.

Module-III DATA TYPES,OPERATORS (4)
Data Types Available in MATLAB - Data Type Conversion - Determination of Data Types, Operators,

Module-IV CONTROL STRUCTURES (5)
Control structures - Decision Making, Loops - Loop Control Statements.

Module-V ADVANCED MATLAB (9)
Strings, Functions - Primary and Sub-Functions, Nested Functions, Private Functions, Global Variables,Data import, Data output, Matlab Plotting, Matlab Graphics.

Module-VI MATLAB FOR BIOLOGICAL APPLICATIONS (9)

Processing biological sequences with MATLAB modules – Sequence acquisition, Operations on nucleotide sequences, Joining sequences, Restriction site detection, Information retrieval from biological databases.

Total Hours: 45

Text Books

1. Amos Gilat "Matlab an introduction with applications ", Wiley, 2004.
2. Gautam B. Singh "Fundamentals of Bioinformatics and Computaional Biology", Springer, 2015.

References Books

1. Stephen J. Chapman, "Essentials of MATLAB Programming", CL Engineering, Second Edition, 2008.
2. William J. Palm III, "Introduction to MATLAB for Engineers", McGraw-Hill Education, 2010.
3. Rafael E. Banchs, "Text Mining with MATLAB ", Springer, 2012.

18BT2056	FUNDAMENTALS OF BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objective:

1. To ensure students to having strong foundation in structure, composition and function of various biomolecules.
2. To introduce them to the basic nature and properties of nucleic acids
3. To understand the significance of these biomolecules

Course Outcome:

The students will be able to

1. Acquire knowledge on structure, properties and biological functions of Primary metabolites which help them to understand the significance of biomolecules
2. Acquire knowledge on nucleic acids structure
3. Assess the significance of vitamins and minerals
4. Relate biomolecules with the biomedical significance
5. Justify the clinical and biological significance of these biomolecules
6. Understand the conjugates of different biomolecules and their importance

Module-I CARBOHYDRATES (9)

Classification, structure, properties and functions of carbohydrates: Monosaccharides –classes, examples, Disaccharides – classes- homo and hetero, examples. Oligosaccharides-examples; Polysaccharide – classes and examples

Module-II FATTY ACIDS (9)

Fatty acids- basic structure, types, isomers, properties, functions and essential fatty acids; Classes, structure, properties and functions of lipids: Simple lipid- examples, Compound lipid- examples, ether lipid, Derived lipid – sterols like cholesterol, clinical significance of fatty acids and lipids –examples.

Module-III AMINO ACIDS (9)

Amino acids- basic structure, isomers, classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides –examples; Proteins- structure / conformation levels, Ramachandran plot, classification, properties and functions of proteins-

Module-IV NUCLEOTIDES (9)

Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-composition, stabilizing bonds, protein –DNA interactions; RNA types, structure and functions; properties of nucleic acids

Module-V VITAMINS (5)

Vitamins: classification, source, daily requirement, functions and deficiency symptoms, review on nutraceuticals and Vitamin supplementations;

Module-VI MINERALS (4)

Minerals: classification, specific function and deficiency disorders.

Total Hours: 45

Text Books

1. Lehninger, A.L, Nelson D.L and Cox, M.M, "Principles of Biochemistry", Freeman Publishers, New York, 4th edition, 2005.

Reference Books

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.
2. Lubert Stryer, "Biochemistry", WH Freeman & Co., 4th edition, 2000.
2. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.
3. Jain and Jain "Biochemistry", Chand publication, 4th edition, 2008.

18BT2057	PATHOLOGY AND MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. Gain knowledge on the structural and functional aspects of living organisms
2. To understand the properties of antigens and antibodies and the concept of antigen-antibody interactions
3. To understand the morphological characteristics and cultivation of bacteria

Course outcome:

1. Acquire the knowledge of concepts of cell injury, neoplasia and changes produced thereby in different tissues and organs
2. Understand in brief, about the hematological diseases and investigations necessary to diagnose them
3. Demonstrate various antigen-antibody interactions and techniques
4. Evaluate the working principle of microscope in diagnosis of infectious and non-infectious diseases
5. Recognize the fundamental concepts in the structure and functioning of a cell
6. Acquire knowledge of common immunological techniques for disease diagnosis

Module I CELL INJURY, INFLAMMATION AND REPAIR (9)

Cell injury: Causes and Mechanism: Ischemic, Toxic. Reversible cell injury: Types, morphology: Swelling, vacuolation, hyaline, fatty change. Irreversible cell injury: Types of Necrosis. Calcification: Dystrophic and Metastatic. Amyloidosis: classification, Pathogenesis, Morphology. Acute inflammation: Inflammatory cells and Mediators, Chronic inflammation: Causes, types, nonspecific and Granulomatous with examples, wound healing by primary and secondary union, healing at specific sites including bone healing

Module II NEOPLASIA AND IMMUNOPATHOLOGY (9)

Atrophy, Hypertrophy, Hyperplasia, Hypoplasia, Metaplasia, Malformation, Agenesis, Dysplasia. Neoplasia: Classification, Histogenesis, Biologic Behaviour: Benign and Malignant; Carcinoma and Sarcoma. Malignant Neoplasia: Grades and Stages, Local and distant spread. Carcinogenesis, Tumor immunology. Laboratory diagnosis: Cytology, Biopsy, Tumor markers Immune system: organisation, cells, antibodies and regulation of immune responses. Hypersensitivity, Antibody and cell mediated tissue injury: Primary immunodeficiency, Secondary Immunodeficiency: Auto-immune disorders like systemic lupus erythematosis.

Module III PRINCIPLES OF MICROBIOLOGY (9)

Commensal and pathogenic microbial flora of human body, host-microbe interactions, routes of transmission of microbes in the body, mode of action of anti microbial agents, antimicrobial susceptibility test, nosocomial infections, post operative infections

Module IV MORPHOLOGY AND STERILIZATION (9)

Morphological features and structural organization of bacteria, growth curve, identification of bacteria – staining techniques, Gram positive and Gram negative cell wall, culture media and its types, culture techniques and observation of culture, control of microorganisms.

Module V INFECTIOUS DISEASES (5)

Mycobacterial Diseases: Tuberculosis and Leprosy. Bacterial diseases: Pyogenic, Typhoid, Diphtheria, Gram negative infection, Bacillary dysentery, Syphilis. Viral: Polio, Herpes, Rabies, Measles; Rickettsial, Chlamydial infection.Fungal diseases and opportunistic infections.

Module VI PARASITIC DISEASES (4)

Parasitic Diseases: Malaria, Filaria, Amebiasis, Kala-azar, Cysticercosis, Hydatid. AIDS: Aetiology, modes of transmission, diagnostic procedures and handling of infected material and health education.

Total Hours: 45

Textbooks:

1. Ramzi S Cotran, Vinay Kumar and Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2010.
2. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2014.

Reference books:

1. Prescott, Harley and Klein, "Microbiology", 8th edition, McGraw Hill, 2013.
2. Underwood JCE: General and Systematic Pathology Churchill Livingstone, 5rd edition, 2010.
3. Ananthanarayanan and Panicker, "Microbiology" Orientblackswan, 2015.

18BT2058	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	0	3

Course objective:

1. To explain the basics on the structure animal cell and organs
2. To illustrate the different systems of the body and their functioning
3. To demonstrate the fundamentals in human anatomy and physiology

Course Outcome:

The students will be able to

1. To give outline on animal cells, their functions and membrane transportation of cells.
2. To explain the composition of blood and its function on maintaining homeostasis.
3. To demonstrate the components of respiratory and cardiovascular systems.
4. To describe briefly about the anatomical locations, structures and their physiological functions of respiratory and cardiovascular systems.
5. To illustrate the structure and functions of nervous system and parts of brain.
6. To explain about the structure of eye, ear and kidney and their functions.

Module I CELL (9)

structure and organelles, function of each component. Cell membrane, transport across membrane, origin of cell membrane potential (Nernst and Goldman and Katz equations), action potential.

Module II: BLOOD COMPOSITION (9)

Functions of blood, functions of RBC. WBC types and their functions, blood groups, importance of blood groups, identification of blood groups, blood flows factors regulating blood flow such as viscosity, radius, density etc.

Module III COMPONENTS OF RESPIRATORY SYSTEM (3)

Oxygen and carbon di oxide transport and acid base regulation

Module IV HEART AND ITS REGULATION (6)

structure of Heart, properties of cardiac muscle, cardiac muscle and pace maker potential, cardiac cycle, ECG, Heart sound, volume and pressure changes and regulation of heart rate.

Module IV STRUCTURE OF A NEURON (9)

Synaptic conduction. Conduction of action potential in neuron. Parts of brain cortical localization of functions, EEG. Simple reflexes, with drawls reflexes. Autonomous nervous system and its functions

Module V: STRUCTURE OF VISUAL PATHWAYS (9)

Structure of Eye, Ear and auditory and visual pathways. Structure of kidney and nephron, Mechanism of Urine formation and base regulation. Dialysis.

Total Hours: 45

Text Books:

1. Anne Waugh, Allison Grant, "Ross and Wilson: Anatomy and Physiology in health and Illness", Churchil Livingston Elsvier 2010.

References:

1. Elaine . N. Marieb, "Essentials of Human Anatomy and Phsiology" 8th edition, Pearson education, New Delhi 2007
2. William F Ganang "Review of Medical physiology" 2nd edition McGraw Hill , New Delhi, 2000.

18BT2059	ENTREPRENEURSHIP, IPR AND BIOSAFETY	L	T	P	C
		3	0	0	0

Course Objective:

1. To impart various aspects of product design and development
2. To inculcate concept generation and selection
3. To understand technology behind the product of the service

Course Outcome:

1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype and biosafety.
6. Transform research based ideas into feasibility and business plans and IPR.

Module I: CONCEPT OF ENTERPRENEURSHIP (5)

Concept and evolution of entrepreneurship, development of Entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Role of SSI in economic development, Government support for SSI.

Module II: SOCIETAL ROLE IN ENTERPRENEURSHIP (4)

Role of society and family in the growth of an entrepreneur. Challenges faced by women in entrepreneurship.

Module III: PRODUCT PROCESS AND DESIGN (9)

Identification of business opportunities, project selection, contents, formulation, guidelines by planning commission for project report. Product design, importance, objectives, factors influencing product design, Product Development Process, sources of ideas for designing new products, stages in product design.

Module IV: INNOVATION AND PROTOTYPE (9)

Creativity and innovation, generation of ideas, technical and market feasibility study, opportunity assessment, business plan preparation, execution of business plan, conversion of ideas to prototype, risk taking-concept; types of business risks.

Module V: BIOSAFETY (9)

Procedure for getting license and registration, challenges and difficulties in starting an enterprise, host institution support, The role of technology/social media in creating new forms of firms, organizations, networks and cooperative clusters. Market- traditional and E-commerce, expanding markets: local to global.

Module VI: IPR AND COPYRIGHT (9)

IPR and copy right, financial opportunity identification; banking sources; non banking institutions and agencies; venture capital and angel investors, meaning and role in entrepreneurship, government schemes for promoting entrepreneurship.

Total Hours: 45

Text Books:

1. Jayshree Suresh, "Entrepreneurial Development", , 5th Edition, Margham Publications, 2008.
2. Robert D. Hisrich, "Entrepreneurship", 6th Edition, Tata McGraw Hill Publications.2009.

Reference Books:

1. Donald F. Kuratko, "Entrepreneurship: Theory", Process and Practice 9th Edition, Cengage Learning, 2011.
2. Sateesh MK, Bioethics and Biosafety, IK International, 2012.
3. Anupam Singh and Ashwani Singh. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), NPH, New Delhi, 2010.

18BT3001	Advances in Biopolymers and Applications	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Application of biopolymers in the field of pharma and food industries.
2. Interaction of biopolymers and their structure – function relationship
3. Recent trends in biomolecules research

Course Outcome:

The students will be able to

1. Understand the significance of the biopolymers and their industrial role.
2. Learn the advances in glycobiology and their application in pharma industry
3. Acquire information on protein engineering and their application in food and nanotechnology
4. Study about the importance of enzymes and lipids in industries
5. Understand the role of hormones, their regulations, nucleic acids and importance of biosensors in diagnosis
6. Apply their knowledge on the emerging biopolymers of industrial significance and to develop possible new drugs for emerging diseases.

Unit-1 Glycobiology (10 hours)

Glycoconjugates – Glycan structure of proteoglycan, glycoproteins, glycolipids and lipopolysaccharides; role of glycans in glycoconjugates - in cell-cell interaction/adhesion, recognition markers; Scope of Glycobiology; Lectins use and interaction with glycoconjugates; Glycans in biotechnology and pharmaceutical industry: as components of vaccines and small molecule drugs, glycosylation engineering, therapeutic glycans. Applications of carbohydrate biopolymers in encapsulation and the synthesis of nanomaterials

Unit-2 Protein Engineering (8 hours)

Structure- function relationship in fibrous and globular proteins, protein motifs; industrially significant peptides; Protein associated diseases and protein marker in disease diagnosis, Protein Engineering Methods - application of amino acids in the synthesis of nanomaterials Applications of proteins: Food industry, Environmental, Medical.

Unit-3 Enzyme Technology and Applications (8 hours)

Enzyme markers in disease diagnosis – hepatobiliary diseases, myocardial disorders, atherosclerosis, renal dysfunction, oxidative stress and cancer; enzyme based biosensors; Enzymes in food, and pharmaceutical industries; Application of enzymes in agriculture and environment protection; enzyme immobilization techniques and its applications.

