DEPT. OF BIOTECHNOLOGY

Curriculum 2019

VISION AND MISSION OF THE DEPARTMENT OF BIOTECHNOLOGY

VISION

- To raise biotechnologists with potential to innovate and disseminate technical knowledge towards betterment of the community.

MISSION

- To impart academic excellence, professional competence with ethics to develop processes and valuable bio-products.
- To recognize and solve problems pertaining to Water, Food, Health Care and Energy through biotechnology approaches.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

Biotechnology Graduates will

1. Demonstrate knowledge towards sustainable development in Biotechnology meeting the International standards.
2. Exhibit skills in Biotechnological process development, product optimization, commercialization and social application.
3. Establish bioethical practices and ensure awareness on professional codes

PROGRAM OUTCOMES (POs)

Graduates will have ability to,

1. **Engineering Knowledge**: Apply the knowledge of mathematics, science and engineering to solve the problems related to biotechnology.
2. **Problem analysis:** Identify, formulate and analyze the complex problem in biotechnology and provide appropriate conclusions using principles of engineering & sciences
3. **Design/development of solutions:** Design solutions for complex bio-based problems and design process that address the specified needs for the public health, safety and environmental considerations
4. **Conduct investigations of complex problems:** Design experiments, analyze, interpret data and synthesize information using knowledge based research tools to arrive at valid conclusions
5. **Modern tool usage:** Create, select and apply appropriate techniques, software resources and modern engineering tools for prediction and modeling of complex engineering and biotechnology problems in different fields to understand the limitations
6. **The engineer and society:** Rational use of contextual knowledge to asses societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice and modern biotechnological research and development
7. **Environment and sustainability:** Understand and exhibit the knowledge vital for sustainable development in societal and environmental contexts using the professional engineering and biotechnology solutions.
8. **Ethics:** Inculcate ethical principles to imbibe professional ethics, responsibilities and norms of the engineering practice and biotechnology research
9. **Individual and team work:** Function effectively as an individual, member or leader of diverse teams in multidisciplinary settings
10. **Communication:** Effectively communicate with engineering community on activities relevant to society at large and comprehend reports & documentation, make effective presentations and exchange clear instructions
11. **Project management and finance:** Create competency in engineering management and finance principles and apply these to one's own work and multidisciplinary team environments

12. **Life-long learning:** Recognize the need for independent and life-long learning experience for a lucrative professional career

PROGRAM SPECIFIC OUTCOMES (PSOs)

1. Graduates have strong knowledge in the field of biotechnology and applied sciences.

2. Graduates will design and conduct experiments in biotechnology as well as analyze and interpret data.

3. Graduates will use current techniques, skills and modern tools necessary for modeling and design of bioprocesses.

LIST OF COURSES AND MAPPING WITH FOCAL THEME AREA

B. Tech Biotechnology Courses - 2019:

Sl.No	Course Code	Name of the Course	Focal Theme Area			
			Food	Water	Health	Energy
1.	19BT2001	Cell Biology			√	
2.	19BT2002	Basics of Industrial Biotechnology	√	√	√	√
3.	19BT2003	Bioprocess Calculations		√		√
4.	19BT2004	Bio-analytical Techniques	√	√	√	√
5.	19BT2005	Bio-analytical Techniques Lab	√	√	√	√
6.	19BT2006	Biochemistry	√		√	
7.	19BT2007	Biochemistry Lab	√		√	
8.	19BT2008	Microbiology	√	√	√	
9.	19BT2009	Microbiology Lab	√	√	√	
10.	19BT2010	Fluid Mechanics		√		
11.	19BT2011	Fluid Mechanics and Heat Transfer Lab		√		
12.	19BT2012	Bioprocess Principles	√	√		
13.	19BT2013	Bioprocess Lab	√	√		
14.	19BT2014	Molecular Biology			√	
15.	19BT2015	Genetic Engineering and Bioethics	√		√	
16.	19BT2016	Molecular Biology and Genetic Engineering Lab	√		√	
17.	19BT2017	Bioprocess Engineering	√	√		
18.	19BT2018	Enzyme Engineering and Technology	√	√		
19.	19BT2019	Heat & Mass Transfer	√	√		
20.	19BT2020	Downstream Processing	√	√		
21.	19BT2021	Downstream Processing Lab	√	√		
22.	19BT2022	Immunology			√	
23.	19BT2023	Cell Biology and Immunology Lab			√	
24.	19BT2024	Chemical Reaction Engineering	√	√		
25.	19BT2025	Mass Transfer and Chemical Reaction Engineering Lab	√	√		
26.	19BT2026	Biochemical Thermodynamics				√
27.	19BT2027	Basics of Bioinformatics			√	
28.	19BT2028	Bioinformatics Lab			√	

29.	19BT2029	Industrial safety and Hazard analysis	√	√		
30.	19BT2030	Environmental Pollution Control Engineering	√	√		
31.	19BT2031	Process Equipment Design and Economics	√	√		
32.	19BT2032	Process Dynamics and Control	√	√		
33.	19BT2033	Mechanical Operation	√	√		
34.	19BT2034	Mechanical Operation Lab	√	√		
35.	19BT2035	Biochemical Engineering	√	√		
36.	19BT2036	Biochemical Engineering Lab	√	√		
37.	19BT2037	Cancer Biology			√	
38.	19BT2038	Clinical Database Management			√	
39.	19BT2039	Clinical Database Management Lab			√	
40.	19BT2040	Plant and Animal Biotechnology	√		√	
41.	19BT2041	Stem Cell Technology			√	
42.	19BT2042	Biopharmaceutical Technology			√	
43.	19BT2043	Agricultural Biotechnology	√		√	
44.	19BT2044	Metabolic Engineering.	√		√	
45.	19BT2045	Research Methodology	√	√	√	√
46.	19BT2046	Molecular Forensics			√	
47.	19BT2047	Protein Engineering	√		√	
48.	19BT2048	Plant Tissue Culture	√		√	
49.	19BT2049	Animal Biotechnology and Cell Culture			√	
50.	19BT2050	Plant and Animal Tissue Culture Lab	√		√	
51.	19BT2051	Role of Biotechnology in Environment	√	√	√	√
52.	19BT2052	Industrial Pollution Control	√	√	√	
53.	19BT2053	Biomass and Bioenergy	√			√
54.	19BT2054	Environmental Biotechnology	√	√	√	√
55.	19BT2055	Matlab Programming				√
56.	19BT2056	Fundamentals of Biochemistry	√		√	
57.	19BT2057	Pathology and Microbiology	√	√	√	
58.	19BT2058	Human Anatomy and Physiology			√	
59.	19BT2059	Entrepreneurship, IPR and Biosafety	√		√	
60.	19BT2060	Tissue Engineering			√	
61.	19BT2061	Cell Biology and Immunology			√	
62.	19BT2062	Molecular Biology for Biomedical Engineers	√		√	
63.	19BT2063	Biology in Everyday Life	√	√	√	√

M. Tech Biotechnology Courses:

Sl.No	Course Code	Name of the Course	Focal Theme Area			
			Food	Water	Health	Energy
1.	19BT3001	Advances in Biopolymer and Applications	√	√	√	√
2.	19BT3002	Genetic Engineering and Recombinant Products	√		√	
3.	19BT3003	Bioprocess Modelling and Simulation		√		√

4.	19BT3004	Analytical Techniques in Biotechnology Lab	√	√	√	√
5.	19BT3005	Animal and Plant Tissue Culture Lab	√		√	
6.	19BT3006	Advanced Process Equipment Design and Drawing Lab	√	√	√	√
7.	19BT3007	Recombinant DNA Technology Lab	√		√	
8.	19BT3009	Enzyme Technology and Industrial Applications	√	√	√	√
9.	19BT3010	Microbial Biotechnology	√	√	√	
10.	19BT3011	Agriculture and Food Biotechnology	√	√	√	
11.	19BT3012	Big Data Analytics	√	√	√	√
12.	19BT3013	Bioethics and Biosafety	√	√	√	√
13.	19BT3014	Chemical Process Technology	√	√	√	√
14.	19BT3015	Immunotechnology	√		√	
15.	19BT3016	Computational Biology			√	
16.	19BT3017	Metabolic Regulation and Engineering			√	√
17.	19BT3018	Clinical trials and Bioethics			√	
18.	19BT3019	Sustainable Bioprocess Development	√	√	√	√
19.	19BT3020	Advanced Animal Biotechnology & Tissue Culture			√	
20.	19BT3021	Molecular Diagnostics	√		√	
21.	19BT3022	Drug Design and Discovery	√		√	
22.	19BT3023	Transport Phenomena	√		√	√
23.	19BT3024	Pharmaceutical Biotechnology	√		√	
24.	19BT3025	Bioreactor Engineering	√	√	√	√
25.	19BT3026	Stem Cell Therapeutics			√	
26.	19BT3027	Nanobiotechnology	√	√	√	√
27.	19BT3028	Advanced Plant Biotechnology	√	√	√	√
28.	19BT3029	Cancer Management Techniques			√	
29.	19BT3030	Genomics and Proteomics			√	
30.	19BT3031	Advanced Environmental Biotechnology	√	√	√	√
31.	19BT3032	Entrepreneurship and Management	√	√		√
32.	19BT3033	Industrial Waste Management	√	√		√
33.	19BT3034	Industrial Safety	√	√	√	√

List of Nptel Courses suggested for B. Tech (Biotechnology) 2019 Batch

No.	Course Id	Institute	Discipline	Course Name	SME Name	Duration	Credits
1	noc19- bt15	IIT Guwahati	Biotechnology & Bioengineering	Genetic Engineering: Theory and Application	Prof. Vishal Trivedi	12 weeks	3:0:0
2	noc19- bt16	IIT Kanpur	Biotechnology & Bioengineering	Bioenergy	Prof. Mainak Das	8 weeks	2:0:0
3	noc19- bt17	IIT Roorkee	Biotechnology & Bioengineering	Plant Developmental Biology	Prof. Shri Ram Yadav	4 weeks	1:0:0
4	noc19- bt19	IIT Bombay	Biotechnology & Bioengineering	Introduction to Biostatistics	Prof. Shamik Sen	8 weeks	2:0:0
5	noc19- bt21	IIT Kanpur	Biotechnology & Bioengineering	Nanotechnology in Agriculture	Prof. Mainak Das	8 weeks	2:0:0
6	noc19- bt22	IIT Madras	Biotechnology & Bioengineering	Computer Aided Drug Design	Prof. Mukesh Doble	8 weeks	2:0:0
7	noc19- bt23	IISc Bangalore	Biotechnology & Bioengineering	Drug Delivery: Principles and Engineering	Rachit Agarwal	12 Weeks	3:0:0
8	noc19- bt24	IIT Kanpur	Biotechnology & Bioengineering	Functional Genomics	Prof. S. Ganesh	4 weeks	1:0:0
9	noc19- bt25	IIT Bombay	Biotechnology & Bioengineering	Introduction To Proteomics	Prof. Sanjeeva Srivastava	8 weeks	2:0:0
10	noc19- bt26	IIT Bombay	Biotechnology & Bioengineering	Introduction to Proteogenomics	Prof. Sanjeeva Srivastava	12 weeks	3:0:0
11	noc19- bt27	IIT Kharagpur	Biotechnology & Bioengineering	Biomicrofluidics	Prof. Tapas Kumar Maiti & Prof. Suman Chakraborty	4 Weeks	1:0:0
12	noc19- bt28	IIT Roorkee	Biotechnology & Bioengineering	Biomedical nanotechnology	Prof. P. Gopinath	4 weeks	1:0:0
13	noc19- bt29	IISc Bangalore	Biotechnology & Bioengineering	Fundamentals of micro and nanofabrication	Prof Sushobhan Avasti Prof. Shankar Selvaraja	12 Weeks	3:0:0
14	noc19- bt31	IIT Madras	Biotechnology & Bioengineering	Principles Of Downstream Techniques In Bioprocess	Prof. Mukesh Doble	12 Weeks	3:0:0
15	noc19- bt33	IIT Madras	Biotechnology & Bioengineering	Tissue engineering	Prof. Vignesh Muthuvijayan	8 weeks	2:0:0

B. Tech (Biotechnology) - 2018 Batch
(REVISED COURSE COMPONENTS AND CURRICULUM)

PROGRAMME STRUCTURE

S. No.	Category	Credits
1	Humanities and Social Sciences including Management courses	9
2	Basic Science Courses	30
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	22
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	**162**

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	2:0:0:2
	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	**9**

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)	0:0:2:1
	2	18ME1004	Workshop / Manufacturing Practices Laboratory	0:0:2:1
	3	18EE1003	Basic Electrical and Electronics Engineering	3:1:0:4
	4	18EE1004	Basic Electrical and Electronics Engineering Laboratory	0:0:2:1
	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	**22**

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 and 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 and Genetic Engineering Lab	0:0:3:1.5
	12	18BT2017	Bioprocess Engineering	3:0:0:3
	13	18BT2018	Enzyme Engineering and Technology	3:0:0:3
	14	18BT2019	Heat and 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 and Immunology Lab	0:0:3:1.5
	19	18BT2024	Chemical Reaction Engineering	3:1:0:4
	20	18BT2025	Mass transfer and 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
5. Project work, internship	1	18BT2999 / 18BT2998	Project	12/6
	2	ISP2931 / ISP2911	Internship	6 / 2
	3	MP2911	Mini Project	2
	4	ITP2921	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	2:0:0:2
2	18MA1010	Matrices and Calculus	3:1:0:4
3	18PH1009	Applied Physics and Properties of Matter	3:1:0:4
4	18CH1006	Applied Chemistry	3:1:0:4
5	18EN1002	English Language Lab	0:0:2:1
6	18PH1010	Applied Physics and Properties of Matter Lab	0:0:3:1.5
7	18CH1002	Applied Chemistry Laboratory	0:0:3:1.5
8		Mandatory Course I	3:0:0:0
Total			**18**

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	3:1:0:4
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	0:0:2:1
6	18CS1002	Programming for Problem Solving Lab	0:0:3:1.5
7	18ME1002	Engineering Graphics (AutoCAD)	0:0:2:1
8	18ME1004	Workshop / Manufacturing Practices Laboratory	0:0:2:1
9		Mandatory Course II	0
Total			**18.5**

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	18BT2003	Bioprocess Calculations	3:0:0:3
3	18BT2006	Biochemistry	3:1:0:4
4	18BT2008	Microbiology	3:0:0:3
5	18BT2002	Basics of Industrial Biotechnology	3:0:0:3

6	18BT2009	Microbiology Lab	0:0:3:1.5
7	18BT2007	Biochemistry Lab	0:0:3:1.5
8		Mandatory Course III	0
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	18BT2004	Bio-analytical Techniques	3:0:0:3
5	18BT2010	Fluid Mechanics	3:1:0:4
6	18BT2026	Biochemical Thermodynamics	3:1:0:4
7	18BT2005	Bio-analytical Techniques Lab	0:0:3:1.5
8	18BT2011	Fluid mechanics and Heat transfer Lab	0:0:3:1.5
9		Mandatory Course IV	0
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-2	3:0:0:3
6	18BT2013	Bioprocess Lab	0:0:3:1.5
7	18BT2023	Cell biology and Immunology Lab	0:0:3:1.5
8		Mandatory Course V	0
Total			**19**

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 and 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 and Genetic Engineering Lab	0:0:3:1.5
8	18BT2025	Mass transfer Lab and Chemical Reaction Engineering Lab	0:0:3:1.5
9		Mandatory Course VI	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	12
		Total	**15**

B. Tech (Biotechnology) - 2019 Batch
(Revised Course Components & Curriculum)

PROGRAMME STRUCTURE

S. No.	Category	Credits
1	Humanities and Social Sciences including Management courses	9
2	Basic Science Courses	30
3	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	25
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	**165**

COURSE COMPONENTS

Table 1

Category	S.No	Course Code	Name of the Course	Credits L:T:P:C]
1.Humanities & Social Science	1	18EN1001	English	2:0:0:2
	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	**9**

Table 2

Category	S.No	Course Code	Name of the Course	Credits [L:T:P:C]
2.Basic Science	1	19MA1010	Matrices and Calculus	3:0:2:4
	2	19MA1011	Ordinary Differential Equations, Vector Calculus and Complex Integration	3:0:2:4
	3	19MA2007	Mathematical and Numerical Methods	3:0:2:4
	4	19MA2008	Probability, Statistics and Random Process	3:0:2:4
	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	19BT2001	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)	0:0:2:1
	2	19BT2064	Workshop Practices for Biotechnologists	0:0:2:1
	3	18EE1003	Basic Electrical and Electronics Engineering	3:1:0:4
	4	18EE1004	Basic Electrical and Electronics Engineering Laboratory	0:0:2:1
	5	18CS1004	Programming for Problem Solving	3:0:0:3
	6	18CS1002	Programming for Problem Solving Lab	0:0:3:1.5
	7	19BT2002	Basics of Industrial Biotechnology	3:0:0:3
	8	19BT2003	Bioprocess Calculations	3:0:0:3
	9	19BT2004	Bio-analytical Techniques	3:0:0:3
	10	19BT2005	Bio-analytical Techniques Lab	0:0:3:1.5
	11	19CS2012	Artificial Intelligence for Biotechnology	3:0:0:3
			Total credits	**25**

Table 4

Category	S.No	Course Code	Name of the Course	Credits [L:T:P:C]
4.Professional core	1	19BT2006	Biochemistry	3:1:0:4
	2	19BT2007	Biochemistry Lab	0:0:3:1.5
	3	19BT2008	Microbiology	3:0:0:3
	4	19BT2009	Microbiology Lab	0:0:3:1.5
	5	19BT2010	Fluid Mechanics	3:1:0:4
	6	19BT2011	Fluid Mechanics and Heat transfer Lab	0:0:3:1.5
	7	19BT2012	Bioprocess Principles	3:0:0:3
	8	19BT2013	Bioprocess Lab	0:0:3:1.5

	9	19BT2014	Molecular Biology	3:0:0:3
	10	19BT2015	Genetic Engineering and Bioethics	3:0:0:3
	11	19BT2016	Molecular Biology and Genetic Engineering Lab	0:0:3:1.5
	12	19BT2017	Bioprocess Engineering	3:0:0:3
	13	19BT2018	Enzyme Engineering and Technology	3:0:0:3
	14	19BT2019	Heat and Mass Transfer	3:1:0:4
	15	19BT2020	Downstream Processing	3:0:0:3
	16	19BT2021	Downstream Processing Lab	0:0:3:1.5
	17	19BT2022	Immunology	3:0:0:3
	18	19BT2023	Cell Biology and Immunology Lab	0:0:3:1.5
	19	19BT2024	Chemical Reaction Engineering	3:1:0:4
	20	19BT2025	Mass Transfer and Chemical Reaction Engineering Lab	0:0:3:1.5
	21	19BT2026	Biochemical Thermodynamics	3:1:0:4
	22	19BT2027	Basics of Bioinformatics	2:0:0:2
	23	19BT2028	Bioinformatics Lab	0:0:2:1
			Total credits	**59**

Table 5

Category	S.No	Course Code	Name of the Course	Credits
5. Project work, internship	1	19BT2999 / 19BT2998	Project	12/6
	2	ISP2931 / ISP2911	Internship	6 / 2
	3	MP2911	Mini Project	2
	5	ITP2921	Industrial Training	1
			Total Credits	**15 / 9**

SEMESTERWISE CURRICULUM

Semester-1

S.No	Course Code	Name of the Course	Hours/Week			Credits [L:T:P:C]
			L	T	P	
1	19MA1010	Matrices and Calculus	3	0	2	4
2	18PH1009	Applied Physics and Properties of Matter	3	1	0	4
3	18EE1003	Basic Electrical and Electronics Engineering	3	1	0	4
4	18PH1010	Applied Physics and Properties of Matter Lab	0	0	3	1.5
5	18EE1004	Basic Electrical and Electronics Engineering Laboratory	0	0	2	1
6		Mandatory Course- I				0
					Total	**14.5**

Semester-2

S.No	Course Code	Name of the Course	Hours/Week			Credits [L:T:P:C]
			L	T	P	
1	18EN1001	English	2	0	0	2

2	18EN1002	English Language Lab	0	0	2	1
3	19MA1011	Ordinary Differential Equations, Vector Calculus and Complex Integration	3	0	2	4
4	18CH1006	Applied Chemistry	3	1	0	4
5	18CS1004	Programming for Problem Solving	3	0	0	3
6	18CH1002	Applied Chemistry Laboratory	0	0	3	1.5
7	18CS1002	Programming for Problem Solving Lab	0	0	3	1.5
8	18ME1002	Engineering Graphics (AutoCAD)	0	0	2	1
9	19BT2064	Workshop Practices for Biotechnologists Laboratory	0	0	2	1
10	19CS2012	Artificial Intelligence for Biotechnology	3	0	0	3
11		Mandatory Course - II				0
Total						**22**

Semester-3

S.No	Course Code	Name of the Course	Hours/Week			Credits [L:T:P:C]
			L	T	P	
1	19MA2007	Mathematical and Numerical Methods	3	0	2	4
2	19BT2003	Bioprocess Calculations	3	0	0	3
3	19BT2006	Biochemistry	3	1	0	4
4	19BT2008	Microbiology	3	0	0	3
5	19BT2002	Basics of Industrial Biotechnology	3	0	0	3
6	19BT2009	Microbiology Lab	0	0	3	1.5
7	19BT2007	Biochemistry Lab	0	0	3	1.5
8		Mandatory Course - III				0
Total						**20**

Semester-4

S.No	Course Code	Name of the Course	Hours/Week			Credits [L:T:P:C]
			L	T	P	
1	19MA2008	Probability, Statistics and Random Process	3	0	2	4
2	18MS2005	Managerial Skills	3	0	0	3
3	19BT2001	Cell biology	3	0	0	3
4	19BT2004	Bio-analytical Techniques	3	0	0	3
5	19BT2010	Fluid Mechanics	3	1	0	4
6	19BT2026	Biochemical Thermodynamics	3	1	0	4
7	19BT2005	Bio-analytical Techniques Lab	0	0	3	1.5
8	19BT2011	Fluid mechanics and Heat transfer Lab	0	0	3	1.5
9		Mandatory Course - IV				0
					Total	**24**

Semester-5

S.No	Course Code	Name of the Course	Hours/Week	Credits [L:T:P:C]

			L	T	P	
1	19BT2012	Bioprocess Principles	3	0	0	3
2	19BT2014	Molecular Biology	3	0	0	3
3	19BT2019	Heat and Mass Transfer	3	1	0	4
4	19BT2022	Immunology	3	0	0	3
5		Professional Elective-1	3	0	0	3
6		Professional Elective-2	3	0	0	3
7	19BT2013	Bioprocess Lab	0	0	3	1.5
8	19BT2023	Cell Biology and Immunology Lab	0	0	3	1.5
9		Mandatory Course - V				0
					Total	**22**

Semester-6

S.No	Course Code	Name of the Course	Hours/Week			Credits [L:T:P:C]
			L	T	P	
1	19BT2015	Genetic Engineering and Bioethics	3	0	0	3
2	19BT2017	Bioprocess Engineering	3	0	0	3
3	19BT2018	Enzyme Engineering and Technology	3	0	0	3
4	19BT2024	Chemical Reaction Engineering	3	1	0	4
5		Professional Elective-3	3	0	0	3
6		Open Elective-1	3	0	0	3
7	19BT2016	Molecular biology and Genetic Engineering Lab	0	0	3	1.5
8	19BT2025	Mass Transfer and Chemical Reaction Engineering Lab	0	0	3	1.5
9		Mandatory Course - VI				0
Total						**22**

Semester-7

S.No	Course Code	Name of the Course	Hours/Week			Credits [L:T:P:C]
			L	T	P	
1	19BT2020	Downstream processing	3	0	0	3
2	18MS2004	Total Quality Management	3	0	0	3
		Professional Elective-4	3	0	0	3
3		Professional Elective-5	3	0	0	3
4		Open Elective-2	3	0	0	3
5	19BT2027	Basics of Bioinformatics	2	0	0	2
6	19BT2021	Downstream processing Lab	0	0	3	1.5
7	19BT2028	Bioinformatics Lab	0	0	2	1
8		Professional Elective-6	0	0	3	1.5
9		Professional Elective-7	0	0	3	1.5
Total						**22.5**

Semester-8

S.No	Course Code	Name of the Course	Hours/Week			Credits
			L	T	P	

1		Open Elective-3	3	0	0	3
2	19BT2999	Full Semester Project				12
Total			**3**	**0**	**12**	**15**

M.Tech. (Biotechnology) 2019 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	Industrial Training / Mini Project	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	19BT3001	Advances in Biopolymer and Applications	3	0	0	3
3	19BT3002	Genetic Engineering and Recombinant Products	3	0	0	3
4	19BT3003	Bioprocess Modelling and Simulation	3	0	0	3
5	19BT3004	Lab - I Analytical Techniques in Biotechnology Lab	0	0	4	2
6	19BT3005	Lab – II Animal and Plant Tissue Culture Lab	0	0	4	2
7	19BT3006	Lab - III Advanced Process Equipment Design and Drawing Lab	0	0	4	2
8	19BT3007	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	19BT3998	Project – Phase I	0	0	20	10
12	19BT3999	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	19BT3009	Enzyme Technology and Industrial Applications	3	0	0	3

2	19BT3010	Microbial Biotechnology	3	0	0	3
3	19BT3011	Agriculture and Food Biotechnology	3	0	0	3
4	19BT3012	Big Data Analytics	3	0	0	3
5	19BT3013	Bioethics and Biosafety	3	0	0	3
Elective – II						
1	19BT3014	Chemical Process Technology	3	0	0	3
2	19BT3015	Immunotechnology	3	0	0	3
3	19BT3016	Computational Biology	3	0	0	3
4	19BT3017	Metabolic Regulation and Engineering	3	0	0	3
5	19BT3018	Clinical trials and Bioethics	3	0	0	3
Elective – III						
1	19BT3019	Sustainable Bioprocess Development	3	0	0	3
2	19BT3020	Advanced Animal Biotechnology & Tissue Culture	3	0	0	3
3	19BT3021	Molecular Diagnostics	3	0	0	3
4	19BT3022	Drug Design and Discovery	3	0	0	3
Elective – IV						
1	19BT3023	Transport Phenomena	3	0	0	3
2	19BT3024	Pharmaceutical Biotechnology	3	0	0	3
3	19BT3025	Bioreactor Engineering	3	0	0	3
4	19BT3026	Stem Cell Therapeutics	3	0	0	3
5	19BT3027	Nanobiotechnology	3	0	0	3
Elective – V						
1	19BT3028	Advanced Plant Biotechnology	3	0	0	3
2	19BT3029	Cancer Management Techniques	3	0	0	3
3	19BT3030	Genomics and Proteomics	3	0	0	3
4	19BT3031	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	19BT3032	Entrepreneurship and Management	3	0	0	3
2	19BT3033	Industrial Waste Management	3	0	0	3
3	19BT3034	Industrial Safety	3	0	0	3

Table 4
AUDIT COURSE (MANDATORY COURSES) – 2 COURSE

S. No.	Course Code	Course Name	Hours per Week			Credits
			L	T	P	
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	19BT3001	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	19BT3004	Lab - I Analytical Techniques in Biotechnology Lab	0	0	4	2
6	19BT3005	Lab – II Animal and Plant Tissue Culture Lab	0	0	4	2
7	18MS3104	Research Methodology and IPR	2	0	0	2
8	Audit course	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	19BT3002	Genetic Engineering and Recombinant Products	3	0	0	3
2	19BT3003	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	19BT3006	Lab - III Advanced Process Equipment Design and Drawing Lab	0	0	4	2
6	19BT3007	Lab – IV Recombinant DNA Technology Lab	0	0	4	2
7	ITP3901/ MP3951	Industrial Training/ Mini Project	0	0	4	2
8	Audit course	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	Open Elective	3	0	0	3
3	19BT3998	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	19BT3999	Project – Phase II	-	-	32	16
		Total	**-**	**-**	**32**	**16**

LIST OF NEW COURSES

Sl.No	Course Code	Name of the Course	Credits [L:T:P:C]
1.	19BT2001	Cell Biology	3:0:0:3
2.	19BT2002	Basics of Industrial Biotechnology	3:0:0:3
3.	19BT2003	Bioprocess Calculations	3:0:0:3
4.	19BT2004	Bio-analytical Techniques	3:0:0:3
5.	19BT2005	Bio-analytical Techniques Lab	0:0:3:1.5
6.	19BT2006	Biochemistry	3:1:0:4
7.	19BT2007	Biochemistry Lab	0:0:3:1.5
8.	19BT2008	Microbiology	3:0:0:3
9.	19BT2009	Microbiology Lab	0:0:3:1.5
10.	19BT2010	Fluid Mechanics	3:1:0:4
11.	19BT2011	Fluid Mechanics and Heat Transfer Lab	0:0:3:1.5
12.	19BT2012	Bioprocess Principles	3:0:0:3
13.	19BT2013	Bioprocess Lab	0:0:3:1.5
14.	19BT2014	Molecular Biology	3:0:0:3
15.	19BT2015	Genetic Engineering and Bioethics	3:0:0:3
16.	19BT2016	Molecular Biology and Genetic Engineering Lab	0:0:3:1.5
17.	19BT2017	Bioprocess Engineering	3:0:0:3
18.	19BT2018	Enzyme Engineering and Technology	3:0:0:3
19.	19BT2019	Heat and Mass Transfer	3:1:0:4
20.	19BT2020	Downstream Processing	3:0:0:3
21.	19BT2021	Downstream Processing Lab	0:0:3:1.5
22.	19BT2022	Immunology	3:0:0:3
23.	19BT2023	Cell biology and Immunology Lab	0:0:3:1.5
24.	19BT2024	Chemical Reaction Engineering	3:1:0:4
25.	19BT2025	Mass Transfer and Chemical Reaction Engineering Lab	0:0:3:1.5
26.	19BT2026	Biochemical Thermodynamics	3:1:0:4
27.	19BT2027	Basics of Bioinformatics	2:0:0:2
28.	19BT2028	Bioinformatics Lab	0:0:2:1
29.	19BT2029	Industrial safety and Hazard analysis	3:0:0:3
30.	19BT2030	Environmental Pollution Control Engineering	3:0:0:3
31.	19BT2031	Process Equipment Design and Economics	3:0:0:3
32.	19BT2032	Process Dynamics and Control	3:0:0:3
33.	19BT2033	Mechanical Operations	3:0:0:3
34.	19BT2034	Mechanical Operations Lab	0:0:3:1.5
35.	19BT2035	Biochemical Engineering	3:0:0:3
36.	19BT2036	Biochemical Engineering Lab	0:0:3:1.5
37.	19BT2037	Cancer Biology	3:0:0:3
38.	19BT2038	Clinical Database Management	3:0:0:3
39.	19BT2039	Clinical Database Management Lab	0:0:3:1.5
40.	19BT2040	Plant and Animal Biotechnology	3:0:0:3
41.	19BT2041	Stem Cell Technology	3:0:0:3
42.	19BT2042	Biopharmaceutical Technology	3:0:0:3

43.	19BT2043	Agricultural Biotechnology	3:0:0:3
44.	19BT2044	Metabolic Engineering.	3:0:0:3
45.	19BT2045	Research Methodology	3:0:0:3
46.	19BT2046	Molecular Forensics	3:0:0:3
47.	19BT2047	Protein Engineering	3:0:0:3
48.	19BT2048	Plant Tissue Culture	3:0:0:3
49.	19BT2049	Animal Biotechnology and Cell Culture	3:0:0:3
50.	19BT2050	Plant and Animal Tissue Culture Lab	0:0:3:1.5
51.	19BT2051	Role of Biotechnology in Environment	3:0:0:3
52.	19BT2052	Industrial Pollution Control	3:0:0:3
53.	19BT2053	Biomass and Bioenergy	3:0:0:3
54.	19BT2054	Environmental Biotechnology	3:0:0:3
55.	19BT2055	Matlab Programming	3:0:0:3
56.	19BT2056	Fundamentals of Biochemistry	3:0:0:3
57.	19BT2057	Pathology and Microbiology	3:0:0:3
58.	19BT2058	Human Anatomy and Physiology	3:0:0:3
59.	19BT2059	Entrepreneurship, IPR and Biosafety	3:0:0:3
60.	19BT2060	Tissue Engineering	3:0:0:3
61.	19BT2061	Cell Biology and Immunology	3:0:0:3
62.	19BT2062	Molecular Biology for Biomedical Engineers	3:0:0:3
63.	19BT2063	Biology in Everyday Life	3:0:0:3
64.	19BT2064	Workshop Practices for Biotechnologists Laboratory	0:0:2:1
65.	19BT3001	Advances in Biopolymer and Applications	3:0:0:3
66.	19BT3002	Genetic Engineering and Recombinant Products	3:0:0:3
67.	19BT3003	Bioprocess Modelling and Simulation	3:0:0:3
68.	19BT3004	Analytical Techniques in Biotechnology Lab	0:0:4:2
69.	19BT3005	Animal and Plant Tissue Culture Lab	0:0:4:2
70.	19BT3006	Advanced Process Equipment Design and Drawing Lab	0:0:4:2
71.	19BT3007	Recombinant DNA Technology Lab	0:0:4:2
72.	19BT3009	Enzyme Technology and Industrial Applications	3:0:0:3
73.	19BT3010	Microbial Biotechnology	3:0:0:3
74.	19BT3011	Agriculture and Food Biotechnology	3:0:0:3
75.	19BT3012	Big Data Analytics	3:0:0:3
76.	19BT3013	Bioethics and Biosafety	3:0:0:3
77.	19BT3014	Chemical Process Technology	3:0:0:3
78.	19BT3015	Immunotechnology	3:0:0:3
79.	19BT3016	Computational Biology	3:0:0:3
80.	19BT3017	Metabolic Regulation and Engineering	3:0:0:3
81.	19BT3018	Clinical trials and Bioethics	3:0:0:3
82.	19BT3019	Sustainable Bioprocess Development	3:0:0:3
83.	19BT3020	Advanced Animal Biotechnology & Tissue Culture	3:0:0:3
84.	19BT3021	Molecular Diagnostics	3:0:0:3
85.	19BT3022	Drug Design and Discovery	3:0:0:3
86.	19BT3023	Transport Phenomena	3:0:0:3
87.	19BT3024	Pharmaceutical Biotechnology	3:0:0:3

88.	19BT3025	Bioreactor Engineering	3:0:0:3
89.	19BT3026	Stem Cell Therapeutics	3:0:0:3
90.	19BT3027	Nanobiotechnology	3:0:0:3
91.	19BT3028	Advanced Plant Biotechnology	3:0:0:3
92.	19BT3029	Cancer Management Techniques	3:0:0:3
93.	19BT3030	Genomics and Proteomics	3:0:0:3
94.	19BT3031	Advanced Environmental Biotechnology	3:0:0:3
95.	19BT3032	Entrepreneurship and Management	3:0:0:3
96.	19BT3033	Industrial Waste Management	3:0:0:3
97.	19BT3034	Industrial Safety	3:0:0:3

19BT2001	CELL BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Recall the dynamic characteristics of cellular organelles
2. Relate the significance of chemical energy for cellular activities
3. Investigate the specific processes and proteins involved in membrane transport.
4. Analyze the behavior of cells in their microenvironment in multicellular organisms
5. Infer the receptor subclasses and their possible uses in cell signaling and signal transduction
6. Appraise the components of prokaryotic and eukaryotic system

Module 1: Features of Cell and its Organelles (9 hrs)

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 2: Cell Cycle and its Regulation (6 hrs)

Cell cycle and molecules that control cell cycle, Regulation of cell cycle. Cell cycle and cancer: Tumor suppressor genes and Oncogenes.