Unit-4 Hormones and Antibodies (6 hours)

Mechanism of actions of chemically diverse hormones, Regulation of hormone release-by signals; Hormone drugs and their actions; applications of hormones in anti-ageing medicine. Hormone and antibody based biosensors; Antibody engineering, Abzymes

Unit-5 Lipid Technology and Applications (7 hours)

Industrial applications of fatty acids and lipids; liposomes and their novel applications, role of lipids in pharmaceutical industry, Lipid biotransformation, Techniques for the extraction of lipid from natural origin, Structured Lipids for Food and Nutraceutical Applications

Unit-6 Nucleic Acid Biopolymer (6 hours)

Applications of nucleic acid polymer in diagnosis and therapy - nucleic acid probes in clinical laboratory; Application of functional nucleic acids. Review on current status of gene therapy research.

Reference Books

1. Varki A, Cummings R.D, Esko J.D, Freeze H.H, Stanley P, Bertozzi C.R, Hart G.W,Etzler M.E., " Essentials of Glycobiology", Second edition; Published by Cold Spring Harbor Laboratory Press, New York, 2009
2. Lehninger A. L, Nelson D. L. and Cox M. M. "Principles of Biochemistry" Fourth Edition (Freeman Publishers), New York, 2005.
3. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.
4. Donald Voet and Judith G. Voet . "Biochemistry" – Volume 1, Biomolecules, Mechanisms of Enzyme Action and Metabolism, John.Willey and sons, 2004.
5. D. D. Lasic is at Liposome Consultations, 7512 Birkdale Drive, Newark, CA 94560, USA.
6. Burcu Turanli-Yildiz, Ceren Alkim and Z. Petek Cakar (2012). Protein Engineering Methods and Applications, Protein Engineering, Prof. Pravin Kaumaya (Ed.), ISBN: 978-953-51-0037-9

18BT3002	Genetic Engineering and Recombinant Products	L	T	P	C
		3	0	0	3

Course Objectives:

To gain knowledge about

1. The history and future of genetic engineering
2. The techniques employed in Genetic Engineering in the field of medicine and the biotech industry.
3. The techniques involved in generating transgenic microbes, plants and animals.

Course Outcome:

The students will be able to

1. Understand the basic concepts in Genetic engineering.
2. Understand the usage of the tools of genetic engineering.
3. Learn the techniques employed in genetic manipulation of microbes.
4. Learn the techniques employed in the genetic manipulation plants for crop improvement
5. Learn the techniques employed in the genetic manipulation animals for commercial purposes.
6. Learn the genetic manipulation techniques employed in the production of therapeutics.

Module I: Introduction & Tools employed in Genetic engineering. (5 Hours)

Impact of r-DNA products in food, drug, agriculture, and industry. Market share of various r-DNA products, the Indian scenario of r-DNA products.

Module II: Vectors (6 Hours)

Properties of ideal vectors, Cloning vectors PBR322- pUC, M13-Lambda phage vectors ,Cosmid vectors, Phagemids Cloning vectors in Gram positive bacteria- Streptomycetes, Shuttle vectors. Expression vectors : pGEX, T7 system, Alternate systems, YAC,BAC, mammalian vectors: SV40 vectors, CMV vectors, Plant vectors, Ti Plasmid vectors, CMV vectors.

Module III: Polymerase Chain Reaction (6 Hours)

Introduction to PCR, Primer design, Mechanism of PCR, Types of PCR, Inverse PCR, Nested PCR, Taqman PCR, Molecular beacons, RACE PCR, RAPD, Reverse Transcriptase PCR, Real Time PCR, Nucleic acid sequenzing methods. PCR/Oligonucleotide directed mutagenesis.

Module IV Construction & Analysis of recombinant DNA (10 Hours)

Construction of Genomic DNA libraries & cDNA libraries, PCR Cloning of DNA for Expression in E.coli, Yeast, Plant & Mammalian cells. Physical, chemical and biological methods of transferring recombinant DNA into target cells: Preparation of competent cell & Transformation into bacteria, Electroporation, Transfection, Biolistics & Gene gun.
Restriction analysis, Colony PCR, Probe preparation-Radioactive & nonradioactive labels-Different labelling methods: End and Body labelling.
Southern hybridization-Northern hybridization; Western blotting, subtractive hybridization, Autoradiography/Chemifluorescence.

Module V: Protein and Nucleic Acid products of rDNA technology (9 Hours)

Production of hormones, enzymes for therapeutics and diagnostics. Recombinant enzymes for industrial applications. Vaccines, Chimeric & humanized antibodies, and immune modulators. DNA vaccines, Gene therapy. DNA oligonucleotides for Antigene applications, DNAzymes, ribozymes, aptamers, RNA decoys, siRNA, micro RNA and CRISPER-CAS.

Module VI: Genetically Modified Organisms (9 Hours)

Improved crop varieties GMOs: drought resistant, pest resistant, virus resistant salinity tolerant, Terminator technology, Biofortified crops, Phytic Acid GMOs, Plantibodies and Vaccines production in plants. Genetically enhanced animals, hypoallergenic cows, GMO pets, fluorescent aquariums fish.

References

1. Berhard R. Glick, Chery L. Patten, **Molecular Biotechnology: Principles and Applications of Recombinant DNA**, 5th edition
2. W T Godbey, **An Introduction to Biotechnology** ,AP
3. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski, **Recombinant DNA: Genes and Genomes**, W.H. Freeman
4. Kadema Carter, Biomedical Applications of DNA Recombinant Technology, Koros – 2014
5. Lilia Alberghina, **Protein Engineering For Industrial Biotechnology**, Hardwood Academic Press
6. Nigel W. Scott, Mark R. Fowler, Adrian Slater, **Plant Biotechnology**: **The genetic manipulation of plants**,2nd Edition
7. Carl A. Pinkert, **Transgenic Animal Technology**: A Laboratory Handbook.

18BT3003	Bioprocess Modelling & Simulation	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Principles and frameworks of data driven modeling
2. Mathematical models relevant to industrial and environmental bioprocess systems
3. Basics of MATLAB required for formalization of Bioprocess models and its simulation

Course Outcome:

The students will be able to

1. Discretize a given bioprocess system into a set of key mathematical expressions
2. Design required data collection scheme for identification of bioprocess parameters
3. Apply MATLAB for numerical modelling with coupled differential or algebraic equations
4. Perform parameter sensitivity and confidence interval estimation
5. Predict future trend and suggest remedial measures to have sustainable bioprocess
6. Select and Implement appropriate modelling framework depending on bioprocess system

Module I: Introduction to Bioprocess modelling (7 Hours)

Basic modeling principles – Purpose of modelling transient or steady state behaviour – types of mathematical models and modelling approaches. Fundamental laws guiding modelling framework – mass

and energy balance, charge balance, equilibrium states and chemical kinetics, continuity equation. Model parameter and complexity

Module II: Mathematical formalization of Bioprocess (7 Hours)

Representation of Bioprocess (with examples) in terms of key mathematical expression, Data availability and designing data collection. Parameter identifiability, estimations and redundancy. Kinetic, stochiometric relations in terms of coupled differential or algebraic equations. Numerical modelling algorithm – initial and boundary value problem.

Module III: Matlab basics for modelling (8 Hours)

Basics of Matlab environments, data import and export, variables, vector-matrices operations, Matlab functions, Numerical integration, Euler and fourth order Runge-Kutta method, Matlab ODE and DAE solvers. Simulating a bioprocess with known process parameters

Module IV: Matlab application in bioprocess modelling (9 Hours)

Solving problems by numerical integration using MATLAB. Modelling simple microbial growth, substrate consumption and product formation kinetics in batch Process. Dynamic simulation of CSTR.

Module V: Parameter Estimation and sensitivity analysis, model fitness (7 Hours)

Parameter estimation from experimental and modelled data, Least square regression techniques -exercise, Embedding numerical bioprocess model into constrained multivariable optimization problem. Sensitivity and confidence interval estimation using boot-strapping

Module VI: Advanced Bioprocess Modelling examples (7 Hours)

Kinetic model for simultaneous saccharification and fermentation, Mathematical modelling of anaerobic digestion, Modelling and Simulation of Citric Acid Production from Corn Starch Hydrolysate, Enzymatic hydrolysis of lignocellulose

References

1. Verma, Ashok Kumar (2014) ***Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering***, CRC Press
2. Dunn, Irving J. (2003) ***Biological reaction engineering : dynamic modelling fundamentals with simulation examples***, Wiley-VCH
3. Nicoletti, Maria Carmo (2009) ***Computational Intelligence Techniques for Bioprocess Modelling, Supervision and Control***. Springer
4. Snape, Jonathan B. Dunn, Irving J., Ingham John, Prenosil Jiri E. (2008) ***Dynamics of Environmental Bioprocesses: Modelling and Simulation***, John Wiley & Sons

18BT3004	Analytical Techniques in Biotechnology Lab	L	T	P	C
		0	0	4	2

Co-requisite: 18BT3001 Advances in Biopolymer and Applications

Course Objectives:

To improve knowledge on

1. Clinical role of biomolecules in biological sample.
2. Importance of biomolecules with the cells and organs of the body
3. Advanced analytical techniques

Course Outcome:

The students will be able to

1. Understand the procedure on assay of antioxidants
2. Know the protocol to isolation of biomolecules from various sources
3. Practice the free radical scavenging and antioxidants assays
4. Study methods of isolation and screening of phytochemicals from plants
5. Learn advanced separation techniques
6. Understand the latest techniques on determination and structure prediction using sophisticated techniques

List of Experiments

1. Assay of acid phosphatase
2. Assay of lipid peroxidation (LPO) in plasma
3. Estimation of glucose by glucose oxidase and peroxidase (GOD – POD) method
4. Estimation of serum hexosamine by Wagner method
5. Determination of peroxide value of an oil
6. Isolation and preparation of lecithin from egg
7. Determination of total antioxidant capacity by phosphomolybdenum method (Prieto *et al.)*
8. Modified hydroxyl radical scavenging assay
9. Phytochemical screening from plants using HPTLC
10. Separation of phytochemicals by HPLC
11. Determination of molecular weight of phytochemicals by Mass spectrometry
12. Biomolecular structure prediction using X-Ray diffraction

18BT3005	Animal and Plant Tissue Culture Lab	L	T	P	C
		0	0	4	2

Course Objectives:

To impart knowledge on

1. Plant tissue culture and transformation techniques
2. Animal tissue culture and assays
3. Sterilization techniques on Plant and Animal Tissue Culture

Course Outcome:

After completing the course the students will be able to

1. Demonstrate media preparation on PTC and ATC
2. Comprehend on sterilization techniques
3. Experiment plant transformation techniques
4. Evaluate the animal cell culture techniques
5. Demonstrate isolation of macrophages from animals
6. Perform MTT assay and analyze the data

List of Experiments

1. Sterilization Techniques – Media and Explants
2. Callus induction from explants
3. Cell Suspension Culture for metabolite production and growth kinetic studies
4. Bacterial transformation and Raising of *in vitro* plantlets
5. Agrobacterium mediated gene transfer in *in vitro* plantlets
6. Preparation of reagents for tissue culture
7. Preparation of growth medium for cell culture
8. Isolation of macrophages from mouse peritoneum
9. Quantification and checking viability of cells (thymocytes or spleenocytes or macrophages) using trypan blue dye exclusion method.
10. Isolation of lymphocytes from thymus
11. Isolation of spleenocytes from mouse spleen
12. MTT Assay

18BT3006	Advanced Process Equipment Design and Drawing Lab	L	T	P	C
		0	0	4	2

CO- request: Process equipment Design

Course Objectives:

1. To design safe and dependable processing facilities.
2. This course focuses on plant layout and selection.
3. This will provide the basic knowledge to carry out process equipment design and cost effect.

Course Outcome :

After completing the course the students will be

1. On completion of this lab subject students should be able to understanding the symbols of process equipments.
2. Understand the procedures for construction of geometric figures
3. Students know very well about plant layout and safety of process equipments
4. Students should be able to understand the mass and energy balance calculations
5. Students will have completed detailed design of unit operations
6. Students should be able to understanding the drawing of process equipments.

List of Equipments:

1. Basics of various unit operation symbols
2. Plant layout
3. Engineering Letters, Lines and numbers.
4. Shell and tube heat exchanger
5. Single effect evaporator
6. Batch reactor
7. Air lift Fermentor
8. Fractional distillation column
9. Rotary drum filter
10. Absorption column
11. Gate Valves
12. Venturi meter

References:

1. Unit operation by McCabe Smith (Mc Cabe Smith)
2. Heat Transfer by Kern (Kern)

18BT3007	Recombinant DNA Technology Lab	L	T	P	C
		0	0	4	2

Co-requisite: Lab in Molecular Biology

Course Objectives:

To impart knowledge on

1. The basic laboratory techniques employed in a genetic engineering Lab
2. The extraction and analysis of nucleic acids and proteins.
3. Genetic manipulation of Nucleic acids for protein production.

Course Outcome:

After completing the course the students will be able to

1. Isolate nucleic acids
2. Perform electrophoresis of nucleic acids and proteins.
3. Manipulate DNA using enzymes.
4. Purify various RNA and perform reverse transcription
5. Amplify nucleic acids using PCR
6. Express, purify and analyze recombinant protein

List of Experiments

1. Isolation of plasmid DNA and restriction digestion to estimate molecular weight by Agarose Gel electrophoresis
2. Isolation of total RNA from E.coli
3. Isolation of total RNA from mammalian cells
4. Isolation of mRNA from mammalian cells using poly T beads.
5. Reverse Transcriptase PCR of target gene & Agarose Gel electrophoresis to estimate molecular weight.