Module 3: Cytoskeleton and Cells in their Social Context (5 hrs)

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

Module 4: Cell Transport and Traffic (9 hrs)

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 5: Signaling Molecules and their Receptors (7 hrs)

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 6: Signal Transduction (9 hrs)

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.

19BT2002	BASICS OF INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To ensure students to have a base on the History of Biotechnology, and different kinds of microorganisms deployed for industrial biotechnology.
2. To facilitates for understanding the various production strategies of bio products employed for sustainable bioprocess development

Course Outcomes:

1. Remember the use of microbes for developing industrial products and processes.
2. Understand the techniques for genetic improvement of micro-organisms to improve yield of bio-products.
3. Explain the technical issues related with microorganisms in the production of bio products.
4. Analyse industrial-market value of these bio products and relate them with the scope of biotechnology
5. Relate the clinical and biological significance of these bio products for sustainable bioprocess engineering
6. Evaluate the difference in manufacturing commercial bio products and all the ethical issues involved in it.

Module 1: Introduction to Industrial Bioprocess (9 hrs)

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 2: Production of Primary Metabolites (9 hrs)

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, Production of organic acids, amino acids and alcohols.

Module 3: Production of Secondary Metabolites (9 hrs)

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 steroids.

Module 4: Production of Industrial Enzymes and other Products (9 hrs)

Production of enzymes and specialty chemicals: Production of industrial enzymes such as lipases, celluloses, bio preservatives (Nisin), cheese, biopolymers (xanthan gum, PHB etc), Bio-flavours and bio-pigments.

Module 5: Production of Modern Biotechnological Products (5 hrs)

Strain improvement by using chemical mutagenesis, Bio-fertilizers, Bioenergy-fuel from biomass, production and economics of biofuels, biogas, bio-refineries, Microbial Enhanced Oil Recovery (MEOR).

Module 6: Production of Target Specific Fine Bio products: (4 hrs)

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), 2005.
2. P.F. Stanbury and Whitaker, Fermentation Technology, Second Edition, 2009.

References Books:

1. Elmar Heinzle,Sustainable Bioprocess Development, 2008.
2. Robert H. Perry, Handbook of Chemical Engineering, 2000.
3. Glazer AN, Nikaido H, The process of Microbial Enhanced Oil Recovery and Microbial Leaching Text books, 2007.

19BT2003	BIOPROCESS CALCULATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To develop skills of students in principles and basic calculations
2. To familiarize in material balance for both with and without chemical reactions
3. To conceptualize energy balance for reactive and non-reactive systems

Course Outcomes:

1. Understand the importance and inter conversion of different units
2. Remember the concept of material balances for with and without chemical reactions
3. Relate the concept of stoichiometry in real-time problem
4. Distinguish the properties of ideal gases and gas mixtures
5. Evaluate flow diagram and the concept of recycle, purge and bypass in a process
6. Analyze the concept of energy balances for closed and open system

Module 1: Systems (8 hrs)

Units systems, basic units, derived units, dimension analysis, force, pressure, work, heat, conversion of units, Mass and volumetric flux.

Module 2: Stoichiometry (9 hrs)

Stoichiometry, Avogadro number, molarity, molality and normality, molecular weight, equivalent weight, mass fraction, mole fraction, concept of limiting & excess reactants, fractional conversion, stoichiometry of microbial growth and product formation.

Module 3: Ideal Gases and Gas Mixtures (10 hrs)

Ideal Gases, Standard temperature and pressure, partial pressure, Ideal Gas Equation, Gas laws: Boyle's Law, Charles' law, Amagat's law and Daltons law, Density and molecular weight related problems.

Module 4: Material Balance (10 hrs)

Fundamental of material balance, Basics of calculation, approach of solving material balance problems, Mixing, Tie element, Evaporation, Crystallization, Drying, Absorption, Extraction.

Module 5: Energy Balance (5 hrs)

Basic Energy Concepts, types of Energy, Internal energy, Enthalpy, General Energy-Balance Equations, Heat capacities, Procedure for energy balance calculations.

Module 6: Material Balance involving Recycle (3 hrs)

Bypass, Recycle, Purge, closed and open system

Total Hours: 45

Text Book:

1. Narayanan K.V., Lakshmikutty B., "Stoichiometry and Process Calculations", PHI Learning Private Limited, 4th edition, 2014

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

19BT2004	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. Understand the basic techniques of drug extractions from different sources
2. Illustrate the different methods of analytical techniques for quantitative analysis
3. Classify various separation and purification techniques of compounds
4. Demonstrate the gel electrophoresis and thermal analytical techniques
5. Analyze the methods of structural elucidation of different drugs
6. Asses the importance of radioactive isotopes in modern research

Module 1: Extraction Methods (9 hrs)

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 2: Spectroscopy Techniques (9 hrs)

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

Module 3: Chromatography Techniques (9 hrs)

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

Module 4: Electrophoresis & Thermal Method (9 hrs)

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

Module 5: Structural Elucidation Techniques (5 hrs)

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

Module 6: Radioisotope Methods (4 hrs)

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).

19BT2005	BIO ANALYTICAL TECHNIQUES LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To impart technical knowledge about the working principle and applications of different equipment 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 Outcomes:

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 equipment 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

19BT2006	BIOCHEMISTRY	L	T	P	C
		3	1	0	4

Course Objectives:

1. To acquire knowledge on structure, properties and function of various biomolecules.
2. To know the concepts of metabolism and to study the metabolic pathways
3. To understand the significance of biomolecules in biotechnology and the metabolic disorders

Course Outcomes:

1. Remember the structure of carbohydrates, lipids, nucleic acid and proteins
2. Classify the biomolecules and understand their specific roles in biological system.
3. Understand the significance of conjugated biomolecules
4. Analyze the properties of biomolecules
5. Illustrate the metabolic pathways of biomolecules, bioenergetics and inborn metabolic disorders
6. Integrate the metabolic pathways of synthesis and degradation of biomolecules

Module 1: Carbohydrates (12 hrs)

Classification, structure, properties and functions of carbohydrates (Mono, Di, Oligo and polysaccharides) Monosaccharides, Disaccharides, Oligosaccharides-examples; Polysaccharide – classes- homo and hetero polysaccharides, Conjugated carbohydrates.

Module 2: Fatty Acids and Lipids (8 hrs)

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.

Module 3: Amino Acids, Peptides and Proteins (12 hrs)

Amino acids- structure and classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides; Proteins- classification and structures - primary, secondary, tertiary and quaternary.

Module 4: Nucleotides and Nucleic Acids (8 hrs)

Nucleosides and Nucleotides- composition - Structure of Purines – Pyrimidines, Structure, properties and functions of nucleotides; Nucleic acids- types: DNA- structure and forms, RNA – structure, types and functions, Nucleoprotein complexes.

Module 5: Metabolism and inborn Metabolic Disorders (14 hrs)

Carbohydrate: Glycolysis, TCA cycle, pentose phosphate shunt, glycogen synthesis and degradation, Glycogen storage diseases. Lipids: Biosynthesis and oxidative degradation of fatty acid - ketogenesis, TG, phospholipid and cholesterol, Lipid storage diseases. Amino acids and Proteins: Protein degradation and nitrogen metabolism from amino acids-Transamination, Urea cycle, Biodegradation of aromatic amino acids (Tyr, Trp, Phe) and associated metabolic disorders. Metabolism of purine and pyrimidine and associated metabolic disorders.

Module 6: Bioenergetics and Integration of Metabolism (6 hrs)

High energy compounds-ATP, Bioenergetics in glucose oxidation, and fatty acid oxidation, Respiratory chain and oxidative phosphorylation, Gluconeogenesis and control of blood glucose, Interconvertible metabolic fuels.

Total Hours: 60

Text Books:

1. Lehninger, A. L, NelsonD. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, fourth edition, 2005.
2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.

Reference Books:

1. Jain and Jain "Biochemistry", Chand publication, 2016.
2. Lubert Stryer, "Biochemistry", WH Freeman & Co., 4th edition, 2006.
3. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.

19BT2007	BIOCHEMISTRY LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 19BT2006 -Biochemistry

Course Objectives:

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

Course Outcomes:

1. Understand the basic concept, applications of tests, titrations and estimations of biomolecules
2. Demonstrate the basic lab skill in preparing different solutions of different concentrations and their measurement tools with representing units
3. Apply the basic reaction principle in estimation of different biomolecules using suitable method

4. Analyze through various tests and identify the different carbohydrate, amino acid and lipid molecules present in the given sample solution.
5. Apply suitable extraction methods for the estimation of different biomolecules.
6. Evaluate the level of biomolecules in different food materials

List of Experiments:

1. Preparation of different biochemical solutions, study of concentration, units and measurements
2. Determination of starch in plant tissue
3. Qualitative tests for identification 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 or Bradford Assay
8. Qualitative analysis of amino acids for identification
9. Extraction and estimation of amino acid in different samples by Ninhydrin method
10. Estimation of DNA by diphenylamine method
11. Estimation of RNA by Orcinol method
12. Titration of amino acid

Reference Book:

1. Sawhney S. K., Randhir Singh, Introductory practical Biochemistry. Narosa publishers, 2006

19BT2008	MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Recall the basic knowledge on the development of microbiology
2. Recognize the fundamental concepts pertaining to the structure and functions of microbes
3. Appraise the importance of microscopy, staining techniques and classify the microorganisms
4. Apply appropriate physical and chemical methods to control the growth of microbes
5. Formulate the nutritional requirements for microbial growth and their metabolism
6. Compare and categorize the interactions of microorganisms with humans and animals

Module 1: Introduction to Microbiology (9 hrs)

Historical perspectives of microbiology-classification, and nomenclature of microorganisms- Microscopy – light, phase, fluorescent and electron microscopy (SEM and TEM), Confocal Laser Scanning Microscopy (CLSM)- principles of different staining techniques - Gram staining, acid fast, capsular staining, flagellar staining and spore staining,16sr RNA sequencing

Module 2: Microbial Structure and Multiplication (9 hrs)

Morphology, Structure and Functions of Prokaryotic cells, Multiplication of bacteria, Life cycles- viruses (bacteriophage), algae (Chamydomonas), protozoa (Plasmodicum vivax), fungi (Rhizopus stolonifer), yeast (Neurospora crassa) and actinomycetes

Module 3: Microbial Nutrition and Metabolism (8 hrs)

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

Module 4: Control of Microorganisms (7 hrs)

Physical methods – sterilization: Moist heat, dry heat, radiation and filtration. Chemical methods: Disinfection, phenol, alcohol and detergents; Antibiotics- antibacterial agents, anti-fungal agents, anti-viral agents

Module 5: Microbial Ecology (4 hrs)

Interaction between Microorganisms – Commensalism, Synergism, Mutualism (symbiosis), Lichen symbiosis, Autochthonous, Zymogenous

Module 6: Medical and Food Microbiology (8 hrs)

Normal flora of human healthy host, Importance of nosocomial infections (hospital borne), mode of transmission of airborne pathogens, Medical Biofilms, Food and water borne infections caused by bacteria (botulism, cholera), Significance of microbes in food- Probiotics and fermented products-sauerkraut, cheese

Total Hours:45

Text Books:

1. Pelczar MJ, Chan ECS and Krein NR, Microbiology, Tata McGraw Hill Edition, New Delhi, India.2007
2. Ananthanarayanan and Panicker, "Microbiology" Orientblackswan, 2015.

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.

19BT2009	MICROBIOLOGY LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 19BT2008- Microbiology

Course Objectives:

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. To learn the different parts of microscopes and their functions
3. To identify the microorganisms using various staining techniques and biochemical tests

Course Outcomes:

1. Understand the basic knowledge on microbiological lab safety guidelines
2. Recognize the parts/functions of microscopes
3. Experiment with transfer of living microbes using aseptic technique
4. Develop media for cultivation of microorganisms
5. Demonstrate microbial isolation and staining techniques for identification of microorganism
6. Analyze different kinds of microorganisms present in clinical and environmental samples

List of Experiments:

1. Preparation and inoculation of media- Nutrient broth, Nutrient agar slant
2. Pure culture Techniques– streak plate
3. Enumeration of microorganisms from Soil/Water
4. Anaerobic Cultivation – Fluid Thioglycolate broth
5. Staining Techniques –Simple, Gram staining and spore staining
6. Staining of fungus – Lacto phenol cotton blue staining
7. Motility test by Hanging drop method
8. Antibiotic sensitivity assay – Disc diffusion method
9. Effect of Disinfectants- Phenol Coefficient
10. Growth Curve in Bacteria
11. Effect of pH, Temperature, UV radiation on growth Bacteria
12. Measurement of microbial Size – Micrometry

19BT2010	FLUID MECHANICS	L	T	P	C
		3	1	0	4

Course Objectives:

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. Understand the nature of fluids, statics and dynamics of fluid flow
2. Summarize the principles for flow in transportation of fluids in the problems related to the process engineering
3. Relate flow through pipe and flow past immersed object
4. Analyze the equations of fluid flow
5. Evaluate principles of fluid flow phenomena in scale up
6. Create empirical relations using dimensional analysis

Module 1: Basics of Fluid Statics and Fluid flow Phenomena (12 hrs)

Fluid definition- compressible, in compressible fluids, fluid properties, Newtonian and Non-Newtonian fluids**,** fluid as a continuum, Classification of fluid motion, Fluid statics – basic equation – equilibrium of fluid element – pressure variation in a static fluid – application to manometry, fluid flow phenomena-laminar flow, turbulence, boundary layer

Module 2: Basic equations of Fluid flow (12 hrs)

Differential analysis of fluid motion – continuity, equation of motions, Bernoulli equation and Navier-Stokes equation. Pressure loss in straight pipes – in fittings –expansion and contraction losses (applied to Newtonian Fluids only)

Module 3: Incompressible Flow in pipes and flow past Immersed Objects (12 hrs)

Reynolds number regimes, internal flow – flow through pipes – pressure drop under laminar and turbulent flow conditions, Flow past a sphere- drag and drag coefficient,– friction and pressure drag – flow through fixed bed of solids- pressure drop, fluidization- minimum fluidization velocity.

Module 4: Transportation and Metering of Fluid (8 hrs)

Flow measurement – Constant and variable head meters; Velocity measurement techniques; pipes, fittings, Types, characteristics and sizing of valves; Classification, performance characteristics and sizing of pumps, compressors and fans.

Module 5: Agitation and mixing of liquids (8 hrs)

Agitated vessels, Blending and mixing, Agitator selection and scale up

Module 6: Dimensional Analysis and Similitude (8 hrs)

The principle of dimensional homogeneity – dimensional analysis, Rayleigh method and the Pi-theorem – non-dimensional action of the basic equations – similitude – relationship between dimensional analysis and similitude – use of dimensional analysis for scale up studies

Total hours: 60

Text Books:

1. Munson, B. R., Young, D.F., Okiishi, T.H. “Fundamentals of Fluid Mechanics”, 5th Edition“, John Wiley, 2006
2. Noel de Nevers, “Fluid Mechanics for Chemical Engineers “, Second Edition, McGrawHill, 2001.

Reference Books:

1. White, F.M., “Fluid Mechanics “, IV Edition, McGraw-Hill Inc., 2005

2. James O Wilkes and Stacy G Bike, “Fluid Mechanics for Chemical Engineers’ Prentice Hall PTR (International series in Chemical Engineering) 2004.
3. McCabe W.L, Smith, J C and Harriot. P “Unit operations in Chemical Engineering”, McGraw Hill, VII Edition, 2005

19BT2011	FLUID MECHANICS AND HEAT TRANSFER LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

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 Outcomes:

1. Understand the heat transfer concept and its applications.
2. Estimate the importance of fluid mechanics in different 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. Evaluate the thermal conductivity of materials for wide range of applications in heat exchangers
6. Relate annular pipe for wide range of applications in industry.

List of Experiments:

1. Determinations of Minor Losses in Pipes Due to Sudden Expansion
2. Determination of Coefficient of Discharge of Venturimeter
3. Determination of Darcy’s Friction Factor
4. Determination of Friction Factor Losses Coefficient in Helical Pipe
5. Determination of Friction Factor in Annular Pipe
6. Determinations of Minor Losses in Pipes Due to Sudden Contraction
7. Determination of Coefficient of Discharge of Orifice Meter
8. Determination of Coefficient of Discharge of Rotameter
9. Determination of Thermal Conductivity of Composite Wall
10. Determine the overall heat transfer coefficient in Double pipe Heat Exchanger (Parallel and Counter Flow)
11. Determine the overall heat transfer coefficient in Shell and Tube Heat Exchanger

19BT2012	BIOPROCESS PRINCIPLES	L	T	P	C
		3	0	0	3

Course Objectives:

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 facts on sterilization kinetics

Course Outcomes:

1. Understand the process of fermentation and its requirements
2. Remember the process of media formulation and medium optimization for fermentation process
3. Analyze the kinetics of sterilization process
4. Apply knowledge on isolation and storage of industrially important microbes
5. Analyze methods to develop inoculum for various fermentation process
6. Evaluate the stoichiometry of cell growth and product formation during fermentation

Module 1: Overview of Fermentation Process (6 hrs)

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

Module 2: Medium Formulation and Optimization (9 hrs)

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

Module 3: Sterilization Kinetics (12 hrs)

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 4: Inoculum Development (8 hrs)

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 5: Stoichiometry of Cell Growth and Product Formation (8 hrs)

Stoichiometry of biochemical reactions, elemental balances, degrees of reduction of substrate and biomass, available electron balances.