6. RE digestion of the PCR product & cloning the digested PCR product into E.coli Expression vector by ligation
7. Preparation of competent E.coli and transformation of the cloned plasmid and selection of recombinant clones.
8. Induction of expression using IPTG and extraction of expressed protein.
9. Analysis of expressed protein using SDS-PAGE.
10. Midi scale expression of target protein
11. Extraction and purification of target protein using affinity beads/column.
12. Western blotting analysis for confirmation of purity and quality of expressed protein

18BT3009	Enzyme Technology and Industrial Applications	L	T	P	C
		3	0	0	3

Course Objective:

1. To understand the mechanism of biocatalyst
2. To learn the kinetics of enzymatic reaction
3. To learn about applications of enzymes

Course Outcome:

1. The students will understand the concept of immobilization
2. The student will understand extraction and purification of enzymes
3. The student will learn the inhibition kinetics of the enzymatic reactions
4. The student will learn the application of enzymes
5. The student will learn protein engineering of enzymes
6. The student will learn about commercial production of enzyme

Module I: Introduction to enzymes (7 hours)

Classification of enzymes, quantification of enzyme activity and specific activity, Enzyme in action & specificity, Enzyme stability, monomer & oligomeric enzymes. Structure of enzymes-ray crystallography of enzymes, control of Enzyme activity

Module II: Enzyme kinetics & modeling of enzymatic systems:- **(7 hours)**

Kinetics of multisubstrate enzyme catalyzed reaction, relation of kinetic parameters, microenvironmetal effects on enzyme kinetics, Enzyme Inhibition – Substrate, Product and Toxic compound inhibition, types and derivation. Enzyme deactivation kinetics. Allosteric regulation of enzymes, Monod changeux wyman model

Module III: Immobilized enzymes: **(8 hours)**

Introduction, Methods of immobilization, kinetics of immobilized enzymes, Analysis of film and Pore diffusion & application in production of L-amino acids, & other uses, enzyme biosensors (design of E electrodes & application.).

Module IV: Industrial enzymes:- (8 hours)

Few industrial nzymes like glucose-isomerase, cellulases, Pectinases, protease etc. Their importance, source production, optimization of fermentation medium, assay, extraction and purification, Characterization, genetic manipulation etc. Applications of enzymes in analysis; Design of enzyme electrodes

Module V: Protein Engineering of Industrial enzymes: (7 hours)

Introduction, targets by Chemo enzymatic Synthesis, rational design methods, site directed mutagenesis, Chemical modification and unnatural amino acids, Random method like molecular evolution, DNA shuffling, sequence space, method for mutagenesis, for recombination, sequence homology independent recombination,screening and selection

Module VI: Enzyme as tools for stereo specific c- c bond formation in Monosaccharide & analogues (8 hours)

Enzymes like DHAP aldolase, pyruvate aldolase, tyrosine kinase & their uses, Uses of mutagenesis to increase substrate specificity. Producing catalytic antibodies etc.

References:

1. Palmer T, P.L. Bonner, "Enzymes: Biochemistry", "Biotechnology", "Clinical chemistry", 2nd Edn, Harwood Publishing Ltd. 2007.
2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2002
3. Bailey J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals", McGraw Hill,2000.
4. Ashok Pande, Colin Webb, Carlos Richard, Cristian Larroche. Enzyme Technology, 2006, Springer
5. Price and Lewis Stevens. Fundamentals of Enzymology, Oxford, United Kingdom, 2000

18BT3010	Microbial Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To learn bacterial genetics and techniques for genetic engineering.
2. To study the role of microbiology in medicine, agriculture, and the environment.
3. To develop value added microbial products and commercialization

Course Outcome:

The students will be able to

1. Evaluate the role of micro-organisms in specific biotechnological processes
2. Study the complex processes behind the development of genetically manipulated organisms
3. Demonstrate a clear understanding of proteomics relate to biotechnological applications
4. Create an array of products to benefit humans, animals and the environment.
5. Interaction of microbiota with plants, animals, bacteriophages
6. Commercialization of a new microbially-based biotechnology product.

Module I: Introduction (8 Lecture Hours)

Microbial life: Microbial Cell Cultivation Systems, Culture media- types, components and formulations. Sterilization: Batch and continuous sterilization, Types of fermentations- Aerobic and anaerobic fermentation, Submerged and solid state fermentation; Factors affecting submerged and solid state fermentation; Substrates used in SSF and its advantages.

Module II: Microbial Genomics (7 Lecture Hours)

Introduction to Microbial genomes, Genome sequencing of different microbes and their importance, Techniques for genome research (chromosome walking, RFLP etc.), Metagenomics; Application of microbial genomic variability for utilizing in human welfare, Phylogenetic relationships between various genera of microbes, Methods to Compare Genomes, Evolution by Genome Expansion and Reduction, Archaeal Genomics, Microbial Genome Annotation.

Module III: Microbial Proteomics (7 Lecture Hours)

Introduction to microbial proteomics, 2D gel profiling, MALDI – ToF, Protein purification work station of various microbes, Microbial pathogenesis at the proteome level, Structural proteomics and computational analysis Proteomics of Archaea, Proteome research for novel drug targets, High throughput proteomic screening for novel enzymes

Module IV: Microbes in agriculture (8 Lecture Hours)

Microbes as biocontrol agents (Baculoviruses, entomopathogenic fungi, *Bacillus thurinigiensis*, *Bacillus sphaericus*, *Bacillus popilae*, Microbe derived inhibitors, biology of nitrogen fixation, preparation of different types of inoculants (nitrogen fixers, phosphate solubilizers, plant growth promoting rhizobacteria (PGPR), composting, biopesticides.

Module V: Microbial interactions (8 Lecture Hours)

Interactions with microorganisms, plants and animals, Bacteriophages in control of bacteria, The gut microbiota, Cancer and the microbiota, Thermal adaptation of decomposer communities to global warming, Gene manipulation of useful microbes, Recombinant vaccines.

Module VI: Commercial products (7 Lecture Hours)

Organic acids- citric acid, acetic acid, Solvents- ethanol, acetone-butanol , Beverages- beer, wine biopolymers, enzyme, vitamins, antibiotics, biosensors, biosurfactants, bioconversion.

References

1. Ian Humphery-Smith and Michael Hecker, Microbial Proteomics: Functional Biology of Whole Organisms by Publisher: Wiley-Interscience; 1st edition, 2010.
2. Thomas J. Dougherty and Steven J. Projan, Microbial Genomics and Drug Discovery by Publisher: CRC; 1st ed. 2013.
3. Rajhi Gupta, Jagjit Singh, T.N. Lakhanpal, and J.P. Jewari, Advances in Microbial Biotechnology by Publisher: A.P.H. Pub. Corp. 2005.
4. Stanbury, P. F., Whitaker and Hall, A. S. J., Principles of Fermentation Technology. Butterworth-Heinemann, 2009.
5. Shuler, M.L. and Karg, I F., Bioprocess Engineering Basic Concepts, 2010.
6. Crueger W. and Crueger, A., Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates, 2008.

18BT3011	Agriculture and Food Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

1. To improve knowledge on principles of Agriculture and plant breeding
2. Understand the concept of agricultural microbiology and biotechnology
3. To know Food processing and packaging techniques
4. To elaborate the understanding of biodiversity and IPR issues in agricultural crops.

Course Outcome:

The students will be able to

1. Acquire knowledge on basics of Agriculture and Plant Breeding
2. Outline the principles Agriculture Microbiology
3. Understand the concept of Agriculture Biotechnology
4. Relate Biodiversity and intellectual property rights
5. Evaluate the advances in Food biotechnology
6. Relate Food processing and Packaging techniques

Module I: Basics of Agriculture and Plant Breeding (8 Lecture Hours)

Factors effecting agriculture and agricultural classification of plants, Origin of cultivated plants and plant indication, Methods of breeding self pollinated and vegetatively propagated plants, Breeding of crops pollinated plants

Module II: Agriculture Microbiology (7Lecture Hours)

Microbes of agricultural importance, Microbe based biofertilizers, Soil microbes and plant growth substances, biocontrol agents, Induced systemic resistance(ISR), Plant growth promoting rhizobacteria (PGPR)

Module III: Agriculture Biotechnology (8 Lecture Hours)

Plant derived Biotechnological Products, Plant tissue culture and Genetic engineering, integrated pest and nutrient management, poly house technology, Biotech industries & institutes in India & world, Concepts of Biotech park. Entrepreneurship biotechnology

Module IV: Biodiversity and intellectual property rights (8 Lecture Hours)

Genetic diversity, Molecular diversity; Species and Population biodiversity, Collection and conservation of biodiversity, endangered plants, endemism and Red Data Book, Biodiversity and centers of origins of plants; Biodiversity hot spots, IPR in relation to Indian Flora

Module V: Food biotechnology (7 Lecture Hours)

Food spoilage causes and prevention, Food borne infections and intoxication immobilization of microbial and cultured plant cells. Principles of down stream processing, industrial production of various food products

Module VI: Food processing and Packaging (7 Lecture Hours)

Scope and importance of food processing. National and international perspectives. Principles and methods of food preservation, Storage of food, Packaging operations, shelf life of packaged foodstuff, methods to extend shelf-life, Food packages and containers

References

1. Principles of Gene Manipulation and Genomics (2006) Sandy B. Primrose and Richard Twyman
2. Gene Cloning and DNA Analysis: An Introduction (2010) by T. A. Brown
3. Understanding biodiversity: Life, sustainability, and equity (1997) by Ashish Kothari
4. Plant Breeding: Principles and prospects (1993) by M.D. Hayward and N.O. Bosemark
5. Plant Breeding (2014) by Jack Brown and Peter Caligari
6. Soil Microbiology, Ecology and Biochemistry, Fourth Edition (2014) by Eldor A. Paul
7. Introduction to Soil Microbiology (1999) by Mark Coyne
8. Fundamentals of Food Biotechnology (2015) by Byong H. Lee
9. Food Biotechnology (2012) by Vinod K. Joshi and R. S. Singh
10. Principles of Aseptic Processing and Packaging (2010) by Philip E. Nelson
11. Food Microbiology (2008) by Frazier

18BT3012	Big Data Analytics	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Fundamental concepts and methods of Big data analysis.
2. Data exploration, visualization and statistical analysis for given data set.
3. Performing big data analytics for Biological data set.

Course Outcome:

The students will be able to

1. Demonstrate fundamental knowledge of Big data analytics.
2. Explore different types of data from different sources.
3. Write R script to analyse data from data interface.
4. Develop and generate different types of charts and graphs.
5. Perform various statistical analysis using R packages for given data set.
6. Apply knowledge of big data analytics on bioinformatics and health care data set.

Module I: Introduction (8 Lecture Hours)

Big data analytics overview, Data life cycle, Traditional Data mining Life cycle, CRISP, Big Data life cycle methodologies, Machine learning implementation, Recommender system ,
Dashboard, Ad-Hoc analysis**.**

Module II: Data Exploration and Visualization (7Lecture Hours)

Problem Definition, Data Collection, Data Pre-processing, Data Cleaning – Homogenization, Heterogenization, Summarizing data, Data Exploration and Visualization.

Module III: Big Data Methods (9 Lecture Hours)

Introduction to R programming, Data Frames, Atomic vectors, Factors, Data types, Variables, Functions, working with excel files, Data interface.

Module IV: Charts & Graphs (6 Lecture Hours)

Develop pie chart, 3D pie chart, Histograms, Bar chart, Group bar chart, Stacked Bar chart, Line graph, Multiline graph and Box plot.

Module V: Statistical Methods (9 Lecture Hours)

Regression models, Linear Regression, Multiple regression, Logistic regression, Mean, Median, Mode, Chi-Square test, T-Test.

Module VI: Big data analytics for Health care (6 Lecture Hours)

Big data analytics in bioinformatics, Health care, Data mining using RNA seq data, Text mining on complex biomedical literature, Biological sequence motifs and patterns.

References

1. Venkat Ankam, "Big Data analytics", Packt publishing 2016
2. Parag Kulkarni, Sarang Joshi, "Big Data analytics", PHI learning2016
3. Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition

18BT3013	Bioethics and Biosafety	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Biosafety regulations and IPR
2. Human genome project and stem cell research
3. ethical issue of organ transplantation and transgenic animals

Course Outcome:

The students will be able to

1. Understand the various biosafety regulations in biotechnology
2. Get familiarized with IPR and patent procedures
3. Comprehend on ethical issues of human genome project and ethical races
4. Gain knowledge on stem cell technology and its application
5. Develop awareness on organ transplantation and its ethics
6. Comprehend on transgenic animals and its ethical issues

Module I: Legal and Socio-economic Impacts of Biotechnology — Biosafety Regulations (7 Lecture Hours)

National and International Level Biosafety Regulations, Trials On-field, Upscaling of Field Trials, Coordination and Capacity Establishment, Screen–A Newsletter on Biosafety, Hazardous Materials Used in Biotechnology—Handling and Disposal, Good Manufacturing Practices, Good Laboratory Practices, Good Laboratory Practice Principles

Module II: Intellectual Property Rights (9 Lecture Hours)

Intellectual Property Rights, World Trade Organisation (WTO), WTO Agreements, General Agreement on Tariffs and Trade (GATT), General Provisions and Basic Principles, Patenting and the Procedures Involved in the Application for Grading of a Patent, Steps to a Patent, Compulsary Licenses, Patent Cooperation Treaty (PCT), Examples of Patents in Biotechnology, Patenting of Living Organisms, Bioethics in Biodiversity

Module III: Human Genome Project (7 Lecture Hours)

Human Genome Project, Ethical Issues of the Human Genome Project, The Human Genome Diversity Project, The Need for a Strategic Framework, Foetal Sex Determination The Indian Law on Abortion, Social Implications of the Act, Ethical Issues in MTP, Ethical Issues Leading to Legal Issues, Genetic Studies on Ethnic Races.

Module IV: Stem Cell Research (9 Lecture Hours)

Introduction**,** Applications of Stem Cells, Ethics Involved in Stem-cell Research, Use of Cell-cultures as Alternatives to Use of Animals, Replacement, Use of Animals for Research and Testing, Animal Cloning, Ethics and Animal Cloning, Human Cloning, Why Cloning Humans is Ethically Unacceptable?, Controlling Someone Else's Genetic Makeup, Instrumentality, Infertility–An Exception to Instrumentality.

Module V: Organs Transplantation in Human Beings (8 Lecture Hours)

Organs Transplantation in Human Beings, Ethics in Xenotransplantation, Bioethical Issues, Transgenesis, Informed Consent, Allocation of Health Care Resources, Patentability and Xenotransplantation, Organ Culture, Ethical Issues.

Module VI: Transgenic Animals (6 Lecture Hours)

CCAC Guidelines on Transgenic Animals (1997), CCAC Guidelines on Animal Welfare, Laboratory Animal Management, The Need for Ethical Review

References

1. Sree Krishna. Bioethics and Biosafety in Biotechnology. New Age International Publishers, New Delhi, 2007

18BT3014	CHEMICAL PROCESS TECHNOLOGY	L	T	P	C
		3	0	0	3

Course objectives

1. This course will give powerful approach in designing new process and product development.
2. This course will be helpful to understand the processes technologies of various organic and inorganic process industries for manufacturing chemicals.
3. This course will be helpful to associated troubleshoot.

Course Outcome

1. Ability to understand the process flow diagram and various process parameters
2. Ability to understand the manufacturing of various inorganic chemicals
3. Ability to understand the manufacturing of various organic chemicals
4. Ability to identify and solve engineering problems during production
5. Ability to understand the process flow diagram and various process parameters
6. Ability to identify and solve engineering problems during production

Module I: Process Flow Diagram (8 Hours)

Basic philosophy of a process flow diagram (PFD). Elements of a PFD. General discussion on Influence of various parameters on deciding process for a product and method of drawing PFD. Nitric acid, sulphuric acid, phosphoric acid and it's important salts

Module II: Industrial Production (8 Hours)

Caustic chlorine industry - mercury, membrane and diaphragm cells. Hydrochloric acid and important chlorine compounds. Soda ash, sodium bicarbonate.Lime, cement and plasters , Glass & ceramic industries

Module III: Oils and Fats (7 Hours)

Methods of extracting vegetable oils (Process Description and Flow sheet). Hydrogenation of oils (Process description & flow sheet), major engineering problems and improved technology.

Module IV: Sugar Derivatives (8 Hours)

Sugar and starch industries: Manufacturing process with flow diagram, Sugar refining, manufacturing process of starch and their different by-products; Glucose, Sorbitol & Polyols.. Pulp and paper Industries, technology and manufacturing methods

Module V: Fermentation Products (7 Hours)

Fermentation industries: Industrial Alcohol, Absolute Alcohol; their production process with flow diagram.

Module VI: Agrochemical Industries (7 Hours)

Elementary ideas on Pesticides, Insecticides, Fungicides, Herbicides, DDT manufacturing process with flow sheet.

References:

1. Dryden, C. E., and Rao, M.G. (Ed.), Outlines of Chemical Technology Affiliated East West Press.2010

2. Austins, G.T., Sherve's Chemical Process Industries, MGH,2012.
3. Venkateswarlu, S. (Ed.) Chemtech (II) Chemical Engineering Development Centre, IIT, Madras.
4. S. K. Ghoshal, S. K. Sanyal and S. Datta, Introduction to Chemical Engineering, Tata McGraw Hill, New Delhi.
5. Kirk & Othmer (Ed.), Encyclopedia of Chemical Technology

18BT3015	IMMUNOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Immune systems and techniques in immunology.
2. Concepts in immunotechnology
3. Advancement in immunology and immunotechnology

Course Outcome:

The students will be able to

1. Understand the basics in functions of immune systems.
2. Learn the types of antibodies and the interaction between antigen and antibodies
3. Know skills and competence in specialized immunological techniques in the diagnosis and management of health related disorders.
4. Acquire knowledge and understanding of research methods employing immunological techniques for application in biomedical and clinical research
5. Apply immunological techniques to manage the immunological diseases
6. Learn about the application of modern technology in diagnosis and treatment of cancer

Module-I – THE IMMUNE SYSTEM (8 Hours)

Introduction - Cells of the Immune system - Innate and Acquired immunity - Primary and secondary lymphoid organs – Nature of antigens - Chemical and molecular basis of antigenecity – Immunogenecity - Haptens-Adjuvants - Primary and Secondary Immune Responses - Theory of Clonal selection. Preparation of antigens for raising antibodies**,**

Module-II – ANTIGEN-ANTIBODY INTERACTION (8 Hours)

In vitro antigen-antibody reactions, Isolation of antibodies, assays for complement, immunoelectrophoresis. ELISA, RIA and immunoblotting, Immunofluorescence, flow cytometry & sorting, T & B cell subset analysis, immuno-electron microscopy.

Module-III – ANTIBODIES (8 Hours)

MAb through hybridoma technology, MAb without hybridoma technology – viral transformation of B cell line, plant as expression systems – plantibodies, applications. Production of abzymes, immunotoxins, chimeric antibodies, bi specific antibodies, single chain Fc, diabodies, tetrabodies, intrabodies; plastibodies; applications. Plaque Forming Cell Assay

Module-IV – CELLULAR IMMUNOLOGY (7 Hours)

PBMC seperation from the blood; identification of lymphocytes based on CD markers; FACS; Lymphoproliferation assay; Mixed lymphocyte reaction; Cr51 release assay; macrophage cultures; cytokine bioassays- IL2, gamma IFN, TNF alpha.; HLA typing.

Module-V - IMMUNITY AND INFECTION MECHANISM: **(7 Hours)**

Tissue injury and Inflammation – Immunosuppression - Immunological Tolerance - Immunity to infectious agents – bacteria, virus, fungi and parasites. Transplantation – Autoimmunity - Tumor Immunology - Vaccines: Conventional Molecular vaccines -Types of vaccines - Recent trends in Immunology of Infectious diseases.

Module-VI – TRANSPLANTATION AND TUMOR IMMUNOLOGY (7 Hours)

Transplantation: genetics of transplantation; laws of transplantation; tumor immunology, Autoimmunity; Autoimmune disorders and diagnosis. Cell Cytotoxicity, mixed lymphocyte reaction, Apoptosis, Cytokine expression; Cell cloning, Reporter Assays, In–situ gene expression techniques;

References

1. David Male Jonathan BrostoffDavid Roth Ivan Roitt, Immunology. 8th Edn., Elsevier, 2012
2. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002
3. Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kerby J. Kuby Immunology, 6th ed., W.H. Freeman, 2005
4. Weir DM and Stewart, J., Immunology, 10th Edn. Churchill Livingston, New York, 2000.

18BT3016	COMPUTATIONAL BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To provide foundation in fundamental concepts, tools and resources in Computational Biology.
2. To introduce machine learning and data mining concepts and techniques relevant to biological data along with practical implementation of machine learning techniques.
3. To develop skills in specialized areas related to Computational Biology which will enable high throughput data processing and analysis.

Course Outcome:

The students will be able to

1. Will be familiar with resources, biological data, its analysis and interpretation.
2. Will be able to analyze high throughput biological data and perform statistical analysis / develop mathematical models
3. Will be able to use data mining and apply machine learning techniques like ANN, SVM and HMM for any data classification and prediction problem
4. Will develop skills in molecular modeling and simulation, whole cell modeling, drug discovery, Systems Biology and other emerging areas
5. Will be familiar with the design and implementation of of algorithms which may help them design their own.
6. Will be familiar with the theory and practical aspects of important experimental techniques.

Module I: Introduction (10 Hours)

Molecular sequences, Genome sequencing: pipeline and data, Next generation sequencing data, Biological databases: Protein and Nucleotide databases, Sequence Alignment, Dynamic Programming for computing edit distance and string similarity, Local and Global Alignment, Needleman Wunsch Algorithm, Smith Waterman Algorithm, BLAST family of programs, FASTA algorithm, Functional Annotation, Progressive and Iterative Methods for Multiple sequence alignment, Applications

Module II: Phylogentic analysis (7Lecture Hours)

Introduction to Phylogenetics, Distance and Character based methods for phylogenetic tree construction: UPGMA, Neighbour joining, Ultrametric and Min ultrametric trees, Parsimonous trees, Additive trees, Bootstrapping.

Module III: Bio molecular structure modelling and simulation (7 Lecture Hours)

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Structural Genomics, Molecular Docking principles and applications, Molecular dynamics simulations.

Module IV: Machine learning methods and analysis (7 Lecture Hours)

Machine learning techniques: Artificial Neural Networks and Hidden Markov Models: Applications in Protein Secondary Structure Prediction and Gene Finding, Introduction to Systems Biology and its applications in whole cell modelling, Microarrays and Clustering techniques for microarray data analysis, informatics in Genomics and Proteomics, DNA
Computing.

Module V: Perl for Bioinformatics (7 Lecture Hours)

Variables, Data types, control flow constructs, Pattern Matching, String manipulation, arrays, lists and hashes, File handling, Programs to handle biological data and parse output files for interpretation

Module VI: Systems Biology and protein network analysis (7 Lecture Hours)

Systems Biology Networks- basics of computer networks, Biological uses and Integration. Micro array – definition, Applications of Micro Arrays in systems biology. Self-organizing maps and Connectivity maps - definition and its uses. Networks and Pathways – Types and methods. Metabolic networks.

References

1. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
2. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
3. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press.
4. Andrew R. Leach, Molecular Modeling Principles And Applications, Second Edition, Prentice Hall
5. Proteomics from protein sequence to function: Edited by S.R.Pennington and M.J.Dunn,Taylor and Francis Group, 2001.
6. Computational systems biology by A.Kriete, R.Eils, Academic Press. 2005
7. Systems Biology and Synthetic Biology by Pengcheng Fu, Sven Panke, Wiley InterScience. 2009

18BT3017	METABOLIC REGULATION AND ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. To develop skills of the students in the area of metabolic regulation and engineering to amend the existing metabolic pathways
2. To enable the students to use molecular techniques to enhance the product yield and also to produce industrially important products in a cost effective manner.
3. To understand the quantitative basis of metabolic networks using enzyme kinetics

Course Outcome:

1. Apprehend the cellular or biochemical changes that conform the basic principles of thermodynamics
2. Acquire knowledge on the regulation of metabolic pathways
3. Analyze different methods to obtain improved and enhanced economically viable products
4. Comprehend the principle role of metabolic engineering practices
5. Demonstrate experiments related to metabolic flux using suitable techniques
6. Appreciate the applications of metabolic engineering in chemical, medical, and environmental fields

Module I: OVER VIEW OF CELLULAR METABOLISM [8 Lecture Hours]

Transport Processes- Altering transport of nutrients including carbon and nitrogen -Fueling reactions- Glycolysis, fermentative pathways- TCA cycle and oxidative phosphorylation, anaplerotic pathways - Catabolism of fats and aminoacids – Metabolomics.

Module II: REGULATION OF METABOLIC PATHWAYS [8 Lecture Hours]

Regulation of enzyme activity – Regulation of enzyme concentration – Regulation of metabolic networks – Regulation at the whole cell level - Mutants which do not produce feedback inhibitors or repressors- auxotrophs-lysine, purine nucleotides

Module III: MANIPULATION AND SYNTHESIS OF METABOLIC PATHWAYS [8 Lecture Hours]

Metabolic pathway manipulations – Enhancement of Product yield and productivity - Extension of substrate range, product spectrum and novel products -Antibiotics, Polyketides and Vitamins,

Module IV: METABOLIC ENGINEERING PRACTICES [7 Lecture Hours]

Fundamentals of Metabolic Control Analysis (MCA), MFA, MPA and their application

Module V: METHODS FOR THE METABOLIC FLUX [7 Lecture Hours]

Methods for the experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using various separation and analytical techniques

Module VI: APPLICATIONS OF METABOLIC ENGINEERING [7 Lecture Hours]

Product over production examples: amino acids, polyhydroxyalkanoic acids, metabolic fluxes in mammalian cell cultures, two successful industrial case studies

References

3. Gregory N. Stephanopoulos, Aristos A. Aristidou & Jens Nielsen, "Metabolic Engineering: Principles and Methodologies", Academic Press, An Imprint of Elsevier India Pvt.Ltd., 1st edition, 1998.
4. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005
5. S. Cortassa, M.A.Aon, A.A.Iglesias and D.Llyod, " An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co. Pte. Ltd, 2002.
6. Christiana D. Smolke, "The Metabolic Pathway Engineering Handbook Fundamentals", CRC Press Taylor & Francis Group, 2010.
7. W.Crueger and A. Crueger, "A Text Book of Industrial Microbiology", Panima Publishing Corporation, 2005
8. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.

18BT3018	CLINICAL TRIALS AND BIOETHICS	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To Explain key concepts in the design of clinical trials
2. To Identify key issues in data management for clinical trials.
3. To describe the roles of Regulatory Affairs in clinical trials.