Module 6: Yield Calculations (4 hrs)

Knowing the Principles 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

19BT2013	BIOPROCESS LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 19BT2012- Bioprocess Principles

Course Objectives:

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 Outcomes:

1. Acquire knowledge in the process of fermentation.
2. Demonstrate enzyme assay qualitatively and quantitatively
3. Examine factors affecting enzyme activity.
4. Apply 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 by wet weight and dry weight method
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 α - Amylase Enzyme by entrapment method
7. Estimation of volumetric mass transfer coefficient

8. Citric acid production by Solid State Fermentation
9. Qualitative Enzyme Assay- Starch Plate Technique
10. Quantitative Enzyme Assay
11. Production of Wine
12. Production of Amylase from Bacillus subtilis and Assaying for its Activity

19BT2014	MOLECULAR BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Recall the fundamental concepts of the prokaryotic and eukaryotic genome organization, its replication and gene expression
2. Understand the process of replication, transcription and translation
3. Recognize common mutations, their natural repair systems and inhibitors of gene expression
4. Distinguish the process of replication, transcription and translation of prokaryotes and eukaryotes
5. Appraise the post-synthesis modifications for transcription and translation
6. Comprehend the role of genetic code, chromatin, operons and cis/trans elements in gene regulation

Module 1: Genome Organization (8 hrs)

Classical experiments to prove genetic material: Griffith, Hershey and chase; Avery McLeod & McCarty. Genome organization in prokaryotes and eukaryotes – Molecular structure of DNA, Bacterial Recombination: Transformation, Transduction –types and Conjugation.

Module 2: DNA Replication – Prokaryotes (9 hrs)

DNA replication- Semi conservative replication - Meselson Stahl experiment, Enzymes in replication, Replication in prokaryotes-E.coli, D-loop and rolling circle mode of replication, regulation of replication, replication in virus - linear viral DNA replication, RNA replicase, Reverse transcriptase.

Module 3: DNA Replication – Eukaryotes and Mutations (5 hrs)

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

Module 4: Transcription (9 hrs)

RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, post-transcriptional modification - RNA splicing and RNA editing, Inhibitors.

Module 5: Genetic Code and Translation (7 hrs)

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

Module 6: Regulation of Gene Expression (7 hrs)

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

19BT2015	GENETIC ENGINEERING AND BIOETHICS	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

1. Describe the basics of genetic engineering
2. Understand the basic tools employed in genetic engineering.
3. Relate and evaluate the use of cloning vectors in genetic engineering.
4. Comprehend the concept of polymerase chain reaction and its applications.
5. Discuss and appraise the strategy and applications of gene cloning.
6. Analyze the need of Bioethics and IPR in biotechnological research.

Module 1: Restriction Enzymes (9 hrs)

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 2: Ideal Vectors Plasmids (9 hrs)

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.

Module 3: Polymerase Chain Reaction (9 hrs)

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

Module 4: Construction of Recombinant DNA (9 hrs)

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 5: Bioethics (5 hrs)

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

Module 6: Biosafety Guidelines (4 hrs)

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. Gene Cloning and DNA Analysis, 6th Edition, Blackwell Publishing Ltd 2010
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. Richard Sherlock, John D. Morrey "Ethical Issues in Biotechnology" Rowman & Littlefield Publishers, 2002.

19BT2016	MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To learn various basic techniques in molecular biology and genetic engineering.
2. To learn how to isolate DNA from various sources.
3. To learn to manipulate DNA.

Course Outcomes:

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

19BT2017	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. Aims to understand the fundamental principles and concepts of Bioreactor engineering.
2. Help to understand stoichiometric calculations, models of growth and product formation
3. To understand the basics of oxygen transfer in microbial bioreactors

Course Outcomes:

1. Remember principles of stoichiometry and concepts of bioreactor engineering.
2. Understand elemental balance equations and models of growth and product formation.
3. Classify various growth and product formation kinetics.
4. Apply methods to calculate volumetric mass transfer coefficients in bioreactors
5. Analyze various bioreactors for fermentation process.
6. Evaluate process control in Fermentation processes.

Module 1: Stoichiometry of Cell Growth and Product Formation (9 hrs)

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 2: Simple Unstructured Kinetic Models (9 hrs)

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 3: Oxygen Transfer in Microbial Bioreactors (9 hrs)

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 4: Bioreactors for free and immobilized cells (9 hrs)

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 5: Parameters to be Monitored and controlled in Fermentation Processes (5 hrs)

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 6: Analyzing process parameters (4 hrs)

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.

19BT2018	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 Outcomes:

1. Understand enzymes and enzymatic reactions
2. Relate the application of enzymes in various industries
3. Apply enzymes in free and immobilized form for various reaction
4. Analyze and solve problems related to enzymes and kinetics
5. Evaluate the processing and purification of enzymes
6. Hypothesize model for enzyme kinetics and inhibition types

Module 1: Classification and characteristics of Enzyme (7 hrs)

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, concept of active site and energetics of enzyme substrate complex formation; principles of catalysis – collision theory, transition state theory; role of entropy in catalysis.

Module 2: Enzyme Kinetics and Inhibition (12 hrs)

Kinetics of enzyme catalyzed reactions. Importance and estimation of Michelis – Menten parameters, Multi substrate reactions- mechanism and kinetics, turnover number; Allosteric regulation of enzymes, Enzyme inhibition types and models- Competitive, Noncompetitive and Uncompetitive inhibitions. Inhibition kinetics- substrate, product and toxic compound; deactivation kinetics.

Module 3: Extraction and Purification of Enzymes (8 hrs)

Extraction and purification of enzymes from plant, animal and microbial sources, Extraction of soluble and membrane bound enzymes. Criteria of purity, Determination of molecular weight of enzymes, development of enzymatic assays

Module 4: Immobilization of Enzymes (7 hrs)

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, Plug flow reactor, Fluidized bed and Membrane bioreactors

Module 5: Enzyme Biosensors (5 hrs)

Design of enzyme electrodes and their application as biosensors in industry: healthcare and environment with example.

Module 6: Enzyme Applications (6 hrs)

Biotransformation application of enzymes- Hydrolytic, Reduction reactions, Oxidation reactions, Enzymes in organic synthesis, Application of enzyme in different industries, Modified and Artificial Enzymes

Total Hours: 45

Text Book:

1. T Palmer, "Enzymes", Harwood 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.

19BT2019	HEAT AND MASS TRANSFER	L	T	P	C
		3	1	0	4

Course Objectives:

1. To ensure fundamental knowledge about heat transfer operations
2. To introduce 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 Outcomes:

1. Understand the basic doctrine of heat transmits
2. Summarize and workout conduction effort
3. Recognize convection effort and amylase heat exchangers
4. Solve problems related to diffusion, leaching and adsorption
5. Estimate the number of stages for Distillation and absorption
6. Analyze the vertical of evaporators

Module 1: Conduction (12 hrs)

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.

Module 2: Convection and Radiation (12 hrs)

Convection– Types of convection-Individual and overall heat transfer coefficient- Reynolds's analogy-Natural convection– Forced convection, Radiation-Thermalradiation-Spectrumofelectromagneticradiation-Monochromatic Emissive Power of blackbody-Planck's Distribution Law – Kirchoff's Law - Total Emissive Power, problems on Stefan- Boltzmann's law and Wien's displacement law

Module 3: Heat Exchanger and Evaporators (12 hrs)

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 4: Diffusion and inter phase mass transfer (12 Hours)

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

Module 5: Distillation and Absorption (8 hrs)

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 6: Heat Transfer applications (4 hrs)

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

Total Hours:60

Text Books:

1. Holman, J. P., Heat Transfer, 9th Edition, McGrawHill, Singapore, 2002
2. Donald Q. Kern, Process Heat Transfer, TataMcGrawHill, New Delhi,1997

Reference Books:

1. Mccabe,W.L.,Smith,J.C., andHarriott,P. Unit Operations of Chemical Engineering, McGraw Hill,NewYork, 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

19BT2020	DOWNSTREAM PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know characteristics of cell types and their disruption methods.
2. To understand the principles of isolation, separation and purification of bioproducts
3. To analyze the different polishing methods available for bioproducts.

Course Outcomes:

1. Understand the fundamentals of product isolation and separation techniques.
2. Distinguish various techniques for product recovery and polishing.
3. Explain operating principles across different solid(liquid)-liquid separation process
4. Analyze product recovery in solid liquid separation processes.
5. Compare the performances of different extraction techniques
6. Apply separation techniques for bio product recovery.

Module 1: Overview of Bio separations (6 hrs)

Broad classification of bio products, characteristics of fermentation broths and bio products. 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 2: Product recovery (12 hrs)

Gravity sedimentation: Mechanisms of sedimentation, thickeners, classifiers, applications in downstream processing. Centrifugal bio separations: 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 3: Isolation of Bio product (12 hrs)

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

Module 4: Purification (7 hrs)

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

Module 5: Finishing operation (4 hrs)

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

Module 6: Heat and Mass transfer in Dryers (4 hrs)

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, 2011.
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.

19BT2021	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 Outcomes:

1. Remember cell disruption techniques for intracellular product recovery.
2. Understand the separation methods to recover microbial cells from aqueous suspensions
3. Apply techniques of bulk product isolation.
4. Design purification strategy based on product characteristics.
5. Evaluate finishing operations.
6. Analyze scale up operations.

List of Experiments:

1. Batch Sedimentation
2. Centrifugation
3. Filtration
4. Flocculation
5. Cell disruption techniques- sonication, homogenizer, solvent
6. Precipitation technique- Isoelectric precipitation, ammonium sulfate, PEG, Acetone
7. Liquid -liquid Extraction
8. Leaching

9. Batch 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, 2011.
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

19BT2022	IMMUNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart basic knowledge in Immunology encompassing, history, development, trend and its impact on society.
2. To familiarize with the organs and cells of the immune system, the immune response and molecular interactions involved in immune response.
3. To create awareness on the applications of immunology such as, immunodiagnosis and immunotherapy.

Course Outcomes:

1. Recall the history and development and controversies of the field of immunology.
2. Recognize the types of immunity, the basic plan of the immune of the immune system and the organs of the immune system.
3. Identify the cells of the immune system and their functions.
4. Understand the functioning of the innate and adaptive immune system
5. Interpret the cellular & molecular interactions, physiology and the pathology of the immune system.
6. Infer the applications of immunology in diagnosis and treatment of diseases.

Module 1: Immune System (7 hrs)

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

Module 2: Cells of the Immune System (9 Hours)

Granulocytes and Agranulocytes, T and B Lymphocytes, NK cells, macrophage and dendritic cells their structure, characteristics, function and their identification. Haematopoiesis, extravasation, phagocytosis.

Module 3: Humoral System (7 hrs)

Molecular nature and function of; Antigens, epitopes, haptens; Adjuvants. Antibody – structure, Classes, Genes and Antibody diversity. Antigen Antibody reactions; Neutralization, Opsonization. Complement system.

Module 4: Adaptive Immunity - Recognition, Responses & Regulation (7 hrs)

Major histocompatibility complex; antigen processing and presentation, T-Cell activation and the cellular immune response. Cytokines Injury and inflammation;

Module 5: Immune Function and Dysfunction (8 hrs)

Immunity to infections: immunity to virus, prokaryotic (Bacteria), & eukaryotic pathogens (parasites & fungi); Transplantation, graft rejection Immunosuppression Cancer immunology –Immune Dysfunction: Autoimmunity, Allergy, hypersensitivity & Immunodeficiency.

Module 6: Application and impact of Immunology (7 hrs)

Diagnostics: Haemagglutination, ELISA, Western Blotting, Immunofluorescence Assay, Immunohistochemistry. Therapeutics and prophylactics; Abzymes, Monoclonal Antibody production, Chimeric & humanized antibodies. Vaccines, anti-vaccination movement and its impact.

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

19BT2023	CELL BIOLOGY AND IMMUNOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

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

Course Outcomes:

1. Student learns the effect of colligative properties on cell structure
2. Compare between live and dead cells
3. Identify the various stages of cell division
4. Perform various immunological techniques to enumerate antigen and/or antibody.
5. Student is aware of the application of immunology in diagnosis of disease.
6. Identify blood groups using immunological technique.

List of Experiments:

1. Staining for Various Stages of Mitosis in Allium cepa (Onion)
2. Microscopically Identification of Cells in Permanent Fixed Slides
3. Widal Test for detecting Typhoid
4. Blood Grouping and Rh typing
5. Differentiation of Blood Cells Using Giemsa Staining
6. Osmosis and Tonicity Studies Using Red Blood Corpuscles
7. Preparation of Plasma and Serum
8. Antigen preparation.
9. Single Radial Immunodiffusion
10. Double Immunodiffusion – Ouchterlony Method
11. Immunoelectrophoresis
12. Counter Current Immunoelectrophoresis
13. Routes of immunization.

19BT2024	CHEMICAL REACTION ENGINEERING	L	T	P	C
		3	1	0	4

Course Objectives:

1. To provide knowledge on estimation of kinetic parameter
2. To establish core foundation for the analysis and design of chemical reactors
3. To impart the knowledge of reaction rate

Course Outcomes:

1. Understand the kinetics of reactions
2. Remember the design equations and the performance of ideal reactors
3. Create various models for describing non- ideal behaviour of reactors
4. Analyse performance of combined reactors
5. Explain adsorption and desorption phenomena in heterogeneous systems.
6. Design of various fermenter / bioreactors

Module 1: Homogeneous Reactions (10 hrs)

Principles of Homogeneous reactions – and rate equations-estimation of rate constants using constant volume and constant pressure Batch reactor-data for typical reactions – Arrhenius equation-Non elementary reaction kinetics, reactions steps; resistances to rate equations.

Module 2: Types of flow and Reactions (9 hrs)

Ideal Flow and Non Ideal flow, RTD in non-ideal flow; non-ideal flow models; reactor performance with non-ideal flow, Gas-Solid and Gas-Liquid reactions, Resistances and rate equations; heterogeneous catalysis; reactions steps; resistances and rate equations.

Module 3: Performance of Bioreactors (7 hrs)

Broad outline of chemical reactors, Performance equations for single batch reactor, ideal CSTR, ideal PFR-Application to design, Industrial scale reactors.

Module 4: Multiple Reactor Systems (7 hrs)

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

Module 5: Non Ideal Reactors (7 hrs)

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 6: Catalytic Reactions (5 hrs)

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.

19BT2025	MASS TRANSFER AND CHEMICAL REACTION ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

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 Outcomes:

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

19BT2026	BIOCHEMICAL THERMODYNAMICS	L	T	P	C
		3	1	0	4

Course Objectives:

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 Outcomes:

1. Recognize relevant thermodynamic properties of ideal and real fluids
2. Explain concept of entropy, enthalpy, partial molar property, fugacity, activity of thermodynamic system
3. Solve mathematical problem involving volumetric, thermodynamic properties of real fluids
4. Infer dependency of biochemical reaction equilibrium on pressure and temperature
5. Design solution of VLE problem with real fluid for improved recovery in bioprocess system
6. Create problems dealing with multi-phase biochemical systems.

Module 1: Basic concepts and volumetric properties of fluid (10 hrs)

System, Surrounding & Processes, Closed and Open systems, State Properties, Intensive & Extensive Properties, Phase rule, State and Path functions, work, heat, internal energy, specific heat, Energy Balance. PVT behavior of pure fluids, equations of state and ideal gas law, PVT dependency. Equations of state for real gases: virial equation, Universal gas constant, virial coefficients, Application of the virial equations van-der Waals equation. Implied property relations for an ideal gas.

Module 2: Thermodynamic Property of Fluids (8 hrs)

Fundamental property relations for a homogeneous fluid, Maxwell's equations, Enthalpy and Entropy as Functions of T and P, Gibbs Energy as a Generating Function, Residual properties, two-phase systems: Clapeyron equation.

Module 3: Solution Thermodynamics (10 hrs)

Chemical potential and phase equilibria, partial molar property, Gibbs-Duhem equation, partial properties in binary solutions, ideal-gas mixtures, fugacity: fugacity, fugacity coefficient, fugacity of pure gases, solids and liquids. Fugacity and fugacity coefficient: species in solution, The Lewis-Randall Rule ideal solution.

Module 4: Phase equilibrium in solution (8 hrs)

Criteria of phase equilibria, Duhem's theorem, Vapor-Liquid Equilibria, P*xy*, T*xy* diagrams. VLE using quantitative expression of Raoult's law, Non-Ideal solutions– activity co–efficient equation, Antoine calculation of Saturation pressure. Use of Margules equations, and the van Laar equations

Module 5: Chemical Equilibrium Reactions (4 hrs)

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.

Module 6: Biochemical Thermodynamics (5 hrs)

Stoichiometry and energetic analysis of Cell Growth and Product Formation, elemental Balances, Degree of reduction concepts; available electron balances; yieldcoefficients; Thermodynamics of microbial growth.; Oxygen consumption and heat evolution, in aerobic cultures; thermodynamic efficiency of growth, Energy balance equation for free, cell culture, Reaction thermodynamics. pH dependence of a Biochemical Reaction.

Total Hours: 45+15(T)

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.