Course Outcome:

The students will be able to

1. Students are equipped to understand the principles of clinical trials
2. Will be familiar with the theory and practical aspects of important techniques
3. Will develop analytical skills and expertise to formulate and implement a research oriented real time problem.
4. Will be trained in major areas related to clinical research and development
5. The experimental component will help them undertake interdisciplinary work.
6. Will equips them with skills to pursue a career either in academia or industry.

Module I: Introduction to Drug Discovery and Development (9Lecture Hours)

Origin and History of Clinical Research, Introduction to Drug Discovery and drug Development, Clinical Trials in India–The National Perspective, Clinical Trial Phase I, Clinical Trial Phase II, Clinical Trial Phase III, Clinical Trial Phase IV –methods, Principles of sampling -Inclusion and exclusion criteria, Methods of allocation and randomization, Termination of trial.

Module II: Ethical Regulation (8Lecture Hours)

Historical guidelines in Clinical Research -Nuremberg code, Declaration of Helsinki, Belmont report, Research ethics and Bioethics –Principles of research ethics; ethical issues in clinical trials; Use of humans in Scientific Experiments; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology

Module III: Regulation in clinical research (7 Lecture Hours)
International Conference on Harmonization (ICH) Brief history of ICH, Structure of ICH, ICH Harmonization Process, Responsibilities of Stakeholders: Sponsors, Investigators, CROs, Monitors, Institutional ethics committee

Module IV: Clinical trial important documentation (7 Lecture Hours)
Essential Documents in Clinical Trials: SOP, Clinical Trial Protocol and 95Protocol Amendment(S), Investigator Brochure, Master Files, Informed Consent Forms, Consort statement, Case Record Form

Module V: Clinical trial data management (8 Lecture Hours)
Project management in clinical trials -principles of project management; Application in clinical trial management; Risk assessment Pharmacovigilance, Project Auditing, Inspection.

Module VI: Clinical data monitoring (7 Lecture Hours)
CRF Review & Source Data Verification, Drug Safety Reporting, Drug Accountability Work, Routine Site Monitoring, Site Close Out Visit

References

1. Lee, Chi -Jen; etal.,"Clinical Trials or Drugs and Biopharmaceuticals." CRC / Taylor &Francis, 2011
2. Matoren, Gary M. "The Clinical Research Process in the Pharmaceutical Industry" Marcel Dekker, 1984.
3. Methodology of Clinical Drug Trials, 2ndEdition.Spriet A., Dupin-Spriet T., Simon P. Publisher: Karger.
4. Design and Analysis of Clinical Trials: Concepts and Methodologies , 3rdEdition.Shein-Chung Chow, Jen-Pei Liu. Publisher: Wiley.
5. Principles and Practice of Pharmaceutical Medicine, 3rdEdition. Lionel D. Edwards, Anthony W. Fox, Peter D. Stonier. Publisher: Wiley-Blackwell.
6. Oxford Handbook of Clinical Medicine, 9 thEdition. Murray Longmore, Ian Wilkinson, Andrew Baldwin, and Elizabeth Wallin.Oxford Medical Handbooks.

18BT3019	Sustainable Bioprocess Development	L	T	P	C
		3	0	0	3

Course Objectives:
To improve knowledge on
1. Microbial Growth Kinetics
2. Enzyme kinetics
3. Bioreactor operation

Course Outcome:
The students will be able to
1. Develop growth model based on the microbial characteristics
2. Understand Immobilization techniques
3. Understand the mass transfer during Immobilization reaction
4. Design bioreactor based on operational mechanism
5. Understand different configurations of bioreactors
6. Understand the involvement of bioprocess engineering in other related areas

Module I: Introduction (8 Lecture Hours)
Microbial diversity, Cell construction, Major products of biological processing, Component parts of fermentation process, Concept of Upstream, downstream processing and scale up.

Module II: Microbial Growth and Quantifying Growth kinetics (7Lecture Hours)
kinetics of microbial growth, Substrate-limited growth, substrate uptake and product formation- monod model, leudeking-piret models, Models with growth inhibitors , oxygen transfer in microbial bioreactors, volumetric mass transfer coefficient, Measurement of k_La

Module III: Enzyme Engineering (7 Lecture Hours)

Enzyme, How enzyme work, Enzyme kinetics, Enzyme immobilization, Industrial utilization of enzyme, Hheterogeneous Reactions in Bioprocessing, Internal Mass Transfer and Reaction

Module IV: Bioreactor Design (8 Lecture Hours)

Mixing, Mixing Equipment, Flow pattern, Mechanism of Mixing, Power requirement for mixing, Bioreactor Configurations (Different Bioreactors), Membrane bioreactor

Module V: Ideal Reactor Operation (8 Lecture Hours)

Batch Operation of a Mixed Reactor, Batch Operation of a Mixed Reactor, Continuous Operation of a Mixed Reactor, Chemostat Operation, Operation of Plug-Flow reactor

Module VI: Advanced Bioprocessing (7 Lecture Hours)

Bioprocess Consideration in plant cell cultures, Bioprocess Consideration in animal cell cultures, Bioprocessing in environmental engineering, Industrial Bioprocess

References

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2005.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
3. *Pauline M. Doran,* Bioprocess Engineering Principles, Elsevier Science & Technology Books, 2nd edition, May 1995

18BT3020	ADVANCED ANIMAL BIOTECHNOLOGY AND TISSUE CULTURE	L	T	P	C
		3	0	0	3

Course Objectives:

1. To Provide insights into animal Animal Biotechnology
2. To Provide knowledge in Animal Breeding
3. To equip the students with technical knowledge of cell culture and its Applications

Course outcomes:

The students will be able to

1. Understand the importance of Animal Biotechnology and its importance in Live stock improvement
2. Gain knowledge in Cryopreservation of embryos, embyo sexing
3. 3.. To identify the genetic defects in animal embryos through molecular defects.
4. To understand the technology used for live stock improvement.
5. Gain knowledge in apllications of cell culture
6. Understand the importance of Tissue engineering.

Module I: Introduction (8 Lecture Hours)

Introduction to Animal Biotechnology, Cryopreservation of Sperms, Ova of livestock, Artificial Insemination, Super Ovulation, In Vitro fertilization, Culture of embryos, Cryopreservation of Embryos, Embryo transfer, Embryo splitting, Embryo sexing.

Module II: Transgenic Animals (7Lecture Hours)

Transgenic manipulation of animal embryos, different applications of transgenic animal technology, Animal cloning basic concept, cloning from- embryonic cells and adult cells, cloning for conservation for conservation endangered species, Ethical, social and moral issues related to cloning

Module III: Germplasm Preservation (7 Lecture Hours)

In situ and ex situ preservation of germplasm, In utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, Gene knock out technology and animal models for human genetic disorders

Module IV: Live Stock Improvement (8 Lecture Hours)

Genetic characterization of livestock breeds, Marker assisted breeding of livestock, Transgenic animal production and application in expression of therapeutic proteins Detection of meat adulteration using DNA based methods.

Module V: Cell Culture (8 Lecture Hours)

Commercial scale production of animal cells, Application of animal cell culture for in vitro testing of drugs, Testing of toxicity of environmental pollutants in cell culture, Cell proliferation assay, migration assay, adhesion assay

Module VI: Tissue Engineering (7 Lecture Hours)

Tissue Engineering, 3D Culture with different type of cells, Scaling up of cell culture – Adherence and Suspension type of cells for the production of various products, Different methods and steps involved in cell line engineering for the production of various products.

References

1. B. Ianfreshney. Culture of Animal cells & Manual of basic technique, fifth edition, Wiley – liss publication, 2006.
2. Dubey R.C. Text book of biotechnology S. Chand & Company Ltd. 2007
3. B.Sasidhar. Animal Biotechnology MJP publishers. 2006
4. *Portner R. 2007. Animal Cell Biotechnology. Humana Press.*
5. *Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. New Generation Vaccines. 3rd Ed. Informa Healthcare*

18BT3021	Molecular Diagnostics	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. History and Traditional diagnostics in genetic disease.
2. Principles and performance of DNA and RNA isolation, amplification, hybridization, and analysis.
3. Applications in microbiology, diagnosis, cancer, transplantation, and forensic medicine.

Course Outcome:

The students will be able to

1. Define basic terminology and describe concepts in molecular diagnostics that provide the foundation for implementing and adapting new techniques and assays.
2. Explain the principle of traditional diagnosis methods.
3. Explain the major metabolic disorders.
4. Apply molecular diagnostic techniques in the diagnosis of microbiological, hematological, thrombotic, and genetic disorders.
5. Explain and perform electrophoresis and hybridization methods, including Southern and Northern blots
6. Discuss ethical considerations and New trends in Diagnostics

Module I: History of Diagnostics (7 Lecture Hours)

Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, Clinical Sample collection- method of collection, transport and processing of samples and Interpretation.

Module II: Traditional Diagnostic Methods (8 Lecture Hours)

Diagnosis of infection caused by Bacteria: *Streptococcus, Coliforms, Salmonella, Shigella, Vibrio, and Mycobacterium.,* Fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. DNA and RNA viruses- Pox viruses, Adenoviruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Protozoan diseases: Amoebiosis, Malaria, Trypnosomiosis, Leishmaniasis. Helminthic diseases- *Fasciola hepatica* and *Ascaris lumbricoides*. Filariasis and Schistosomiasis.

Module III: Major Metabolic disorders (7 Lecture Hours)

Traditional methods for the diagnosis of metabolic errors. Disease due to genetic disorders – Identifying human disease genes. Cancer- different types of cancers, genetics of cancer- oncogenes, tumour suppressor genes. Methods available for the diagnosis of genetic diseases and metabolic disorders. Genetic disorders- Sickle cell anemia, Duchenne muscular Dystrophy, Retinoblastoma, Cystic Fibrosis and Sex – linked inherited disorders.

Module IV: Molecular Diagnosis (8 Lecture Hours)

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Alu-PCR, Hot-start, In situ PCR, Long-PCR, PCR-ELISA, Arbitrarily primed PCR, Ligase Chain Reaction. Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis

Module V: Hybridization and Sequencing (8 Lecture Hours)

Southern, Northern, in-situ (including FISH), microarrays – types and applications; Protein extraction and analysis (including PAGE and its variations); Western Blot. Automated DNA sequencing- Principles, Methods and Instrumentation- Advances in DNA sequencing- New Generation sequencing Methods, Pyrosequencing, · Microarrays- Personalised Medicine- Pharmacogenomics (ADMET)

Module VI: New Trends in Diagnostics (7 Lecture Hours)

DNA chips, automation, gene therapy; applications in diagnosis of genetic disorders, Diagnosis of neonatal genetic disorders, human genome project, ethical considerations. Good Laboratory Practices. Different Levels of Biosafety and Containment. Gene therapy and other molecular based therapeutic approaches. Forensic Medicine. Ethical and legal issues in genetic counselling.

References

1. Bailey & Scott's Diagnostic Microbiology (2012), Betty A. Forbes , Daniel F. Sahm, Alice S.
2. Weissfeld , Ernest A. Trevino, Published by C.V. Mosby
3. Jawetz, Melnick, & Adelberg's Medical Microbiology (2012), Geo F. Brooks, Stephen A. Morse, Janet S. Butel.
4. Fundamentals of Molecular Diagnostics (2010). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
5. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws
6. Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, W.B. Coleman. Humana Press.

18BT3022	Drug Design and Discovery	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To explore the process of drug development, from target identification to final drug registration.
2. To provide the knowledge in drug development as a process involving target selection, lead discovery using computer-based methods and combinatorial chemistry/high-throughputscreening.
3. To develop skills in specialized areas related to bioavailability, clinical trials, and the essentials of patent law

Course Outcome:

The students will be able to

1. Will be able to describe the process of drug discovery and development
2. Will be able to discuss the challenges faced in each step of the drug discovery process
3. Will be able to gaine a basic knowledge of computational methods used in drug discovery
4. Will be able to organise information into a clear report

5. be able to demonstrate their ability to work in teams and communicate scientific information effectively
6. Will be familiar with the Construct, review and evaluate preclinical and clinical pharmaceutical studies with a general understanding of aim, choice of procedures, results, conclusions and importance.

Module I: Drug and their Interaction (8Lecture Hours)

Introduction to Drugs: Drug nomenclature, Routes of drug administration and dosage forms, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs -Lipinski's rule; How drugs work -Drug targets, drug-target interaction and dose-response
Relationships.

Module II: Drug design pipeline (8Lecture Hours)

New Drug Discovery & Development: Overview of new drug discovery, development, cost and time lines. Target Identification & Validation. Lead Discovery: Rational and irrational approaches -Drug repurposing, Natural products, High-throughput screening (HTS), Combinatorial chemistry and computer aided drug design (CADD).

Module III: Fundamental of Drug Actions: (8 Lecture Hours)

Inter and intramolecular interactions: Weak interactions in drug molecules; Chirality and drug action; Covalent, ion, ion-dipole, hydrogen bonding, C-H hydrogen bonding, dihydrogen bonding, van der waals interactions and the associated energies. Cation-and-OH interactions. Receptorology : Drug-receptor interactions, receptor theories and drug action; Occupancy theory, rate theory, induced fit theory, macromolecular perturbation theory, activation-aggregation theory. Topological and stereo chemical consideration.