19BT2027	BASICS OF BIOINFORMATICS	L	T	P	C
		2	0	0	2

Course Objectives:

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 Outcomes:

1. Gain knowledge on Biological databases and tools.
2. Understand the significance of biological databases and their utilization.
3. Apply the knowledge of Bioinformatics skill to solve the biological problems in Genomics and Proteomics
4. Analyze different types of Biological databases and resources.
5. Evaluate the vital role drugs interacting to the target.
6. Create databases and tools of Drug like molecules.

Module 1: Introduction to Bioinformatics (6 hrs)

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 2: Biological Databases (6 hrs)

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 3: Sequencing Alignment and Dynamic Programming (6 hrs)

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 4: Computational Genomics and Proteomics (6 hrs)

Comparative genomics and Proteomics; Understanding DNA microarrays and protein arrays, Gene and protein prediction strategies, phylogenetic analysis

Module 5: Molecular Modeling and Drug Discovery (3 hrs)

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

Module 6: Drug Discovery (3 hrs)

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

Total Hours: 30

Text Books:

1. Dan Gusfield, "Algorithms on Strings Trees and Sequences", Cambridge University Press, Cambridge, 2017.
2. David Mount W., "Bioinformatics sequence and genome analysis", CBS Publishers, New Delhi, 2nd Edition, 2013.

References Books:

1. D.W. Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbour Laboratory Press, New York, 2012.
2. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, Wiley and Sons, 2012
3. S.C. Rastogi and N. Mendiratla and P.Rastogi. Bioinformatics methods and applications-Genomics, Proteomics and Drug Discovery. Prentice Hall India, 2013
4. A.M. Lesk. Introduction to Bioinformatics. Oxford University Press India, 2017.

19BT2028	BIOINFORMATICS LAB	L	T	P	C
		0	0	1	1

Co-requisite:19BT2027-Basics of Bioinformatics

Course Objectives:

1. To provide the necessary protocols about biological resources.
2. To teach the tools used for biological sequential data analysis and phylogenetic.
3. To understand the methods of analyzing and gene and promoter prediction.

Course Outcomes:

1. Know the basic essential tools in bioinformatics and implementation.
2. Understand practically to carry out the protocols about Bioinformatics resources.
3. Apply hands-on experience on pair-wise, multiple sequence alignment along with molecular phylogenetic.
4. Analyze gene and promoter prediction.
5. Evaluate the biological databases resources and tools
6. Create biological databases and tools

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 Families –SCOP, Pfam and CATH

8. Secondary Structure prediction
9. Tertiary Structure Prediction
10. Analysing the geometry of protein and visuavalize the protein using protein databank and swiss-pdb viewer.
11. Homology Modeling Using Modeller Protein
12. Molecular Interaction

19BT2029	INDUSTRIAL SAFETY AND HAZARD ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To inculcate the knowledge among students about safety procedures
2. To understand the risk analysis and assessment
3. To learn and understand hazard identification

Course Outcomes:

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

Module 1: Need for Safety (9 hrs)

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

Module 2: Safety Procedures (9 hrs)

Implementation of safety procedures – periodic inspection and replacement; Accidents – identification and prevention; promotion of industrial safety

Module 3: Planning and risk assessment (4 hrs)

Overall risk analysis-emergency planning-on site & off site emergency planning, risk management ISO 14000, EMS models case studies.

Module 4: Quantitative risk assessment (5 hrs)

Quantitative risk assessment - rapid and comprehensive risk analysis; Risk due to Radiation, explosion due to over pressure, jet fire-fire ball.

Module 5: Safety Audits (9 hrs)

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 6: Case Studies (9 hrs)

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, 3rd edn. 2011.
2. Fawatt, H.H. and Wood, W.S., "Safety and Accident Prevention in Chemical Operation", Wiley Interscience, 1965.

Reference Books:

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.

19BT2030	ENVIRONMENTAL POLLUTION CONTROL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Understand basics of pollution and its types
2. Remember Pollution control acts and regulations.
3. Apply bio safety principles in pollution control.
4. Evaluate audit reports on pollution control.
5. Evaluate various approaches for biomedical waste treatment and disposal
6. Analyse various recycling methods

Module I: POLLUTION CONTROL ACTS (9 Hours)

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 Hours)

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 Hours)

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

Module IV: BIOSAFETY (9 Hours)

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 Hours)

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 Hours)

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.

19BT2031	PROCESS EQUIPMENT DESIGN AND ECONOMICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To design safe and dependable processing facilities.

2. To focus on plant layout and design of piping systems
3. To provide the basic knowledge to carryout design process cost effectively.

Course Outcomes:

1. Understand principles of process equipment design and safety considerations
2. Understand design of storage vessel and pressure vessel asper ASME and ISI codes
3. Apply the Scale up criteria of bioreactors
4. Analyze the plant layout.
5. Design various unit operation equipment
6. Evaluate process economics

Module 1: Introduction to Process Design & Flow Sheet Development (9 hrs)

Introduction. General design information for chemical biochemical processes plants. Development of flow sheet. Design of the equipments as per ASME, ISI codes, drawing according to scale,

Module 2: Heat Exchangers, Evaporators (9 hrs)

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

Module 3: Design of Separation Processes (9 hrs)

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

Module 4: Piping, Plant Lay Out and Design (9 hrs)

Various types of Piping, material of construction, their usage; Pipe lay out; Modern Plant Design and case Studies.

Module 5: Economics (4 hrs)

Introduction to cost diagrams, application of cost diagrams, Introduction to Project Economics, Process Selection and Site Survey, Project Cost estimation, Time Value of Money, Interest and Depreciation, Project Finance & Profitability Analysis

Module 6: Applications (5 hrs)

The use of equipments designed for biotechnology industry for different purposes: Reactors, Airlift, Fluidized Bed, Packed bed reactor, costing of reactors

Total Hours: 45

Text Book:

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

Reference Books:

1. Peters, Max S.,K.D. Timmerhaus and R.E. West,Plant Design and Economics for Chemical Engineers (5th Ed), McGraw-Hill International Editions (Chemical Engineering Series), New York, USA (2003)
2. Mahajani,V.V., Chemical Project Economics, Macmillan Indian Ltd., New Delhi, India (2005)
3. Smith, R., Chemical Process: Design and Integration, John Wiley and Sons, West Sussex, UK (2005)
4. McCabe, W.L., J.C. Smith and P. Harriott "Unit Operations of Chemical Engineering", 6th edition, McGraw-Hill, 2001.
5. Wnell, L.E, & Young, E.H.: Process Equipment Design, Wiley Eastern, New Delhi, 2000.
6. Ludwig, E.E.: Applied Process Design for Chemical & Petrochemical Plants, Vols. I, II & III, (2nd Ed.), Gulf Publishing Company, Texas, 1977, 1979, 1983.
7. Perry, R.H. & Green, D.W.: Perry's Chemical Engineers' Handbook, (7th Ed.),McGraw Hill (ISE), 2000.

19BT2032	PROCESS DYNAMICS AND CONTROL	L	T	P	C
		3	0	0	3

Course Objectives:

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 knowledge on control systems

Course Outcomes:

1. Understand the basic concept of control systems
2. Apply the knowledge of linear loop systems
3. Interpret the principle of control systems
4. Analyse Frequency response and correlate with advanced control systems
5. Evaluate Digital controllers
6. Combine different control modes for process equipment.

Module 1: Instrumentation (9 hrs)

Principles of measurement and classification of process instruments, measurement of temperature, pressure, fluid flow, liquid weight and weight flow rate, viscosity, pH , concentration , electrical and thermal conductivity, humidity of gas

Module 2: Open Loop Systems (8 hrs)

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; transportation lag.

Module 3: Closed Loop Systems (8 hrs)

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; principles of pneumatic and electronic controllers, transient response of closed-loop control systems and their stability

Module 4: Frequency Response (8 hrs)

Introduction to frequency response of closed-loop systems, control system design by frequency response techniques, Bode diagram, stability criterion, tuning of controller settings

Module 5: Advanced Control Systems (8 hrs)

Introduction to advanced control systems, cascade control, feed forward control, model predictive control, Smith predictor controller,

Module 6: Application of Computer Control (4 hrs)

Computer control of chemical processes, Control of distillation Column and heat exchanger, PID Control system in bioreactor

Total Hours: 45

Text Books:

1. Coughnowr, D. R., Process Systems Analysis and Control, Mc Graw Hill, New York, 2nd Edition,2001.
2. George Stephanopolous, Chemical Process Control, Prentice-Hall of India Pvt-Ltd., New Delhi, 2002.
3. D.E. Seborg, T.E. Edgar, D.A. Mellichamp. Process Dynamics and Control, Wiley India Pvt. Ltd., Fourth Edition, 2016.

Reference Books:

1. Doeblin Ernest, Measurement Systems, Mc Graw Hill, New York , 2005
2. A.Suryanarayanan, "Chemical instrumentation and process control", Khanna Publishers, 2nd edition, New Delhi , 1995
3. Process Control – Modeling, Design & Simulation, B. Wayne Bequette
4. Process Dynamics, Modelling and Control, Prentice Hall.B. Ogunnaike and W.H. Ray (1994). Oxford University Press
5. Marlin, T. E., "Process Control ", IInd Edn, McGraw Hill, New York, 2000.
6. Smith, C. A. and Corripio, A. B., "Principles and Practice of Automatic Process Control",IInd Edn., John Wiley, New York, 1997.

19BT2033	MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To ensure 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 outcomes:

1. Understand various size reduction Techniques
2. Explain conveyors &storage vessels for particular applications
3. Illustrate the principle, construction and operation of various classification equipments
4. Apply the principles of agitation and mixing
5. Evaluate the parameters of filtration
6. Summarize different separation process

Module 1: Size Reduction and Solid Particles (13 hrs)

Introduction to unit operations and their role in bio chemical Engineering industries- Characteristics of particulate solids- Sampling techniques- Specifications- Screen analysis- Particlesizedistribution,particlesizemeasurement-Surfaceareameasurements- 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 2: Transportation and Conveying (9 hrs)

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 3: Classification of Solid Particles (9 hrs)

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 4: Mixing Blending (5 hrs)

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

Module 5: Filtration (4 hrs)

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

Module 6: Filtration Devices (5 hrs)

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

Total Hours: 45

Text Books:

1. Mccabe,W.L.,Smith,J.C., andHarriott,P.,Unit Operations of Chemical Engineering, McGraw Hill,NewYork,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. CoulsonJ.M.,RichardsonJ.F.,BackhurstJ.R.andHarkerJ.M.,CoulsonandRichardson'sChemical Engineering, Volume I, ButterworthHeinemann,Oxford,5th Edition, 2002
2. CoulsonJ.M.,RichardsonJ.F.,BackhurstJ.R.andHarkerJ.M.,CoulsonandRichardson's Chemical Engineering, Volume II, Butterworth Heinemann,Oxford,5th Edition, 2002

19BT2034	MECHANICAL OPERATIONS LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To ensure fundamental knowledge about various unit operations
2. To characterize particles and perform sizer education and size analysis of particles.
3. To understand the industrial application and significance of these equipment in biotechnology

Course Outcomes:

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. Drying characteristics using through flow dryer.
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. Drying characteristics using cross flow dryer
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,NewYork,6thEdition, 2004.
2. Geankoplis, C. J, Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4thEdition, 2003.

Reference Books:

1. CoulsonJ.M.,RichardsonJ.F.,BackhurstJ.R.andHarkerJ.M.,CoulsonandRichardson'sChemical Engineering, Volume I, ButterworthHeinemann,Oxford,5thEdition, 2002
2. CoulsonJ.M.,RichardsonJ.F.,BackhurstJ.R.andHarkerJ.M.,Coulsonand Richardson's Chemical Engineering, Volume II, Butterworth Heinemann,Oxford,5thEdition, 2002

19BT2035	BIOCHEMICAL ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. 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 Outcomes:

1. Recognise chemical and biochemical processes
2. Understand growth kinetics and enzyme kinetics in biochemical processes.
3. Apply various growth and enzyme inhibition models in biochemical reactions.
4. Analyze the role of aeration and agitation in fermentation process.
5. Evaluation of sterilization Process
6. Compile instrumentation for monitoring and control of bioreactors.

Module 1: Chemical and Biochemical Processes (6 hrs)

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

Module 2: Enzyme Kinetics (9 hrs)

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 3: Unstructured kinetic models for growth (12 hrs)

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 4: Oxygen Transfer in Microbial Bioreactors (9 hrs)

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 5: Bioreactors for free and immobilized cells (5 Hours)

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

Module 6: Bioreactor Equipment (4 hrs)

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

Total Hours: 45

Text book:

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.

19BT2036	BIOCHEMICAL ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. 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 Outcomes:

1. Understand chemical and biochemical processes
2. Estimate growth kinetics models
3. Illustrate various enzyme kinetics
4. Design batch and continuous Process
5. Analyze batch reactors
6. Apply enzymes in bioprocesses

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. Study of thermal death kinetics
12. Plackett Burmann method

19BT2037	CANCER BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To educate 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 Outcomes:

1. Remember the epidemiology of cancer and principles of carcinogenesis
2. Outline the 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. Relate the cell biology with the regulatory imbalance in carcinogenesis, detection and therapy
5. Recognize the molecular mechanism of cancer spread, its markers and therapy.
6. Evaluate the current strategies of cancer diagnosis, prevention and treatment to develop new drugs.

Module 1: Fundamentals of Cancer Biology (9 hrs)

Cancer: Definition, causes, properties, and classification-incidence; Cell Cycle: Regulation of cell cycle, cell proliferation, differentiation and apoptosis – Role of signal transduction pathways and signal switches, Apoptosis pathways, Modulation of cell cycle in cancer, Cancer metabolism.

Module 2: Principles of Carcinogenesis (6 hrs)

Theory of carcinogenesis- Chemical carcinogenesis, Physical carcinogenesis; X-ray radiation, Biological -mechanisms; Stages of cancer: initiation, promotion, progression. Epigenetics of cancer.

Module 3: Molecular Cell Biology of Cancer (9 hrs)

Signal targets and cancer – Growth factors related to Transformation – Activation of kinases – Oncogenes: c-Myc, Ras, Bcl-2 family – Mechanism of oncogene activation – Retroviruses and oncogenes – Tumor suppressor genes: Rb, p53, APC, BRCA paradigms – Telomerases.

Module 4: Principles of Cancer invasion and Metastasis (6 hrs)

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

Module 5: Cancer Detection Techniques (4 hrs)

Cancer screening – sampling methods, clinical interpretation on stages/grades and early detection, Tumor markers; Imaging techniques, Advances in cancer detection- oncogenes/proto oncogene activity, Tumour suppressors and other molecular markers.

Module 6: Cancer Therapy (5 hrs)

Different forms of therapy: Chemotherapy, Radiation therapy, Immunotherapy, Molecular therapy, Use of signal targets towards therapy of cancer, Gene therapy, Cancer prevention and palliative care 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. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
2. Robert G, Mckinnell, Ralph E. Parchment, Alan.O. Perantoni, G. Barry Pierce, "The Biological Basis of Cancer", Cambridge University Press, New York. 2003.

19BT2038	CLINICAL DATABASE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Outline on clinical trials ,data management and preparation
2. Describe the analytics and decision support using various tools.
3. Utilize enterprise-wide information assets in support of organizational strategies and objectives.
4. Inspect the concepts of database architecture and design.
5. Interpret the roles and responsibilities of healthcare workspace commodities.
6. Elaborate the reliability and accuracy of secondary data sources.

Module 1: Introduction of Clinical trials (9 hrs)

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 2: Clinical Data Management (9 hrs)

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 3: Clinical Data Analysis and Management (9 hrs)

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 4: Clinical case report forms (9 hrs)

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 5: Clinical Quality Audit (4 hrs)

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

Module 6: Clinical Logistics and Regulations (5 hrs)

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

Total Hours: 45

Text Books:

1. Susanne Prokscha, Practical Guide to Clinical Data Management, Third Edition, CRC Press; 3 edition, 2011.
2. Richard K Rondel (2000) Clinical Data Management, Second Edition. Wiley Publishing House, 2000.

Reference Books:

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.

19BT2039	CLINICAL DATABASE MANAGEMENT LAB	L	T	P	C
		0	0	1.5	1.5

Co-requisite:19BT2038- Clinical Database Management

Course Objectives:

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 Outcomes:

1. Rephrase medical terminology, clinical data management to develop databases for health care.
2. Demonstrate clinical data submission and interpret the clinical results.
3. Explain skills to analyze clinical data.
4. Organize the health care skills to validate data.
5. Examine the Case Report Forms to store clinical data.
6. 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

19BT2040	PLANT AND ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

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. Demonstrate *In vitro* fertilization and the manipulation of embryo done for genetic screening will provide wider understating among the students and create awareness
5. Development of transgenic animals for breed development for enhanced milk production
6. Adapt appropriate ethical guidelines in animal biotechnology

Module 1: Plant Cell and Tissue Culture (4 hrs)

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

Module 2: Micro propagation and other techniques (5 hrs)

Micro propagation, 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 3: Plant Genetic Transformation (9 hrs)

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 4: Application of Plant Genetic Transformation (9 hrs)

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

Module 5: Introduction to Cell Culture (9 hrs)

Chemically defined and serum free media. Primary cell culture, Establishment of cell line, Maintenance and Preservation of cell line. Scale up of Cell cultures for Product development.

Module 6: Transgenic Animals (9 hrs)

In Vitro fertilization, Embryo transfer- Micromanipulation technology, germ cell manipulation, sperm and embryo sexing, 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, 2001.
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

19BT2041	STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To take students on a journey into the stem cell biology and biotech revolution.
2. To provide details regarding social implications associated with stem cell technology.
3. To offer 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 Outcomes:

1. Understand the fundamentals of cell culture
2. Distinguish the types of stem cells, their location and their properties
3. Outline the process of Isolation of stem cells from various sources their amplification and storage.
4. Acquire knowledge on the use of stem cells for the treatment of various diseases.
5. Apply the knowledge of genetic engineering and tissue engineering in the generation of artificial organs.
6. Discuss the ethical concerns regarding stem cells and their use in research and in therapy

Module 1: Introduction (4 hrs)

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

Module 2: Techniques (5 Hours)

Aseptic Technique and Cell culture Lab equipments & etiquette.

Module 3: Types of Stems Cells (9 hrs)

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

Module 4: Isolation of Stem Cells (9 hrs)

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

Module 5: Applications of Stem Cell Technology (9 hrs)

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 6: Ethical Concerns of Stem Cell Technology (9 hrs)

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, 2005.
2. Kursad and Turksen, “Embryonic Stem cells”, Humana Press, 2002.

19BT2042	BIOPHARMACEUTICAL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To demonstrate the fundamentals of biopharmaceutical technology to undergraduate students.
2. To motivate the students in understanding and analyzing the metabolism and mode of action of drugs.
3. To elaborate the process of formulations of drugs and to apply them in clinical trials as per the regulations.

Course Outcomes:

1. Recall the steps in preparation of biopharmaceutical products.
2. Illustrate knowledge on drug development, principles and mechanism of actions of drug.
3. Compare various pharmaceutical products available commercially.
4. Infer various testing and quality assurance procedures in drug formulation.
5. Evaluate the advances in drug manufacturing process.
6. Relate the regulations in clinical trial and management.

Module 1: Drugs (9 hrs)

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

Module 2: Manufacturing Principles (9 hrs)

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 3: Formulations (9 hrs)

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 4: Pharmaceutical Products – Vitamins and Antiseptics (4 hrs)

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

Module 5: Antibiotics and rDNA Products (5 hrs)

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

Module 6: Trials & Regulations (9 hrs)

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, 2017.
2. Ansel, H., Allen, L., Popovich, N, “Pharmaceutical Dosage Forms and Drug Delivery Systems”, Williams & Wilkins, 9thEdition, 2010.

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.

19BT2043	AGRICULTURAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

1. Acquire knowledge on genome organization of plants

2. Outline the principles of plant breeding and its techniques
3. Demonstrate various tools involved in genetic engineering
4. Illustrate the different strategies for biodiversity conservation
5. Acquire knowledge on IPR and its importance in patent rights
6. Demonstrate different tools of plant genome analysis

Module 1: Genomes and Genes (9 hrs)

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

Module 2: Agriculture and Plant Breeding (9 hrs)

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

Module 3: Tools and Techniques of Genetic Engineering (9 hrs)

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 4: Biodiversity (6 hrs)

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 5: Intellectual Property Rights (3 hrs)

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

Module 6: Genome Analysis (9 hrs)

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 Blackwell science, 2001.
2. Induction of Bioinformatics – T.K. Attwood & D.J. Parry-Smith, Pealson Education Singapore Pvt. Ltd Indian, Indian Branch, Delhi, 2002.

Reference Books:

1. Gene Cloning and DNA analysis, an introduction, Fourth edition TA Brown Blackwell science, 2001.
2. From Genes to clones, Introduction to gene Technology. Panima Publishing Corporation, 2003.
3. Lewin's Genes XII Hardcover by Jocelyn E. Krebs, Elliott S. Goldstein, Stephen T. Kilpatrick, 2017

19BT2044	METABOLIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Comprehend modern biology with engineering principles
2. Recall the basic principles and regulation of metabolic pathways
3. Adapt suitable metabolic control analysis to identify important steps in pathway control
4. Demonstrate different methods to obtain improved production strains
5. Categorize the synthesis of primary and secondary metabolites and bioconversion process

6. Apply the concept of metabolic engineering in chemical, medical, and environmental fields

Module 1: Cell Metabolic Engineering (4 hrs)

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

Module 2: Regulation of Primary Metabolic Pathways (9 hrs)

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 3: Regulation of Secondary Metabolic Pathways (9 hrs)

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

Module 4: Improved Production of Secondary Metabolites (9 hrs)

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

Module 5: Basics in Metabolic Flux Analysis (9 hrs)

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

Module 6: Applications of Metabolic Engineering (5 hrs)

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,

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., 3rd edition, 2016
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, Seventh edition, 2017.

19BT2045	RESEARCH METHODOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To intend 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 Outcomes:

1. Understand the basic principles of research and its formulation
2. Illustrate the different methods of research designs and its specific applications
3. Classify the various techniques of data collection and statistical analysis
4. Elaborate the steps involved in preparation of different technical report and articles
5. Comprehend the bioethical and biosafety procedures in research
6. Gain knowledge on formulation, execution and evaluation of application oriented research

Module 1: Research Problems (5 hrs)

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

Module 2: Research Design and Experimental Design (4 hrs)

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

Module 3: Sample Design, Measurement and Scaling Techniques (9 hrs)

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 4: Collection, Processing and Analysis of Data (9 Hours)

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 5: Manuscript/Thesis Writing (9 hrs)

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 6: Ethics and Biosafety (9 hrs)

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.

19BT2046	MOLECULAR FORENSICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide 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. To develop observational, organizational and cognitive skills so to be able to integrate their experiences and knowledge so to solve problems.

Course Outcomes:

1. Exhibit the current state of forensic biological testing and infer forensic investigation
2. Find evidence with proper methods of investigation through biological samples
3. Categorize the investigation and identify the criminals based on molecular based techniques for paternal disputes
4. Appraise the knowledge in paleo biology and anthropology and its importance in Forensics
5. Find evidence and identify the suspects through case studies
6. Discover the role of PCR in Forensics,

Module 1: Introduction to Forensic Science (9 hrs)

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 2: Discovery and recovery of human remains (9 hrs)

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 3: Pattern Analysis (9 hrs)

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

Module 4: Finger Printing (5 hrs)

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

Module 5: Rapd in Forensics (4 hrs)

RAPD in Forensics, Study of Kinnship by DNA Profiling.

Module 6: Forensic Case Studies (9 hrs)

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.

Total Hours: 45

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.

19BT2047	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 Outcomes:

1. Illustrate various interactions in protein architecture.
2. Describe the structure and classification of proteins
3. Outline the characteristics of individual amino acids and their effect on the solubility, structure and function of proteins
4. Inspect the factors significant for protein folding processes and stability
5. Analyse the purity and stability and modification of proteins.
6. Formulate measurements of isolated proteins and characterize their purity and stability.

Module 1: Bonds, Energies, Building Blocks of Proteins (9 hrs)

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 2: Protein Architecture (9 hrs)

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 3: Tertiary Structure (9 hrs)

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 4: Structure-Function Relationships (4 hrs)

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 5: Immunoglobulins and Enzymes (5 Hours)

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 6: Protein Engineering and Protein Design (9 Hours)

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, second Edition, Oxford University Press USA, 2004

19BT2048	PLANT TISSUE CULTURE	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

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 1: Cell and Tissue Culture (9 hrs)

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 2: Plant Genetic Engineering Tools (9 hrs)

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 3: Application of Plant Biotechnology (9 hrs)

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 4: Molecular Aspects of Disease Susceptibility and Resistance (9 hrs)

Transposable elements, factors influencing disease resistance and susceptibility RFLP

Module 5: **Transgenics – Abiotic Factors (4 hrs)**

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

Module 6: **Transgenics – Biotic Factors (5 hrs)**

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, 2006.
2. Marx J.L., Revolution in Biotechnology, Cambridge University Press, 2002.

Reference Books:

1. Dodds J.H., Plant Genetic Engineering, Cambridge University Press, 2005.
2. R.C. Dubay and Maheswari. Introduction to Microbiology, S.Chand, 2002.

19BT2049	ANIMAL BIOTECHNOLOGY AND CELL CULTURE	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Demonstrate practically about 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 and ethical issues in animal biotechnology

Module 1: Introduction to Cell Culture (9 hrs)

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 2: Scaling up of Cell Cultures (9 hrs)

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

Module 3: Tissue Engineering (9 hrs)

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

Module 4: Micromanipulation of Embryos (9 hrs)

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 5: Transgenic Animals (5 hrs)

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

Module 6: Stem Cell Technology and Ethics (4 hrs)

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

Total Hours: 45

Text Books:

1. Ian Freshney R. 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.

19BT2050	PLANT AND ANIMAL TISSUE CULTURE LAB	L	T	P	C
		0	0	1.5	1.5

Course Objectives:

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 Outcomes:

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. Adapt *in vitro* techniques in animal and plant cell cultures for product development

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.

19BT2051	ROLE OF BIOTECHNOLOGY IN ENVIRONMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To learn the importance of biotechnology

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

Course Outcomes:

1. Acquire knowledge on the scope of biotechnology
2. Classify 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. Adapt the conservation of biodiversity

Module 1: Scope of Environmental Biotechnology (9 hrs)

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 2: Industrial Waste Water Management (9 hrs)

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

Module 3: Biomass, Energy and Solid Waste Management (9 hrs)

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 4: Biodiversity Types (5 hrs)

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 5: Biodiversity Conservation (4 hrs)

Biodiversity and its Conservation- In situ and Ex situ

Module 6: Bioremediation and Biodegradation (9 hrs)

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

Total Hours: 45

Text Books:

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, 2003.
2. Gupta P.K. "Elements of Biotechnology", Rastogi Publications, 2004.

19BT2052	INDUSTRIAL POLLUTION CONTROL	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Understand basics of pollution, its types
2. Remember Pollution control acts and regulations.
3. Illustrate preparation of EIA report
4. Evaluate audit reports on pollution control.
5. Design waste water treatment methods
6. Analyze the methods of clean and cleanup technologies

Module 1: Prevention and Control of Pollution Acts (9 hrs)

The water (prevention and control of pollution) act 1974 and rules 1975- definitions, constitution, function and fund of central & state boards. The air (prevention and control of pollution) act 1981 and rules 1982, definitions, constitution, function and fund of central & state boards,The environment (protection) act 1986,rules 1986-definitions, constitution, function and fund of central & state boards.Environmental impact assessment notification, 2006-environmental clearance,The plastics manufacture, sale and usage rules, 1999-definitions,restriction on manufacture, sale.

Module 2: Environment Protection (9 hrs)

Environmental impact assessment (EIA), definitions and concepts, rationale, environmental impact statement, environmental appraisal, environmental impact factors and areas of consideration, measurement of environmental impact, organization, scope and methodologies of EIA, status of EIA in India, Environmental audit, definitions and concepts, partial audit, compliance audit, methodologies and regulations; introduction to ISO and ISO 14000

Module 3: Life Cycle Assessment (9 hrs)

Risk and Life Cycle Framework for Sustainability (Introduction, Risk, Life Cycle Frameworks, Life Cycle Assessment Tools), Life Cycle Analysis (Goal Definition, Life Cycle Inventory, Life Cycle Impact Assessment, Life Cycle Interpretation, LCA Software tools), Case studies

Module 4: Industrial Waste Water Engineering (7 hrs)

Standards for treated waters, Physical treatment, pre-treatment, solids removal by setting and sedimentation, filtration centrifugation, coagulation and flocculation, Design of Activated Sludge system using biological process dynamics. Process concepts and design aspects of Trickling Filters, Rotating Biological Contactors (RBC), Fluidized bed reactor/treatment,sludge treatment and disposal

Module 5: Cleaner Technologies (6 hrs)

Clean technology, cleanup technology, industrial symbiosis, material reuse and waste reduction

Module 6: Waste Management (5 hrs)

Biomedical waste, drug industry waste, waste from dyes, pigment, pharmacy industries.

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, 2005.
2. L. Lee Harrison , “Environmental Health and Safety Auditing Handbook”, 2nd edition, McGraw Hill, Inc., New York, 2002.
3. Kirkwood, R. C. and Longley, A. J., “Clean Technology and Environment”, Chapman & Hall, 2001.
4. Hendricks D, Fundamentals of Water Treatment Unit Processes, CRC Press, 2011

19BT2053	BIOMASS AND BIOENERGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To make aware of various renewable feed stocks available for bioenergy
2. To elaborate on the concept of biofuel production from biomass

Course Outcomes:

1. Understand the fundamental principles of biomass and bioenergy
2. Relate the principles underlying the design and operation of biomass to energy
3. Identify the techniques and limitations of Biomass preprocessing
4. Compare Biomass conversion processes
5. Conclude current research issues in biodiesel production
6. Measure the Environmental impacts of biofuels

Module 1: Energy (9 hrs)
Current energy consumption, Energy sources, overview of biofuel/bioenergy, concepts in understanding biofuel/bioenergy production, Renewable and non-renewable feedstocks and their availability
Module 2: Biomass (9 hrs)
Biomass processing: drying, size reduction, and densification, Various biofuels/bioenergy from biomass. Non-wood, forest residues, agricultural biomass (natural fibers), and energy crops - processing, properties, and its applications - biomass utilization and reuse
Module 3: Bioconversion Process (9 hrs)
Biomass conversion: gasification, anaerobic digestion, pyrolysis, Biochemical conversion to ethanol, enzyme hydrolysis
Module 4: Biodiesel (9 hrs)
Carbon capture and sequestration, Biodiesel production from oil seeds and third generations biomass, Biodiesel production from algae – transesterification process, Environmental impact assessment of biofuel production and utilization.
Module 5: Waste to Energy (5 hrs)
Waste composition and Classification: Organic municipal waste, clinical waste, sewage sludge, agricultural waste, Waste & biomass materials handling.
Module 6: Policies and Legislation (4 hrs)
Pollutants arising from waste/biomass to energy plants, Energy processing from waste/biomass, Bio-energy policies & legislation at national and international level

Total Hours: 45

Text Book:

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

Reference Books:

1. Mdpi AG, Bioenergy and Biochemicals Production from Biomass and Residual Resources, Editors: Dimitar Karakashev and Yifeng Zhang Publisher 2018
2. Steve F Warnmer . Progress in Biomass & Bioenergy Research. ISBN: 9781600213281, 1600213286. Nova Science Publishers Inc 2007.

19BT2054	ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Infer the biotechnological solutions to address environmental issues including pollution, mineral, renewable energy and water recycling
2. Appraise the opportunities for incorporating environmental quality into products, processes and projects.
3. Develop technologies for bioremediation and biodegradation
4. Acquaint oneself with the pertinent legislation and methodology of pollutants
5. Demonstrate the professional responsibility towards protecting the environment
6. Apply scientific solutions for the development of environmental sustainable products

Module 1: Environmental Monitoring (8 hrs)
Major types of environmental pollutants, Sampling, physical,chemical and biological analysis, Removal of toxicants from contaminated sources by bioadsorption techniques.
Module 2: Wastewater Treatment (9 hrs)

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, up flow anaerobic sludge blanket reactor, Biological nutrient removal and Sequential batch reactor. Tertiary treatment- Polishing operations: Sand filtration, adsorption by activated carbon and chlorination.

Module 3: Air Pollution and Control Technology (7 hrs)

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 4: Solid Waste Treatment and Management (8 hrs)

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 5: Hazardous Waste Treatment and Biowaste Management (6 hrs)

Types of hazardous waste, Xenobiotic compounds, recalcitrance, biodegradation of xenobiotics and oil spills, biological detoxification,Genomic tools for bioremediation

Module 6: Development of Bio products and Technologies (7 Hrs)

Bioleaching, Bio pesticide, Bio fertilizer, Biodegradable plastics, integrated bio-digester for biogas and electricity generation, biosensor for environmental monitoring

Total Hours: 45

Text Books:

1. Jogdand, S.N. Environmental Biotechnology Himalaya Publishing House, New Delhi,2012
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, 2010.

19BT2055	MATLAB PROGRAMMING	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Identify installation, configuration and environmental setup of Matlab.
2. Demonstrate the usage of basic syntax and structure of Matlab
3. Apply knowledge of data types, operators and control structures to pseudocode
4. Analyze script functionality and offer improved performance in structure
5. Appraise structural validity, reproducibility of used Matlab functions
6. Formulate biological applications in areas such as sequence processing, sequence analysis.

Module 1: Fundamentals (7 Hrs)

Matlab Local Environment Setup, Different window interface: script, and command prompt; working directory, Basic structure of matlab scripts, main function, Syntax - Commonly used Operators and Special Characters, Variables, Naming Variables, Multiple Assignments - Long Assignments, Creating Vectors - Creating Matrices.

Module 2: Matlab Commands (9 hrs)

Commands for Managing a Session - Commands for Working with the System-Input and Output Commands-Vector, Matrix and Array creation, manipulation, data extraction. Cell array, Plotting Commands, M-Files Creating and Running Script File. Data input and output to and from matlab script, environment.

Module 3: Data Types, Operators (6 hrs)

Data Types Available in MATLAB - Data Type Conversion - Determination of Data Types, Operators, Arithmetic, relational, and logical operators, special characters, rounding, Data structure, Table operation, display, Print,

Module 4: Control Structures (7 hrs)

Control structures - Decision Making, Loops and conditional Statements, String comparison, Switch Case. Terminating control structure: Continue, pause, break, return

Module 5: Advanced Matlab (9 hrs)

Strings, Functions - Primary and Sub-Functions, Nested Functions, Private Functions, Global Variables, Data import, Data output, Matlab Plotting, Matlab Graphics.

Module 6: Matlab for Biological Applications (7 hrs)

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. Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg "A Guide to MATLAB" Cambridge University Press, 2014
2. Timmy Siauw, Alexandre M. Bayen "An Introduction to MATLAB Programming and Numerical Methods for Engineers" Academic Press, Elsevier, 2015
3. Amos Gilat "Matlab an introduction with applications" 6th Edition, Wiley, 2016.

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.