Module IV: Drug toxicity, Assays and testing (7 Lecture Hours)

Preclinical Testing of New Drugs: Pharmacology -In vitro/in vivo Pharmacokinetics and Pharmacodynamics testing; Toxicology-Acute, chronic, carcinogenicity and reproductive toxicity testing; Drug formulation testing. Clinical Trial Testing of New Drugs: Phase I, Phase II and Phase III testing; Good clinical practice (GCP) guidelines -Investigators brochures, Clinical trial protocols and trial design; Ethical issues in clinical trials -How are patient rights protected?

Module V: Drug Regulatory Agencies (8 Lecture Hours)

US Food & Drug Administration (US FDA) and Central Drugs Standard Control Organization (CDSCO), India. Regulatory Applications & New Drug Approval: Investigational new drug (IND) application & New drug application (NDA); Regulatory review and approval process. Regulatory Requirements for Drug Manufacturing: Current Good manufacturing practice (cGMP) and GMP manufacturing facility inspection & approval.

Module VI: Intellectual Property Rights (IPR) (8 Lecture Hours)

IPR Definition and implications for discovery & development.Forms of IPR Protection-Copyright, Trademark and Patents. International organization and treaties for IPR protection –World Trade Organization (WTO) & Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreements. Controller General of Patents, Designs & Trade Marks, India (CGPDTM), World Intellectual Property organization (WIPO)-Patent Cooperation Treaty (PCT).

References

1. Drugs: From discovery to approval 2nd Ed by Rick NG. Wiley Blackwell (2009)
2. Essentials of Medical Pharmacology, 6the Edition (Hardcover)
   by Tripathi Kd. Publisher: Jaypee Brothers (2008)
3. Burger's Medicinal Chemistry and Drug discovery. Volume 2, Drug Discovery and development.6th Edition. Ed Donald J AbrahamWiley-Interscience.
4. Intellectual Property Rights In India: General Issues And Implications by Prankrishna Pal. Publisher: Deep & Deep Publications Pvt.Ltd (2008)

5. Stromgaard, Kristian, Povl Krogsgaard-Larsen, and Ulf Madsen. *Textbook of drug design and discovery*. CRC Press, 2009.
6. Katzung, Bertram G., Susan B. Masters, and Anthony J. Trevor. *Basic and Clinical Pharmacology (LANGE Basic Science)*. McGraw-Hill Education, 2012.
7. Spriet, Alain, et al. *Methodology of clinical drug trials*. Basel: Karger, 1994.

18BT3023	Transport Phenomena	L	T	P	C
		3	0	0	3

Course Objective:

2. The study of the subject constitutes the chemical engineering aspects and principles in line with temperature differences.
3. It imparts the knowledge of basic principles of science and engineering applied to Industrial Biotechnology and chemical engineering
4. The study also focuses on how operations related with fluids and how temperature plays a pivotal role in a drug or a chemical plant.

Course Outcome:

1. Gaining knowledge on developments in unit operations.
2. Understanding the principles related to laws of thermal conductivity and movement of fluids through energy balances.
3. Analyzing the fluid dynamics in an industrial point of view.
4. Hydrodynamics of a moving fluid will be observed and it paves a way for the Rheology of fluids.
5. Analyzing the Heat and mass transfer operations in an industrial plant.
6. Knowledge on Heat Transfer Equipments and its design.

Module I Introduction (5 Hours)

Introduction to chemical engineering sciences and its role in the design & analysis of chemical processes. Overview of unit operations and processes in the chemical industry. Units and conversion factor. Introduction to Dimensional analysis.

Module II Material and Energy Balances : . (13 Hours)

Overall and component material balances - Material balances without chemical reactions Material balance calculations with chemical reactions – combustion calculations . Energy balances - Entropy - Latent heat - Chemical reactions - combustion

Module III Fluid Mechanics : (9 Hours)

Properties of fluids; Fluid statics – forces at fluid surfaces, Pressure and measurement of pressure differences; Fluid flow concepts and basic equations of fluid flow – continuity equation and Bernoulli's equation; shear stress relationship and viscous effects in fluid flow; non newtonian fluids; significance of dimensionless groups in fluid flow operations.

Module IV Transportation of Fluids : (8 Hours)

Different types of pumps, compressors and valves. Measurement of fluid flow using hydrodynamic methods, direct displacement method. Types of agitators, flow patterns in agitated vessels, calculation of power consumption – applications in bioreactor design

Module V Heat Transfer : **(5 Hours)**

Nature of heat flow - Conduction, convection, radiation. Steady state conduction, Principles of heat flow in fluids.

Module VI Design of Heat Transfer Equiments: (5 Hours)

Transfer by forced convection in laminar and turbulent flow. Heat exchange equipments- principles and design.

References

1. Bhatt B.I., Vora S.M. Stoichiometry.3rd ed., Tata McGraw-Hill, 1977.
2. McCabe W.L., et al., Unit Operations In Chemical Engineering. 6th ed., McGraw-Hill Inc., 2001.

5. Geankoplis C.J. Transport Processes And Unit Operations. 3rd ed., Prentice Hall India,

18BT3024	Pharmaceutical Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To provide the student well versed with recent advances in the field of Pharmaceutical Biotechnology.
2. To make foundation for understanding the various events at molecular level, keeping a balance between health and disease.
3. To enabling the student to gain in-depth knowledge in fundamental and applied aspects of Microbiology and Immunology.

Course Outcome:

The students will be able to

1. Will be familiar with resources, of DNA based vaccine delivery systems.
2. Will be able to analyze Screening, isolation, characterization and scale-up of microbial products (enzymes, antibiotics and other secondary metabolites) from microorganisms of commercial interest and its pharmacological evaluation.
3. Will be able to Microbial synthesis of nanoparticles: Biosynthesis, isolation and characterization.
4. Will develop skills in molecular signalling pathways in pathogenesis and therapy.
5. Will be familiar in Immunoproliferators: Isolation, characterization and evaluation of cytokine like molecules from microbial source.
6. Will be familiar with the Peptide therapeutics: Design, evaluation and formulation of peptides for therapeutics.

Module I: Biotechnology with reference to Pharmaceutical Sciences. (9Lecture Hours)

introduction to Biotechnology with reference to Pharmaceutical Sciences, Biosensors- Working and applications of biosensors in Pharmaceutical Industries. Brief introduction to Protein Engineering. Use of microbes in industry. Production of Enzymes- General consideration – Amylase, Catalase, Peroxidase, Lipase, Protease, Penicillin's.

Module II: Genetic Engineering (7Lecture Hours)

Basic principles of genetic engineering. Study of cloning vectors, restriction endonucleases and DNA ligase. Recombinant DNA technology. Application of genetic engineering in medicine. Application of r DNA technology and genetic engineering in the products: Interferon b) Vaccines- hepatitis- B c) Hormones- Insulin. Nanodrops, Gene expression analysis.

Module III: Pharmaceutical immunology (7 Lecture Hours)

Structure of Immunoglobulin's, Structure and Function of MHC. Hypersensitivity reactions, Immune stimulation and Immune suppressions. General method of the preparation of bacterial vaccines, toxoids, viral vaccine, antitoxins, serum-immune blood derivatives and other products relative to immunity. Storage conditions and stability of official vaccines. Hybridoma technology- Production, Purification and Applications

Module IV: Immunological techniques and analysis (7 Lecture Hours)

Immunoblotting techniques- ELISA, Western blotting, Southern blotting. Genetic organization of Eukaryotes and Prokaryotes. Microbial genetics including transformation, transduction, conjugation, plasmids and transposons. Introduction to Microbial biotransformation and applications.

Module V:Gene mutation and Fermentation (7Lecture Hours)

Mutation. Types of mutation/mutants. Fermentation methods and general requirements, study of media, equipments, sterilization methods, aeration process, stirring. Large scale production fermenter design and its various controls. Study of the production of – penicillin, citric acid, Vitamin B12, Glutamic acid, Griseofulvin.

Module VI: Microbial Technology (7 Lecture Hours)

Biotransformation for the synthesis of chiral drugs and sterols. Biodegradation of xenobiotics, chemical and industrial wastes. Production of single-cell protein.

References

1. Gene transfer and expression protocols – methods in Molecular Biology, Vol. VII, Edit E.T. Murray.
2. Therapeutic Peptides and Proteins; Formulation, processing and delivery systems: Ajay K Banga.
3. Immobilisation of cells and enzymes: Hosevear kennady Cabral & Bicker staff.
4. Biotechnology of antibiotics and other bioactive microbial metabolites : Gianeario Lancini and Rolando Lorenzetti.
5. Pharmaceutical Biotechnology by Daan J. A. Crommelin, et al
6. Goodman and Gilman's The Pharmacological Basis of Therapeutics Book by J.Hardman, Lee Limbird and A.G. Gilman.
7. "Principles of Pharmacology by D. Golan, A. Tashjian, E. Armstrong, J.Galanter, A.W.Armstrong, R. Arnaout and H.Rose. 2005, Lippincott Williams and Wilkins.

18BT3025	Bioreactor Engineering	L	T	P	C
		3	0	0	3

Course Objective:

1. This course aims at making the students understand the principles and concepts of Bioreactor engineering.
2. This will help the student understand structured models of growth and product formation
3. To understand the of oxygen transfer and parameters to be monitored and controlled in bioreactors

Course Outcome:

The students will be able to

1. Acquire knowledge on design of bioreactors.
2. Devise methods to calculate volumetric mass transfer coefficient and determination methods.
3. Assess on-line data analysis for measurement of important physico-chemical and biochemical parameters.
4. Classify modern biotechnological process in host vector systems.
5. Analyze structured models for analysis of various bioprocess.
6. Discuss on parameters to be monitored and controlled in bioreactors.

Module I: DESIGN AND ANALYSIS OF BIOREACTORS (7 Lecture Hours)

Design and operation of novel bioreactors-Air-lift loop reactors, Fluidized bed-bioreactors, packed bed reactor, Bubble column reactor, stability analysis of bioreactors

Module II: BIOREACTOR SCALE-UP (7 Lecture Hours)

Oxygen mass transfer in bioreactors - microbial oxygen demands; methods for the determination of mass transfer coefficients; mass transfer correlations. Scale up criteria for bioreactors based on oxygen transfer, power consumption and impeller tip speed

Module III: MONITORING OF BIOPROCESSES (7 Lecture Hours)

On-line data analysis for measurement of important physico-chemical and biochemical parameters; State and parameter estimation techniques for biochemical processes.

Module IV: MODERN BIOTECHNOLOGICAL PROCESSES (8 Lecture Hours)

Recombinant cell culture processes, guidelines for choosing host-vector systems, plasmid stability in recombinant cell culture, limits to over expression, Modelling of recombinant bacterial cultures; bioreactor strategies for maximizing product formation; Bioprocess design considerations for plant and animal cell cultures

Module V: MODELLING AND SIMULATION OF BIOPROCESSES (8 Lecture Hours)

Study of structured models for analysis of various bioprocess – compartmental models, models of cellular energetics and metabolism, single cell models, plasmid replication and plasmid stability model. Dynamic simulation of batch, fed batch, steady and transient culture metabolism.

Module VI: BIOREACTOR INSTRUMENTATION AND CONTROL (8 Lecture Hours)

Methods of on-line and off-line biomass estimation; microbial calorimetry. Flow injection analysis for measurement of substrates, products and other metabolites. Parameters to be monitored and controlled during fermentation process.

References:

1. Michael Shuler, Fikret Kargi, "Bioprocess Engineering Principles",Second edition, Prentice Hall,2002
2. P.Stanbury, A.Whitaker,SJ Hall "Principles of fermentation technology", Second edition, Elsvier Pergamon Press,1999.
3. Pauline Doran,"Bioprocess Engineering Principles", Academic Press,1995
4. Elmar Heinzle, Arno P.Biwer, "Development of Sustainable Bioprocess: Modelling and Assessment", Wiley, 2007.
5. Bjorn K.Lyderson, Nancy Ade'lia and Kim Nelson,"Bioprocess engineering *(handcover)",*Wiley Interscience,1994

18BT3026	Stem Cell Therapeutics	L	T	P	C
		3	0	0	3

Course Objectives:

To gain awareness about

1. The history and future of the emerging field of Stem Cell Therapy
2. The impact of Stem Cell therapy in health care system.
3. The impact of Stem Cell Therapy in Human civilization.

Course Outcome:

The students will be able to

1. Understand the basic concepts in culturing animal and mammalian cells
2. Understand the aspects of cellular ageing
3. Understand the types of Stem cells, their development and function.
4. Learn the various methods to isolate and culture Stem cells
5. Learn the various therapeutic applications of stem cells
6. Appreciate the bigger picture of Stem Cell Technology and their impact of society and civilization.

Module I: Introduction (4 Lecture Hours)

Introduction to The Syllabus, Overview of Stem Cells, Introduction and history of Stem cells, Stem cells for therapeutics and research.

Module II: Culturing Cells in the laboratory (5 Lecture Hours)

Introduction to Cell Culture, Pros & Cons of Cell culture, Primary and Secondary cultures, Hayflicks limit, telomerase.

Aseptic Technique and Cell culture Lab equipments & etiquette

Module III: Stem cell-Types (6 Lecture Hours)

Types of Stems Cells, Embryonic stem cells, Pleuripotent Stem Cells, Adult Stem cells, Induced Pleuripotent Stem Cells, Transit amplifying cells

Symmetry during cell division in Stem cells.

Module IV: Location, Nature & culturing of stem cells (10 Lecture Hours)

Stem Cell Niche, Isolation of Stem Cells, & Growth factors, chord cells, Derivation & differentiation of ES Cells, Derivation & differentiation of Pleuripotent Cells

Induced Pluripotent cell-Methods & Genetic & epigenetic reprogramming

Module V: Applications of Stem cell Technology (10 Lecture Hours)

Application of stem cells in disorders of nervous system, Application of Stem cells in Cancer, Stem cells of Gut. Stem cells of the skin- Wound healing & cosmetics, Use of stem cells in tissue engineering & organ generation, Application of stem cells in autoimmune disorders.

Module VI: Ethical Implications of Stem cell therapeutics. (10 Lecture Hours)

Benefits, Problems and perspectives of stem cell therapy. Beginning of human life, legal, scientific, ethical, Religio-spiritual explanations. Treating infertility, multiple parents, Somatic Cell Nuclear Transfer & Human cloning, Extinction prevention, Stem cells and meat production, Alternatives to stem cells

Deeper concerns in stem cell technology-Immortality, longevity, ageing.

References

1. Paul Knoepfler, Stem Cells - An Insider's Guide ”
2. Robert Lanza and Anthony Atala, Essentials of Stem Cell Biology”
3. Satish Totey and Kaushik D. Deb, Stem Cell Technologies: Basics and Applications
4. Warburton David, Stem Cells, Tissue Engineering and Regenerative Medicine .

18BT3027	Nanobiotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To know about biology inspired concepts, nanobiometrics, natural nanocomposites, nano analytics and molecular manufacturing
2. To study the properties of fundamental biological units used to create materials for applications in human health care
3. To understand how biology can be used to learn fundamental design principles

Course Outcome:

The students will be able to

1. Define basic terminology and describe concepts in Nanobiotechnology
2. Explain the principle of various applications in Nanobiotechnology.
3. Explain the properties of Nanomaterials in Biotechnology.
4. Understand Application of Nanodevices in Biological systems.
5. Explain the Application of Molecular recognition elements and transducing.
6. Discuss New trends in Nanobiotechnology and Defence.

Module I: History and Concept of Nanobitoechnology (7 Lecture Hours)

Various definitions and Concept of Nano-biotechnology & Historical background. Fundamental sciences and broad areas of Nanobiotechnology. Various applications of Nano-biotechnology. Cell – Nanostructure interactions. Functional Principles of Nanobiotechnology- Information-Driven Nanoassembly- Energetic- Chemical Transformation- Regulation- Traffic Across Membranes- Biomolecular Sensing- Self-Replication- Machine-Phase Nanobiotechnology

Module II: Nanomaterials in Biotechnology (9 Lecture Hours)

Drug Nanoparticles- Structure and Preparation, Liposomes, Cubosomes and Hexosomes, Lipid based Nanoparticles-Liquid nanodispersions- Solid Lipid Nanoparticles (SLP)- Biofunctionalsiation of SLP, Charatcterisation- Nanoparticles for crossing biological membranes. Fundamentals- Physicochemical Principles of Nanosized Drug Delivery Systems-Nanotubes, Nanorods, Nanofibers, and Fullerenes for Nanoscale Drug Delivery, Carbon nanotubes biocompatibility and drug delivery. Nanoparticles, quantum dots, nanotubes and nanowires. Microbial Nanoparticle Production : Methods of microbial nano-particle production, Applications of microbial nano-particles, Bacteriorhodopsin and its potential in technical applications – overview, structure, photoelectric applications, photochromic applications and applications in energy conversion.

Module III: DNA-Protein Nanostructures (9 Lecture Hours)

Overview and introduction - Oligonucleotide-Enzyme conjugates, DNA conjugates of binding proteins, Non-covalent DNA-Streptavidin conjugates, DNA-Protein conjugates in microarray technology. Protein-based Nanostructures, Nanobiomachines & Signalling - Overview, chemistry and structure, Genetics & Secondary cell-wall polymers, Self-assembly in suspension, Re-crystallization at solid supports, Formation of regularly arranged Nano-particles, Cell as Nanobiomachine, link between the signaling pathways & molecular movements as well as neuron function, Concepts in nanobiomachines for information processing and communications

Module IV: Nanodevices and Tools used in Nanotechnology (5 Lecture Hours)

Biosensors; different classes - molecular recognition elements, transducing elements. Applications of molecular recognition elements in nanosensing of different analytes. Application of various transducing elements as part of nanobiosensors. Tools in Nanotechnology.

Module V: Biological Nanoparticles (8 Lecture Hours)

Production - plants and microbial. Nanobiotechnological applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.

Module VI: New Concepts in Nanobiotechnology (7 Lecture Hours)

Cancer treatment and DNA Origami, Green Technology in India, Biological Motors and DNA Origami, Three Concepts – New "Nano" concept, Societal Implications of Nanoscience and Nanotechnology – Environmental Issues, Nano Ethics, Nanotribolgy and Quantum Computing.

References

1. Nanobiotechnology: Concepts,Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
2. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
3. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.
4. R.S. Greco, F.B.Prinz and R.L.Smith, Nanoscale Technology in Biological Systems, CRC press, 2005.
5. Tuan Vo-Dinh, Protein Nanotechnology Protocols, Instrumentation and Application, Series ; Methods in Molecular Biology (2005)
6. Christof M. Neimeyer, Chad.A.Mirkin (eds.,) Nanobiotechology : Concepts, Applications and perspectives, Wiley VCH Weinheim (2004)
7. David. S. Goodsell, Bionanotechnology: concepts, lessons from nature, Wiley-Liss (2004)
8. Sandra J Rosethal, David W Wright, Nanobiotechnology Protocols, Series Methods in Molecular Biology (2005).
9. B. Bhushan , Springer Handbook of Nanotechnology: Volume 1&2, Springer-Verlag. Second ed., (2007)
10. Christof M. Neimeyer, Chad.A.Mirkin (eds.,) Nanobiotechology II : More Concepts, and Applications, Wiley VCH Weinheim (2007)

18BT3028	Advanced Plant Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Plant genetic materials and molecular biology techniques
2. Plant metabolic engineering and its importance
3. Plant transformation techniques and GM crops

Course Outcome:

The students will be able to

1. Understand the plant genome and its molecular mechanisms
2. Get familiarized about additional genomic materials in plant cells
3. Comprehend on metabolic engineering of plant cell metabolites

4. Gain knowledge on Agrobacterium mediated gene transfer techniques
5. Develop knowledge on mechanisms of plant virus vectors
6. Comprehend on GM crops and its ethical issues

Module I: INTRODUCTION TO PLANT MOLECULAR BIOLOGY (8 Lecture Hours)

Genetic material of plant cells, nucleosome structure and its biological significance; transposons,; outline of transcription and translation, alternative and trans splicing, constitutive and differentially expressed genes in plants

Module II: CHLOROPLAST AND MITOCHONDRIA (9 Lecture Hours)

Structure, function: Light and dark reaction and genetic material; rubisco synthesis and assembly, coordination, regulation and transport of proteins. Mitochondria: Genome, cytoplasmic male sterility and import of proteins, comparison and differences between mitochondrial and chloroplast genome, chloroplast transformation

Module III: PLANT METABOLISM AND METABOLIC ENGINEERING (7 Lecture Hours)

Nitrogen fixation, Nitrogenase activity, nod genes, nif genes, bacteroids, plant nodulins, production of secondary metabolites, flavanoid synthesis and metabolic engineering

Module IV: AGROBACTERIUM MEDIATED GENE TRANSFER (5 Lecture Hours)

Pathogenesis, crown gall disease, genes involved in the pathogenesis, Ti plasmid –TDNA, importance in genetic engineering

Module V: PLANT VIRUSES (9 Lecture Hours)

Plant viruses and different types, Viral Vectors: Gemini virus, cauliflower mosaic virus, viral vectors and its benefits, vectors used for plant transformation, Methods used for transgene identification

Module VI: APPLICATIONS OF PLANT BIOTECHNOLOGY (7 Lecture Hours)

Outline of plant tissue culture, transgenic plants, herbicide and pest resistant plants, molecular pharming, therapeutic products, RNA i, Transgene silencing,ethical issues; case studies on successful transgenics including drought management.

TOTAL : 45 PERIODS

References

1. Slater A et al. Plant Biotechnology : The Genetic Manipulation of Plants, Oxford University Press, (1st and 2nd edition), 2008
2. Grierson D. and Covey, S.N. Plant Molecular Biology, 2nd ed., Blackie,1988

18BT3029	Cancer Management Techniques	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. The pathology, grades and molecular biology of cancer
2. Cancer type specific symptoms and early diagnostic markers
3. Cancer management techniques like detection, treatment, prevention and palliative care

Course Outcome:

The students will be able to

1. Understand the pathology of different types of cancer and their reporting systems.
2. Learn the molecular pathways involved in cancer development and progression.
3. Study the molecular targets for diagnosis and therapy
4. Develop new technologies for early diagnosis, targeted therapy and for effective management of post therapy cases with the help of cancer markers
5. Analyze the future challenges in improving the efficacy of current cancer diagnosis and therapy
6. Investigate new means of cancer management, prevention strategies and modes of palliative care to prolong the life of cancer cases.

Module I Pathology and Types of Cancer (8 Lecture Hours)

Benign and cancer tumor; Characteristics and hallmarks of cancer; Cancer malignancy – spread, invasion and metastasis; Histopathology of cancer; Cancer staging and its classifications; Cancer differentiation grades; Cancer classes and types; Cancer death - obstructions.

Module II Molecular Cell Biology of Cancer (8 Lecture Hours)

Cell growth regulation abnormalities in cancer – Alteration in Growth factors and cell signaling pathways, signal targets; Cell adhesion defects in cancer; Cell migration promoters in cancer-Proteases; Metastatic spread promoters, cancer cells mimicking inflammatory immune cells; Apoptosis regulation defects in cancer; Angiogenesis promoters in cancer.

Module III Cancer Symptoms and Markers (7 Lecture Hours)

Cancer Symptom – General and specific; Cancer metabolism – Metabolic alterations and role of mitochondria; Cancer Markers – Proteins – Enzymes, Antigens, Antibodies, Hormones; Testing samples - Urine, Blood, Stool, Tumor tissue, other body fluids; Gene expressions – DNA, mRNA and Protein; scope for early diagnosis.

Module IV Cancer Detection Methods and Techniques (8 Lecture Hours)

Cancer Screening and symptoms; Clinical Examination; Radiologic Imaging Techniques – CT, MRI,and PET scans, Ultra sound and Endoscopic Examinations, Mammography and Isotopic Techniques; Laboratory Tests for cancer markers; Immunodetection techniques; Genetic Testing; Confirming cancer by pathologic report - Biopsy and Smear examinations; Early diagnostic methods

Module V Cancer Therapeutics (7 Lecture Hours)

Combination Therapy; Adjuvant therapy- Chemotherapy and Radiotherapy; Targeted therapy – Targeted drug delivery, targeted therapy drugs; Molecular therapy, Immunotherapy –Antibody, Interferon, Molecular and Gene therapy; Hormone therapy; Treatment fatigue; Clinical trials.

Module VI Cancer Prevention and Palliative care (7 Lecture Hours)

Cancer risk factors; Food and lifestyle in cancer prevention; Post treatment preventive measures- Recurrence prevention, Cancer diagnosis cum therapy; Paliative care; Herbal remedies and plant derived drugs.

References:

1. Stella Pelengaris, Michael Khan, The molecular Biology of Cancer, Blackwell Publishing, 1st edition, 2006.
2. Robert A. Weinberg, The Biology of Cancer, Garland Science, 2nd edition, 2014
3. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
4. Richard Pazdur, Kevin A. Camphausen, Lawrence D. Wagman, William J. Hoskins, Cancer Management: A Multidisciplinary Approach**,** 11th illustrated edition, Oncology Publishers, 2003
5. Thomas N. Sayfried, Cancer as a Metabolic Disease**:** On the Origin, Management, and Prevention of Cancer 1st Edition, Wiley Publications; 2012

18BT3030	Genomics and Proteomics	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Genomics, and proteomics using model organisms representing plants and animals.
2. The course will cover recent developments in genetics, epigenetics, small RNAs, proteomics, gene expression, mutagenesis and mapping genes.
3. Develop skills in experimental design within the context of learning about biology including: signal transduction, regulation of transcription and translation, cancer, aging, drought stress and metabolic pathways

Course Outcomes:

The students will be able to

1. Genomics and Proteomics deals with a rapidly evolving scientific area that introduces students into genomes, proteomes and databases that store various data about genes, proteins, genomes and proteomes.
2. Students would learn about genomics, proteomics and bioinformatics 3. Students would gain skills in applied bioinformatics, comparative, evolutionary, human genomics and functional genomics.
3. Students shall have basic knowledge of genome sequencing, major differences between prokaryotic and eukaryotic genomes, basic proteomics and its applications.
4. Apply interdisciplinary knowledge (e.g. chemistry, biophysics) to solve problems in proteomics and genomics
5. Perform database search and analyze genomes, proteins
6. The acquired knowledge during the course would be helpful to those students who want to work in core facilities and commercial biological and medical laboratories

Module I: Introduction to Genomics (8 Lecture Hours)

Introduction to Genomics, Genome Organization of prokaryotes and Eukaryotes, Gene Structure of Bacteria, Archaebacteria and Eukaryotes, Human Genome Project

Module II: DNA sequence and mapping (8 Lecture Hours)

Methodology for DNA sequencing, Contig Assembly, Genetic Mapping- Mendel's Laws of Inheritance, Partial Linkage, DNA Markers and its types, Physical Mapping and its types

Module III: Functional Genomics and its applications (7 Lecture Hours)

Introduction to Functional Genomics, Genome Annotation- traditional routes of gene identification, Detecting Open Reading Frames, Software programs for finding genes, Identifying the function of new gene, Gene Ontology

Module IV: Introduction to Proteomics (7 Lecture Hours)

Proteomics- Introduction, The proteome, Genomics Vs. Proteomics, Proteomics and the New biology

Module V: Analytical Proteomics (8 Lecture Hours)

2 Dimensional Polyacrylamide Gel Electrophoresis, Mass Spectrometry for Protein and Peptide Analysis (MALDI-TOF and ESI-Tandem MS), Designing Microarray experiments, Types of Microarrays

Module VI: Applications of Proteomics (7 Lecture Hours)

Applications of Proteomics- Mining Proteomes, Protein Expression Profiling, Mapping Post-translational Modification, Peptide Mass Fingerprinting

References

1. Brown T.A., "Genomes ", BIOS Scientific Publishers Ltd, Oxford, 2nd Edition, 2002
2. Daniel C. Liebler, "Introduction to Proteomics: Tools for New Biology", Humana Press, Totowa, New Jersey, 2002
3. HEYER, L. -- CAMPBELL, A. *Discovering Genomics, Proteomics and Bioinformatics*. USA: Cold Spring Harbor Lab. Press, 2006. 352 p. ISBN 0-8053-4722-4.