19BT2056	FUNDAMENTALS OF BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To ensure students to have strong foundation in structure, composition and functions 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 Outcomes:

1. Remember the structure and properties of Primary metabolites
2. Understand the biological functions of metabolism
3. Acquire knowledge on vitamins
4. Relate biomolecules with the biomedical significance
5. Appraise the clinical and biological significance of these biomolecules
6. Compile the information of different biomolecules and their importance

Module 1: Carbohydrates (9 hrs)

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

Module 2: Fatty Acids (9 hrs)

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 3: Amino Acids (9 hrs)

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 4: Nucleotides (9 hrs)

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 5: Vitamins (5 hrs)

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

Module 6: Minerals (4 Hrs)

Minerals: classification, specific function and deficiency disorders.

Total Hours: 45

Text Books:

1. Lehninger, A.L, NelsonD.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, 2006.
2. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.
3. Jain and Jain "Fundamentals of Biochemistry", Chand publication, 4th edition, 2016.

19BT2057	PATHOLOGY AND MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. To learn the characteristics of disease processes based on etiology and pathogenesis
2. To understand how disease processes affect physiological function
3. To analyze how disease processes can result in specific clinical signs and symptoms

Course Outcomes:

1. Recognize the basic elements concerning cell injury and death, tumors and the mechanisms of response to tissue injury
2. Understand the basic elements of bacteriology, virology and transmission of infectious disease
3. Formulate experiments to identify microorganisms, interpret the data and communicate it
4. Identify the physical and chemical methods to control the growth of microbes
5. Apply the knowledge of pathogenesis for the control of infectious diseases
6. Evaluate immunopathology, oncology, general and organ-specific pathophysiology

Module 1: Cell Injury, Inflammation and Repair (9 hrs)

Cell injury: Causes and Mechanism: Ischemic, Toxic. Reversible cell injury: Types, morphology: Swelling, vacuolation, Irreversible cell injury: Types of Necrosis. Calcification: Dystrophic and Metastatic. Acute inflammation: Inflammatory cells and Mediators, Chronic inflammation: Causes, types,

non-specific and Granulomatous with examples, wound healing by primary and secondary union, healing at specific sites including bone healing

Module 2: Neoplasia and Immunopathology (9 hrs)

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: antibodies and regulation of immune responses. Hypersensitivity, Antibody and cell mediated tissue injury: Auto-immune disorders - systemic lupus erythematosis.

Module 3: Principles of Microbiology (9 hrs)

Normal flora of human body, host-microbe interactions, routes of transmission of microbes in the body, nosocomial infections, post-operative infections, mode of action of anti-bacterial agents, antibacterial susceptibility test

Module 4: Morphology and Sterilization (9 hrs)

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

Module 5: Infectious Diseases (5 hrs)

Mycobacterial Diseases: Tuberculosis, Bacterial diseases: Typhoid, Diphtheria, Gram negative infection, Bacillary dysentery, Syphilis. Viral: Dengue, Zika, Rabies, AIDS; Fungal diseases and opportunistic infections (Candidiosis).

Module 6: Parasitic Diseases (4 hrs)

Parasitic Diseases: Malaria, Filariasis, Kala-azar, Cysticercosis, Hydatid. 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” Orient blackswan, 2015.

19BT2058	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

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 Outcomes:

1. Recall facts and basic concepts of cells, their functions and membrane transportation
2. Recognize and explain the composition of blood and its function on maintaining homeostasis.
3. Demonstrate the function and the components of respiratory and cardiovascular systems.
4. Comprehend the role of neurons and its application
5. Relate the structure and functions of nervous system and parts of brain of Human system
6. Inference the structure of eye, ear and kidney and understand the facts of its functions.

Module 1: Cell (9 hrs)

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 2: Blood Composition (9 hrs)

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 3: Components of Respiratory System (3 hrs)

Oxygen and carbon di oxide transport and acid base regulation

Module 4: Heart and its Regulation (6 hrs)

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 5: Structure of a Neuron (9 hrs)

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 6: Structure of visual Pathways (9 hrs)

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 Book:

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

Reference Books:

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.

19BT2059	ENTREPRENEURSHIP, IPR AND BIOSAFETY	L	T	P	C
		3	0	0	0

Course Objectives:

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 Outcomes:

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 1: Concept of Entrepreneurship (5 hrs)

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 2: Societal Role in Entrepreneurship (4 hrs)

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

Module 3: Product Process and Design (9 hrs)

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 4: Innovation and Prototype (9 hrs)

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 5: Biosafety (9 hrs)

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 6: IPR and copyright (9 hrs)

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.

19BT2060	TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To introduce the basic concepts of tissue organisation in the human body and the theories related to normal physiology and repair
2. To inculcate knowledge on cell culture, cell signalling and molecular growth factors.
3. To develop tissue implants and transplants and understand its regulation in tissue engineering

Course Outcomes:

1. Recall the fundamental concepts about types of cells and culturing procedures
2. Analyze the cellular interaction and molecular aspects of cell differentiation, communication and growth.
3. Design scaffolds, tissue implants and its use in tissue engineering
4. Gain knowledge in 3D culture mechanism and cell interactions
5. Acquire Knowledge in the tissue engineering applications
6. Adapt the regulatory issues and ethical issues in Tissue Engineering

Module 1: Introduction to Tissue Culture (9 hrs)

Introduction, Basic definition, Structural and organization of tissues: Epithelial, connective; vascularity and angiogenesis, cell culture techniques

Module 2: Transplant Materials (9 hrs)

Unit 2: Scaffold and transplant, engineering biomaterials for tissue engineering, Degradable materials (collagen, silk and polylactic acid), porosity, mechanical strength

Module 3: Organs for Transplants (5 hrs)

Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells in tissue engineering

Module 4: 3D Culturing (9 hrs)

3D cell culturing and protocols involved for the 3D cell culture of different types of cells cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering.

Module 5: Applications in Medical Fields (9 Hours)

Product development using Tissue Engineering, Current scope of development and use in therapeutic and in-vitro testing,

Module 6: Regulatory Issues (4 Hours)

Ethical, FDA and regulatory issues of tissue engineering,

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

Reference Books:

1. Robert. P.Lanza, Robert Langer & William L. Chick, Principles of tissue engineering, , Academic press, 2002
2. Joseph D. Bronzino, The Biomedical Engineering –Handbook, CRC press, 2005.
3. B. Palsson, J.A. Hubbell, R.Plonsey& J.D. Bronzino,Tissue Engineering, CRC- Taylor & Francis, 2006.

19BT2061	CELLBIOLOGY AND IMMUNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart basic knowledge in cell biology & 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 importance of cell organelles and immunity

Course Outcomes:

1. Relate the characteristic features of cell organelles and immune systems
2. Classify various cellular organelles and their functions.
3. Analyze the possible mechanism of cell signaling in immune systems
4. Compare the origin, maturation process, and general functions of B and T lymphocytes.
5. Comprehend the cellular/molecular pathways in health and disease.
6. Apply the principles of immunology in disease protection and autoimmune disorders.

Module 1: Features of cell and cell cycle (8 hrs)

History of cytology and cell theory, Prokaryotes and Eukaryotes (plant cell and animal cell), Membranes of the cell: Plasma membrane, Nuclear membranes, Organelle membranes. Outline of organelles: Nucleus, nucleolus, ribosome, mitochondria, chloroplast, vacuole, endoplasmic reticulum, golgi apparatus, lysosome, centriole, cilia and flagella. Regulation of cell cycle and molecules that control cell cycle.

Module 2: Cytoskeleton and Cell Transport (8 hrs)

Microtubules, microfilaments, intermediate filaments and their binding proteins, Cell- cell communications, 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.

Module 3: Signaling Molecules and Signal Transduction (7 hrs)

Signaling molecules: autocrine, paracrine and endocrine and its mode of action in cell signaling. G-protein coupled receptor and protein tyrosine kinases receptor for cell signaling, different models of signal amplifications: role of cyclic AMP, cyclic GMP and G proteins in signal transduction

Module 4: Overview of Immunology (5 hrs)

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 5: Features of Lymphocytes, Antigen-Antibody Complex (9 hrs)

Haematopoisis, T and B Lymphocytes & NK cells. Major histocompatibility complex; antigen processing and presentation, T-Cell activation and the cellular immune response. Antigens- chemical and their molecular nature; Haptens; Adjuvants. Antibody – structure andclasses, Antigen-Antibody reactions: Neutralization, Opsonization, Complement, Cytokines

Module 6: **Immune Responses to Infections (8 hrs)**

Immunity to bacteria, and virus; Transplantation: consequences and genetics of transplantation, Cancer immunology – Tumour Associated Antigens and Tumour Specific Antigens; Autoimmunity; Autoimmune disorders, hypersensitivity, Immunosuppression and AIDS immunity.

Total Hours: 45

Text Books:

1. Alberts, Molecular Biology of the Cell, Garland Sciences, 6th edition, 2012.
2. Roitt I, Male, Brostoff, "Immunology", Mosby Publishers, 5th edition, 2011.

Reference Books:

1. Geoffrey M. Cooper, Robert E. Hausman, The Cell, A Molecular Approach – 6th Edition Sinauer Associates, Inc.. 2015
2. Tizard, "Immunology", Saunders college publication, 6th Edition, 2010.
3. Kuby J, "Immunology", WH Freeman & Co., 2013.

19BT2062	MOLECULAR BIOLOGY FOR BIOMEDICAL ENGINEERS	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

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

Module 1: Chromosome Organization (9 hrs)

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

Module 2: DNA Replication – Prokaryotes (4 hrs)

DNA replication- Semi conservative replication, Meselson stahl experiment, Enzymes in replication, Replication in prokaryotes,

Module 3: DNA Replication – Eukaryotes and Mutations (5 hrs)

Replication in eukaryotes and telomere replication. Mutation: types, DNA repair mechanism

Module 4: Transcription (9 hrs)

RNA polymerase, features of promoters and enhancers, transcription factors, Prokaryotic and eukaryotic transcription, inhibitors, post-transcriptional modification - RNA splicing

Module 5: Translation (9 hrs)

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

Module 6: Regulation of Gene Expression (9 hrs)

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

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, NelsonD. 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.

19BT2063	BIOLOGY IN EVERYDAY LIFE	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Define Life and Life forms.
2. Recognize the importance of Human health and welfare.
3. Apply biological processes to engineer Molecules.
4. Debate the Significance of entrepreneurship and industry.
5. Design a sustainable idea that defines research as a trend for the future.
6. Evaluate ethics and honors for research in Biology.

Module 1: Life and Life-Forms (9 hrs)

Brief Introduction about the Course. Classification of Life forms. Body plan and Design of Life Forms – Evolution. Biodiversity. A History of Biology in 20 Objects Case Study – Neanderthals to Homo-Sapiens.

Module 2: Health and Well-Being and Stress Management (9 hrs)

Nutrition in Humans – Macronutrients and Micronutrients. The Human Body during Health and Disease – Example – Three Systems – Digestive, Nervous and Excretory. 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 3: Molecules that make us (9 hrs)

Biomolecules (Carbohydrates, Proteins, Lipids, and Nucleic Acids) – Types and Properties. From Molecules to Cells. Genes, Evolution and Development. Case Study - Crime Scene Investigation (FBI and CBI).

Module 4: Biotechnology at home and in Industry (9 hrs)

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,

Module 5: Advanced Trends in Biology (4 hrs)

Genetically Modified Organisms (GMO) – Plants, Animals and Microbes (Two Examples Each). Microbes as Fertilizer, Organisms as Pesticides, Biofuels. Human Cloning. Stem Cells Depot. Drug Resistance and Pathogens. Case Study: A GMO study.

Module 6: Ethics and Interdisciplinary Research (5 hrs)

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

Total Hours: 45

Text Books:

1. G. K. Suraish Kumar, Biology for Engineers, Oxford University Press, 2019.
2. Alberts B et al. Essential Cell Biology 5th Edition Garland Science, 2009.

3. Coyne, JA. Why Evolution is True. Oxford University Press, 2009.

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. Arthur C Guyton, "A Textbook of Human Physiology", Elsevier Saunders, International Edition, 11th Edition, 2006.
3. Peter Raven et al "Biology", McGraw-Hill Education; 10th Edition, 2013.

19BT2064	WORKSHOP PRACTICES FOR BIOTECHNOLOGISTS	L	T	P	C
		0	0	2	1

Course Objectives:

1. To impart knowledge on good Laboratory Practices
2. To impart knowledge on planning and procedures to develop models in biotechnology laboratories.
3. To impart knowledge on sequence of operations adopted in laboratories to fabricate models.

Course Outcomes:

1. Understand various laboratory tools and their applications.
2. Prepare basic solutions for chemical applications and their disposal.
3. Learn basic electrical processes involved in equipment and their trouble shooting.
4. Understand plumbing
5. Design and fabricate the various objects in sheet metal using hand tools.
6. Apply manufacturing process for various biotech applications.

List of Experiments:

1. Measurements, tools and its usages
2. Fundamental electricals, electronics and trouble shooting
3. Basics of laboratory safety, first aid and disposal process
4. Basics of calculations and measurements
5. Introductory plumbing
6. Computer hardware and installations
7. Sheet metal fabrication and carpentry

19BT3001	ADVANCES IN BIOPOLYMER AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To improve knowledge on application of biopolymers in the field of pharma and food industries.
2. To interaction of biopolymers and their structure – function relationship
3. To improve knowledge on recent trends in biomolecules research

Course Outcomes:

1. Recall the basic concepts in biomolecules (carbohydrates, Proteins, enzymes, hormones, nucleic acids) and their function.
2. Compare and demonstrate the applications of biomolecules in medical, pharma, food and agro industries
3. Choose and apply techniques in protein engineering, glysosylation engineering, enzyme engineering, antibody engineering to study the biomolecules
4. Compare and contrast the structure functional relationship of different biomolecules
5. Appraise the applications of biomolecules as biomarkers in diagnosis of diseases and as biosensors
6. Compile, discuss and critically review the recent updates / progress in biomolecules research

Module 1: Glycobiology (10 hrs)

Glycoconjugates – Glycan structure of proteoglycan, glycoproteins, glycolipids and lipopolysaccharides; Glycans and blood groups, 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.

Module 2: Protein Engineering (8 hrs)

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

Module 3: Enzyme Technology and Applications (8 hrs)

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.

Module 4: Hormones and Antibodies (6 hrs)

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

Module 5: Lipid Technology and Applications (7 hrs)

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

Module 6: Nucleic Acid Biopolymer (6 hrs)

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

Total Hours: 45

Text 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. LehningerA. L, NelsonD. L. and CoxM. M. "Principles of Biochemistry" Fourth Edition (Freeman Publishers), New York, 2005.

Reference Books:

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.
2. Donald Voet and Judith G. Voet . "Biochemistry" – Volume 1, Biomolecules, Mechanisms of Enzyme Action and Metabolism, John.Willey and sons, 2005.
3. BurcuTuranli-Yildiz, CerenAlkim and Z. PetekCakar (2012). Protein Engineering Methods and Applications, Protein Engineering, Prof. Pravin Kaumaya (Ed.), ISBN: 978-953-51-0037-9

19BT3002	GENETIC ENGINEERING AND RECOMBINANT PRODUCTS	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

1. Understand the basic concepts in Genetic engineering.
2. Recognize the usage of the tools of genetic engineering.
3. Choose the techniques employed in genetic manipulation of microbes.

4. Analyze the techniques employed in the genetic manipulation plants for crop improvement
5. Illustrate the techniques employed in the genetic manipulation animals for commercial purposes.
6. Discuss the genetic manipulation techniques employed in the production of therapeutics.

Module 1: Introduction to Genetic Engineering and the Market of r-DNA Products (4 hrs)

Impact of r-DNA products in food, drug, agriculture, and industry.

Module 2: Tools Employed in Genetic Engineering: Vectors & Enzymes (7 hrs)

Properties of ideal vectors, Cloning vectors & Expression Vectors. Vectors for Bacteria; plasmids, cosmids and Phagemids, BAC and YAC. Shuttle vectors. Expression vectors for bacteria, yeast, animal/mammalian cells and plants.

Module 3: Polymerase Chain Reaction (6 hrs)

Types of PCR, Inverse PCR, Nested PCR, RACE PCR, Reverse Transcriptase PCR, Real Time PCR, Nucleic acid sequencing methods.

Module 4: Construction & Analysis of Recombinant DNA (10 hrs)

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. Restriction analysis, Probe preparation and labeling methods, hybridization methods,

Module 5: Protein and Nucleic Acid Products of rDNA Technology (9 hrs)

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 6: Genetically Modified Organisms (9 hrs)

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

Total Hours: 45

Text Books:

1. Berhard R. Glick, Chery L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th edition, 2010
2. W T Godbey, An Introduction to Biotechnology ,AP, 2014
3. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski, Recombinant DNA: Genes and Genomes, W.H. Freeman, 2007
4. Lilia Alberghina, Protein Engineering For Industrial Biotechnology, Hardwood Academic Press, 2000
5. Nigel W. Scott, Mark R. Fowler, Adrian Slater, Plant Biotechnology: The genetic manipulation of plants,2nd Edition, 2008

Reference Books:

1. Kadema Carter, Biomedical Applications of DNA Recombinant Technology, Koros, 2014
2. Carl A. Pinkert, Transgenic Animal Technology: A Laboratory Handbook, 2012.