18BT3031	Advanced Environmental Biotechnology	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To analyse environmental problems and find solutions through innovations
2. To develop bioreactors and biotreatment methods of industrial wastewater
3. To learn novel technologies for remediation of environmental pollution

Course Outcome:

The students will be able to

1. Create an awareness of professional responsibility towards protecting the environment.
2. Learn environmental issues involved engineering and resources projects
3. Study the natural and engineered bio-treatment methods to remediate the pollutants

4. Develop treatment methods and create awareness about opportunities in environmental management
5. Future challenges for bioremediation and biodegradation process
6. Investigate the opportunities for incorporating environmental quality into products, processes and projects

Module I: Introduction (8 Lecture Hours)

Current status of biotechnology in environmental protection and its future prospects. Characteristics of wastewater, Classification of pollutants, Impact of pollutants on biotreatment.

Module II: Environmental pollution (7Lecture Hours)

Types, causes and its effects on environment of Soil pollution, Water pollution, Air pollution**,** Oil pollution, Heavy metal pollution

Module III: Bioreactors for wastewater treatment (7 Lecture Hours)

Design and evaluation of suspended growth reactors, Activated sludge, Biological nutrient removal, Biofiltration, Aerobic digestion, anaerobic processes and lagoons , Design and evaluation of attached growth reactors, Trickling filter, Rotating Biological Contactor, Fluidized bed biological reactors, Upflow anaerobic sludge blanket reactor ,Hybrid reactor, Sequential batch reactor , Techniques for Evaluating Kinetics and Stoichiometric parameters.

Module IV: Biotreatment of industrial wastewater (8 Lecture Hours)

Wastewater treatment of effluents from dye, tannery, dairy and food industries, Wastewater treatment of effluents from pharmaceutical, distilleries, polymer, electrochemical industries, Wastewater treatment of effluents from explosive, pesticide and petrochemical industries, Treatment of industrial gaseous pollutants and Vocs. Medical waste and solid waste management.

Module V: Bioremediation and biodegradation (8 Lecture Hours)

Biostimulation of naturally occurring microbial activities, Bioaugmentation, *In situ, ex situ* and engineered bioremediation, Microbial system for heavy metal accumulation , Biosorption, Bioleaching, Detoxification of chlorinated hydrocarbons, aromatics and DIOXINS, Biodesulphurisation of crude petroleum , Future challenges, fate and effects of xenobiotic organic chemicals

Module VI: Novel Biotechnology methods for pollution control (7 Lecture Hours)

Application of nanobiotechnology in environment, Vermitechnology, Genomic tools in bioremediation Biodegradable and ecofriendly products Global environmental problems: Ozone depletion, UV-radiation, Green house gases, acid rain and biotechnological approaches of their management

References

1. Metcalf and Eddy, "Waste water Engineering Treatment, Disposal and Reuse". McGraw Hill, 2010.
2. Jogdand, S.N. "Environmental Biotechnology". Himalaya Publishing House, New Delhi, 2007.
3. Karnely D. Chakrabarty K. Ovnen G.S. "Biotechnology and Biodegradation, Advances in Applied Biotechnology series", Gulf Publications Co. London 2008
4. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2014.
5. R. C. Dubey A Textbook of Biotechnology, S.Chand publications, 4th edition, 2009
6. Indu Shekhar Thakur, "Environment Biotechnology basic concepts and applications", IK International, 3rd edition, 2006
7. Graty. C.P.L., Daigger, G and Lim, H.C, "Biological Wastewater Treatment". 3rd Edition, Marcel Dekker, 2008

18BT3032	Entrepreneurship and Management	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. To impart various aspects of product design and development

2. To inculculate concept generation and selection
3. To understand technology behind the product of the service

Course Outcome:

The students will be able to

1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.
4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype and biosafety.
6. Transform research based ideas into feasibility and business plans and IPR.

Module I: Introduction (8 Lecture Hours)

Entrepreneurship and economic development. evolution of entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Role of SSI in economic development, Government support for SSI. Role of society and family in the growth of an entrepreneur. Challenges faced by women in entrepreneurship.

Module II: Product design (7 Lecture Hours)

Product design, importance, objectives, factors influencing product design, Product Development Process, sources of ideas for designing new products, stages in product design. Guidelines of DBT for formulating project and financing.

Module III: Innovation and prototype (7 Lecture Hours)

Creativity and innovation, generation of ideas, technical and market feasibility study, opportunity assessment, business plan preparation, execution of business plan, conversion of ideas to prototype, risk taking-concept; types of business risks.

Module IV: IPR and copyright (8 Lecture Hours)

IPR and copy right, financial opportunity identification; banking sources; non banking institutions and agencies; venture capital and angel investors, meaning and role in entrepreneurship, government schemes for promoting entrepreneurship. GMO and IPR; WTO, GATT and TRIPS agreement; Indian Patent Act; Patenting procedures

Module V: Biosafety (8 Lecture Hours)

Plant Breeder's Rights; Biosafety – levels; Biosafety guidelines; Role of Biosafety committee; Definition of GMOs & LMOs; Risk factors; Overview of National Regulations and relevant International Agreements including Cartagena Protocol, Biological material transfer procedure.

Module VI: Start up process (7 Lecture Hours)

Procedure for getting license and registration, challenges and difficulties in starting an enterprise, host institution support, Funding agencies – BIRAC, NEN, STEP, DST-NIMAT, TSDB; The role of technology/social media in creating new forms of firms, organizations, networks and cooperative clusters. Market- traditional and E-commerce, expanding markets: local to global.

References

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
2. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt. Ltd., 2007.
3. "Entrepreneurship: Theory", Process and Practice, Donald F. Kuratko, 9th Edition, Cengage Learning, 2011.
4. 4. S.S.Kanka Entrepreneurship Development, S.Chand and Co, New Delhi 2007.
5. Anupam Singh and Ashwani Singh. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), NPH, New Delhi (2010)
6. "Entrepreneurial Development", Jayshree Suresh, 5th Edition, Margham Publications, 2008.

7. "Entrepreneurship", Robert D. Hisrich, 6th Edition, Tata McGraw Hill Publications.2009.

18BT3033	Industrial Waste Management	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Understanding of problems of different kind of hazardous waste from industrial process.
2. Engineering and technical options for site specific waste management
3. Cleaner Industrial process and zero waste sustainable initiatives

Course Outcome:

The students will be able to

1. Identify the purpose and strategic options for industrial waste management
2. Analysis of hazardous waste constituents understand health and environmental issues
3. Select appropriate waste-water treatment process depending on the scenarios
4. Evaluate challenges and design aspect of land-fill operation for solid-waste management
5. Apply steps in solid waste management-waste reduction at source
6. Design cleaner production strategies and cooperation in industrial complexes

Module 1: Introduction to Industrial waste management system (9 Lecture Hours))

Uses of water by industry-Sources and types of industrial wastewater; regulatory requirements for treatment of industrial wastewater-Industrial waste survey Industrial Wastewater generation; Treatment Evaluation for Air Emission and Solid waste; Waste Characterization and classification; Population equivalent-Toxicity of Industrial effluents and Bioassay tests.

Module II: Pollution prevention (5 Lecture Hours)

Prevention vs. control of Industrial Pollution, Benefits and Barriers-Source reduction techniques, Waste audit; Evaluation of Pollution Prevention options, Co2 mitigation in industrial environment.

Module III: Industrial Waste water treatment (10 Lecture Hours)

Equalization- Neutralization- Oil separation Flotation-Precipitation-Heavy metal Removal - Refractory organics separation by adsorption. Aerobic and anaerobic biological treatment Sequencing batch reactors-High Rate reactors Chemical; Oxidation –Ozonation. Photo catalysis Wet Air Oxidation-Evaporation Ion Exchange-Membrane Technologies – Nutrient removal.

Module IV: Solid waste treatment and disposal (7 Lecture Hours)

Categories and Characterization, Solid waste land fill, Land-fill cover and Cap, Waste stabilization, Management of Organic industrial waste, Incineration strategies and Energy recovery, Composting Industrial waste

Module V: Case studies with different Industrial Scenarios (7 Lecture Hours)

Tanneries-pulp and paper-metal finishing; Petroleum Refining-Pharmaceuticals-Sugar and Distilleries; Food Processing-fertilizers-Thermal Power Plants; and Industrial Estates, Textile and Paper Industries

Module VI: Cleaner production and Newer Management strategies (7 Lecture Hours)

Waste management Approach – Volume and strength reduction – Material and process modifications – Recycle, reuse and by-product recovery – Applications, Zero discharge attainment strategies, Naturally Evolving Industrial complexes

References

1. Woodard Frank (2001) ***Industrial Waste treatment Handbook***, Butterworth Heinemann
2. Nelson Leonard Nemerow (2010) ***Industrial Waste Treatment: Contemporary Practice and Vision for the Future***, Elsevier
3. Wang Lawrence K., Hung Yung-Tse, Lo Howard H., Constantine Yapijakis (2006) ***Hazardous Industrial Waste Treatment***, CRC Press
4. John Pichtel, ***Waste Management Practices: Municipal, Hazardous, and Industrial***, Second Edition, CRC Press

5. Wang Lawrence K., Hung Yung-Tse, Shammas Nazih K. (2009) ***Handbook of Advanced Industrial and Hazardous Wastes Treatment***, CRC Press

18BT3034	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

Course Objectives:

1. The course is intended to provide a general concept in the dimensions of disasters caused by nature beyond the human control
2. The disasters and environmental hazards induced by human activities with emphasis on disaster preparedness, response and recovery.
3. To improve knowledge about rescue methods

Course Outcome:

1. To learn the different safety aspects in industrial application and daily life
2. To learn safety procedure followed in industries
3. To learn the different types of rescues
4. To know the procedure for risk analysis
5. To know different type of disaster
6. To know procedure for damage assessment

Module I Safety Management (8 Hours)

- Concept of Safety, Applicable areas, unsafe actions &Conditions. Responsibility of Safety - Society, Govt., Management, Union & employees.

Safety Officer - Appointment, Qualification, Duties of safety officer. Safety Committee - Membership, Functions & Scope of Safety committee. Motivation & Training of employees for safety in Industrial operations.

Module II Disaster Management (8 Hours)

Introduction on Disaster Different Types of Disaster : Natural Disaster Man-made Disaster Biological Disasters,Accidents (Air, Sea, Rail & Road), Structural failures(Building and Bridge), War & Terrorism etc. Causes, effects and practical examples for all disasters.

Module III Risk Analysis (8 Hours)

Risk and Vulnerability Analysis ,Risk Reduction , Strategic Development for Vulnerability Reduction,Disaster Preparedness and Response Preparedness- Disaster Preparedness: Concept and Nature,Disaster Preparedness Plan, Prediction, Early Warnings and Safety Measures of Disaster, Role of Information, Education, Communication, and Training, Role of Government, International and NGO Bodies.

Module IV Responsibility of Engineers (8 Hours)

Role of Engineers on Disaster Management. Response- Disaster Response : Introduction, Disaster Response Plan, Communication, Participation, and Activation of Emergency Preparedness Plan, Search, Rescue, Evacuation and Logistic Management, Role of Government, International and NGO Bodies, Psychological Response and Management (Trauma, Stress, Rumor and Panic) , Relief and Recovery ,Medical Health Response to Different Disasters

Module V Reconstruction and Recovery (7 Hours)

Rehabilitation, Reconstruction and Rehabilitation as a Means of Development, Damage Assessment, Post Disaster effects and Remedial Measures, Creation of Long-term Job Opportunities and Livelihood Options, Disaster Resistant House Construction , Sanitation and Hygiene,

Module VI Safety Awareness (6 Hours)

Education and Awareness, Dealing with Victims' Psychology, Long-term Counter Disaster Planning , Role of Educational Institute.

References:

1. Dr. Mrinalini Pandey, Disaster Management, Wiley India Pvt. Ltd.

2. Tushar Bhattacharya , Disaster Science and Management, McGraw Hill Education (India) Pvt. Ltd.
3. Jagbir Singh, Disaster Management : Future Challenges and Opportunities , K W Publishers Pvt. Ltd.
4. Crowl D A, Louvar J F, " Chemical Process Safety Fundamentals with applications", 2nd Prentice Hall, NJ (2002).
5. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services2005
6. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
7. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
8. Cheremisinoff, N. P., Practical Guide to Industrial Safety: Methods for Process Safety Professionals, CRC Press, 2001.