19BT3003	BIOPROCESS MODELLING AND SIMULATION	L	T	P	C
		3	0	0	3

Course Objectives:

1. To improve knowledge on Principles and frameworks of data driven modeling
2. To create mathematical models relevant to industrial and environmental bioprocess systems
3. To know the basics of MATLAB required for formalization of Bioprocess models and its simulation

Course Outcomes:

1. Recognize the different stages and their inter-relationship in bioprocess modelling

2. Relate modelling, simulation and parameter estimation modules
3. Develop bioprocess system models from experimental data using Matlab tool
4. Examine the suitability of developed models in a quantitative manner
5. Interpret the bioprocess modelling outcome for refinement of model structure
6. Formulate simplification strategies and simulate bioprocess models with relevant examples

Module 1: Introduction to Bioprocess Modelling (7 hrs)

Basic modeling principles – Purpose of modelling transient or steady state behavior – 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 2: Mathematical Formalization of Bioprocess (7 hrs)

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 value problem.

Module 3: Matlab Basics for Modelling (8 hrs)

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 4: Matlab Application in Bioprocess Modelling (9 hrs)

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 5: Parameter Estimation and Sensitivity Analysis, Model Fitness (7 hrs)

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 6: Advanced Bioprocess Modelling Examples (7 hrs)

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

Total Hours: 45

Text Book:

1. Dunn, Irving J. (2003) Biological reaction engineering : dynamic modelling fundamentals with simulation examples, Wiley-VCH
2. Snape, Jonathan B. Dunn, Irving J., Ingham John, Prenosil Jiri E. (2008) Dynamics of Environmental Bioprocesses: Modelling and Simulation, John Wiley & Sons

Reference Books:

1. Verma, Ashok Kumar (2014) Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Press
2. Nicoletti, Maria Carmo (2009) Computational Intelligence Techniques for Bioprocess Modelling, Supervision and Control. Springer

19BT3004	ANALYTICAL TECHNIQUES IN BIOTECHNOLOGY LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To analyze clinical role of biomolecules in biological sample.
2. To know the importance of biomolecules with the cells and organs of the body
3. To experience advanced analytical techniques

Course Outcomes:

1. Recall the basic concepts and principles of different assays

2. Understand the protocol for isolation and extraction of biomolecules from various sources
3. Experiment with the assay procedures of acid phosphatase. Glucose, hexosamine, and antioxidants assays
4. Infer the results and draw conclusion
5. Compare the different methods of extraction of phytochemicals, and exposed to latest techniques on determination and structure prediction using sophisticated techniques
6. Propose and apply the above learnt experimental skills in their project work

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
8. Modified hydroxyl radical scavenging assay
9. Solvent extraction of phytochemicals and qualitative screening
10. Separation of phytochemicals by HPLC
11. Determination of molecular weight of phytochemicals by Mass spectrometry
12. Biomolecular structure prediction using X-Ray diffraction

19BT3005	ANIMAL AND PLANT TISSUE CULTURE LAB	L	T	P	C
		0	0	4	2

Course Objectives:

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

Course Outcomes:

1. Demonstrate media preparation on Plant and Animal Tissue Culture
2. Comprehend on sterilization techniques
3. Experiment plant transformation techniques
4. Perform in vitro animal cell culture techniques
5. Demonstrate cell viability assays using different types of animal cells
6. Analyze the cell toxicity of drugs

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

19BT3006	ADVANCED PROCESS EQUIPMENT DESIGN AND	L	T	P	C

	DRAWING LAB	0	0	4	2

Course Objectives:

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

Course Outcomes:

1. Understand the unit operation symbol, letters and plant layout
2. Summarize the effect of heat exchangers and evaporators
3. Recognize batch reactor
4. Evaluate the efficiency of distillation
5. Analyze the process of filtration and absorption
6. Comprehend the uses of valves in flow measuring devices

List of Experiments:

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

Reference Books:

1. Donald Q.Kern, "ProcessHeatTransfer",Tata Mc Graw Hill, New Delhi, 2007.
2. Mccabe, W. L.,Smith, J. C., and Harriott,P., "Unit Operations of Chemical Engineering", McGraw Hill,NewYork,6th Edition,2004

19BT3007	RECOMBINANT DNA TECHNOLOGY LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To impart knowledge on the basic laboratory techniques employed in a genetic engineering Lab
2. To impart knowledge on to extract and analysis of nucleic acids and proteins.
3. To learn genetic manipulation of Nucleic acids for protein production.

Course Outcomes:

1. Isolate nucleic acids
2. Perform electrophoresis of nucleic acids and proteins.
3. Experiment the DNA manipulation and transformation techniques.
4. Evaluate RNA expression by reverse transcription
5. Analyze nucleic acid amplifications 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

19BT3009	ENZYME TECHNOLOGY AND INDUSTRIAL APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

1. Understand the concept of immobilization
2. Understand extraction and purification of enzymes
3. Create inhibition kinetics of the enzymatic reactions
4. Evaluate application of enzymes
5. Apply protein engineering of enzymes
6. Analyze commercial production of enzyme

Module 1: Introduction to Enzymes (7 hrs)

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 2: Enzyme Kinetics & Modeling of Enzymatic Systems (7 hrs)

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 3: Immobilized Enzymes (8 hrs)

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 4: Industrial Enzymes (8 hrs)

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 5: Protein Engineering of Industrial Enzymes (7 hrs)

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 6: Enzyme as Tools For Stereo Specific C- C Bond Formation In Monosaccharide & Analogues (8 hrs)

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

Total Hours: 45

Text Books:

1. Palmer T, P.L. Bonner, "Enzymes: Biochemistry", "Biotechnology", "Clinical chemistry", 2nd Edn, Harwood Publishing Ltd. 2007.
2. Ashok Pande, Colin Webb, Carlos Richard, Cristian Larroche. Enzyme Technology, 2006, Springer

Reference Books:

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2002
2. Bailey J.E. and Ollis, D.F. "Biochemical Engineering Fundamentals", McGraw Hill,2000.
3. Price and Lewis Stevens. Fundamentals of Enzymology, Oxford, United Kingdom, 2000

19BT3010	MICROBIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

1. Analyze microbial growth and product formation in batch and continuous culture
2. Demonstrate the complex events involved in the development of genetically modified organisms
3. Apply the concept of genomics and proteomics in biotechnology with regard to microorganisms
4. Develop industrially important products theta benefits human, animal and environment
5. Compare and categorize the interactions of microorganisms with plants, animals and viruses
6. Analyze and evaluate the scientific data in research paper and develop critical thinking for future research direction

Module 1: Introduction (8 hrs)

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

Module 2: Microbial Genomics (8 hrs)

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

Module 3: Microbial Proteomics (8 hrs)

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, Proteome research for novel drug targets, High throughput proteomic screening for novel enzymes

Module 4: Microbes in Agriculture (8 hrs)

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

Module 5: Microbial Interactions (7 hrs)

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

Module 6: Commercial Products (6 hrs)

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

Total Hours: 45

Text Books:

1. Ian Humphery-Smith and Michael Hecker, Microbial Proteomics: Functional Biology of Whole Organisms by Publisher: Wiley-Interscience; 1st edition, 2010.
2. Stanbury, P. F., Whitaker and Hall, A. S. J., Principles of Fermentation Technology. Butterworth-Heinemann, 2009.
3. Crueger W. and Crueger, A., Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates, 2008.

Reference Books:

1. Thomas J. Dougherty and Steven J. Projan, Microbial Genomics and Drug Discovery by Publisher: CRC; 1st ed. 2013.
2. Rajhi Gupta, Jagjit Singh, T.N. Lakhanpal, and J.P. Jewari, Advances in Microbial Biotechnology by Publisher: A.P.H. Pub. Corp. 2005.
3. Shuler, M.L. and Karg, I F., Bioprocess Engineering Basic Concepts, 2010.

19BT3011	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. To analyze the Food processing and packaging techniques
3. To elaborate the understanding of biodiversity and IPR issues in agricultural crops.

Course Outcomes:

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. Analyze Food processing and Packaging techniques

Module 1: Basics of Agriculture and Plant Breeding (8 hrs)

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 2: Agriculture Microbiology (7 hrs)

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 3: Agriculture Biotechnology (8 hrs)

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 4: Biodiversity and Intellectual Property Rights (8 hrs)

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 5: Food Biotechnology (7 hrs)
Food spoilage causes and prevention, Food borne infections and intoxication, immobilization of microbial and cultured plant cells. Principles of downstream processing, industrial production of various food products

Module 6: Food Processing and Packaging (7 hrs)
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.

Total Hours: 45

Text Books:

1. Jack Brown and Peter Caligari, Plant Breeding, (2014).
2. Vinod K. Joshi and R. S. Singh, Food Biotechnology (2012).
3. Frazier, Food Microbiology (2008).

Reference Books:

1. Sandy B. Primrose and Richard Twyman, Principles of Gene Manipulation and Genomics, (2006)
2. T. A. Brown, Gene Cloning and DNA Analysis: An Introduction, (2010).
3. Ashish Kothari, Understanding biodiversity: Life, sustainability and equity, (1997).
4. Eldor A. Paul, Soil Microbiology, Ecology and Biochemistry, Fourth Edition, (2014).
5. Byong H. Lee, Fundamentals of Food Biotechnology, (2015).
6. Philip E. Nelson, Principles of Aseptic Processing and Packaging, (2010).

19BT3012	BIG DATA ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives:
1. To know fundamental concepts and methods of big data analysis.
2. For data exploration, visualization and statistical analysis for given data set.
3. To manage big data analytics for Biological data set.

Course Outcomes:
1. Know various types of big data platform and cloud computing model.
2. Understand the fundamentals of big data technologies
3. Apply the big data tools and software in handling the biological data.
4. Evaluate variety of big data analytics tools.
5. Explore use of R platform for biological big data analysis.
6. Design and develop Biological models based on big data techniques.

Module 1: Introduction (8 hrs)
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 2: Data Exploration and Visualization (7 hrs)
Problem Definition, Data Collection, Data Pre-processing, Data Cleaning – Homogenization, Heterogenization, Summarizing data, Data Exploration and Visualization.

Module 3: Big Data Methods (9 hrs)
Introduction to R programming, Data Frames, Atomic vectors, Factors, Data types, Variables, Functions, working with excel files, Data interface.

Module 4: Charts & Graphs (6 hrs)
Develop pie chart, 3D pie chart, Histograms, Bar chart, Group bar chart, Stacked Bar chart, Line graph, Multiline graph and Box plot.

Module 5: Statistical Methods (9 hrs)

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

Module 6: Big Data Analytics for Health Care (6 hrs)

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

Total Hours: 45

Text Books:

1. Venkat Ankam, "Big Data analytics", Packt publishing 2016
2. Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition, 2014
3. Robert Gentleman, R Programming for Bioinformatics, CRC press, Taylor & Francis,2008

References Books:

1. Parag Kulkarni, Sarang Joshi, "Big Data analytics", PHI learning 2016
2. Mark Gardener. Beginning R: The Statistical Programming Language. John Wiley & Sons, 2012.
3. Avril Coghlan, A Little Book of R For Bioinformatics, Release 0.1, 2017

19BT3013	BIOETHICS AND BIOSAFETY	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

1. Recall different rDNA technology of transgenic in animals, humans and plants
2. Understand the various biosafety regulations in transgenics
3. Illustrate IPR and patent procedures
4. Comprehend on various techniques of genome, stem cells and organ research in humans
5. Aware of modern rDNA research and its ethical procedures
6. Comprehend on recent ethical, legal and social economic impacts of rDNA research in biotechnology and its applications

Module 1: Legal and Socio-Economic Impacts of Biotechnology - Biosafety Regulations (7 hrs)

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 2: Intellectual Property Rights (9 hrs)

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 3: Human Genome Project (7 hrs)

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 4: Stem Cell Research (9 hrs)

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 5: Organs Transplantation in Human Beings (8 hrs)

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 6: Transgenic Animals (6 hrs)

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

Total Hours: 45

Text Book:

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

19BT3014	CHEMICAL PROCESS TECHNOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. To address designing new process and product development.
2. To understand the processes technologies of various organic and inorganic process industries for manufacturing chemicals.
3. To associated troubleshoot.

Course Outcomes:

1. Remember the process flow diagram for various chemical process
2. Understand the steps in manufacturing process of organic and inorganic chemicals
3. Classify various chemical, agrochemical and fermentation products
4. Illustrate the process flow diagram of carbohydrates, oils, fats etc.
5. Analyze various chemical process to solve engineering problems during production
6. Evaluate major engineering problems and in order to provide technological solutions in chemical process industries.

Module 1: Process Flow Diagram (8 hrs)

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 2: Industrial Production (8 hrs)

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 3: Oils and Fats (7 hrs)

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

Module 4: Sugar Derivatives (8 hrs)

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 5: Fermentation Products (7 hrs)

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

Module 6: Agrochemical Industries (7 hrs)

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

Total Hours: 45

Text Book:

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

Reference Books:

1. Austins, G.T., Sherve's Chemical Process Industries, MGH,2012.
2. Venkateswarlu, S. (Ed.) Chemtech (II) Chemical Engineering Development Centre, IIT, Madras, 2009.
3. S. K. Ghoshal, S. K. Sanyal and S. Datta, Introduction to Chemical Engineering, Tata McGraw Hill, New Delhi, 2010.
4. Kirk & Othmer (Ed.), Encyclopedia of Chemical Technology, 2011.

19BT3015	IMMUNOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know the immune systems and techniques in immunology.
2. To learn concepts in immunotechnology
3. To analyze advancement in immunology and immunotechnology

Course Outcomes:

1. Recall the basics in functions of immune systems.
2. Compare the types of antibodies and the interaction between antigen and antibodies
3. Apply skills and competence in specialized immunological techniques in the diagnosis and management of health related disorders.
4. Infer research methods employing immunological techniques for application in biomedical and clinical research
5. Evaluate immunological techniques to manage the immunological diseases
6. Develop modern technology in diagnosis and treatment of cancer

Module 1: The Immune System (8 hrs)

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 2: Antigen-Antibody Interaction (8 hrs)

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 3: Antibodies (8 hrs)

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 4: Cellular Immunology (7 hrs)

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 5: Immunity and Infection Mechanism (7 hrs)

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 6: Transplantation and Tumor Immunology (7 hrs)

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;

Total Hours: 45

Text Books:

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.

19BT3016	COMPUTATIONAL BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Understand the principles of biological data and interpretation.
2. Demonstrate high throughput biological data and perform statistical analysis
3. Make use of advanced data mining and machine learning techniques
4. Create skills on molecular modeling and simulation, whole cell modeling, drug discovery, and Systems Biology
5. Clarify the implementation of algorithms which may help them design their own.
6. Explain the theory and practical aspects of important experimental techniques.

Module 1: Introduction (10 hrs)

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 2: Phylogentic Analysis (7 hrs)

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 3: Bio Molecular Structure Modelling and Simulation (7 hrs)

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

Module 4: Machine Learning Methods and Analysis (7 hrs)

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 5: Perl for Bioinformatics (7 hrs)

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 6: Systems Biology and protein network analysis (7 hrs)

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.

Total Hours: 45

Text Books:

1. David W. Mount Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbor Laboratory Press, Second Edition, 2004.
2. Dan Gusfield. Algorithms on Strings Trees and Sequences, Cambridge University Press.2010
3. Andrew R. Leach, Molecular Modeling Principles And Applications, Second Edition, Prentice Hall. 2001
4. Systems Biology and Synthetic Biology by Pengcheng Fu, Sven Panke, Wiley InterScience. 2009

Reference Books:

1. Arthur M. Lesk, Introduction to Bioinformatics by Oxford University Press, 2008.
2. Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. John Wiley & Sons Inc 2015
3. Computational systems biology by A.Kriete, R.Eils, Academic Press. 2005
4. Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. Sinauer Associates, Inc; 3 edition 2009

19BT3017	METABOLIC REGULATION AND ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Identify the appropriate metabolic pathways to produce a desired product
2. Characterize the different metabolic pathways and propose relevant metabolic engineering strategies to obtain improved and enhanced economically viable products.
3. Adapt suitable metabolic control analysis to identify important steps in pathway control.
4. Construct genome-scale metabolic flux models using available tools and software and perform simulations
5. Design 13C-labeling strategies and perform metabolic flux analysis to determine metabolic pathway utilization
6. Construct a mathematical representation of a metabolic network, and calculate the internal fluxes based on provided external measurements.

Module 1: Review of Central Metabolism (6 hrs)

Enzyme catalyzed reaction, Pathway of Cellular respirations, Glycolysis, Krebs cycle, Fermentative Pathways, Metabolism of Proteins and Lipids

Module 2: Cellular Reaction and Metabolic Flux Analysis (12 hrs)

Stoichiometry of cellular reactions, reaction rate and flux, dynamic mass balance, Flux Analysis basics, Dynamic steady state, Estimation of intracellular metabolic flux, Determined, overdetermined and under determined system, use of linear programming, Elucidation of extreme Pathways

Module 3: Experimental Metabolic Fluxes by Isotope Labeling (8 hrs)

Limitation of Stoichiometric MFA, Isotopic substrate composition, 13C MFA experimentation, Carbon-transition network, Isotopic mass distribution, Detection of 13C labelling patterns, Construction of a metabolic model for 13C flux analysis, FiatFlux® (Matlab)

Module 4: Metabolic Control Analysis (6 hrs)

Coefficients of control analysis, elasticity coefficient, Flux control coefficients, Summation theorem, FC connectivity theorems, Concentration control connectivity, calculating control coefficients, MCA example, predicting the results of perturbation, predicting the results of perturbation, MCA Linear approximation

Module 5: Regulation of Metabolic Pathways (6 hrs)

Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites, Operon model – *trp, lac* operon, Inhibition of enzyme and selectivity

Module 6: Applications of Metabolic Engineering (7 hrs)

Product over production examples: polyhydroxyalkanoic acids, Extension of substrate utilization range for organisms such as *S. cerevisae* and *Z. mobilis* for ethanol production, metabolic engineering of *Enterobacter aerogenes.*

Total Hours: 45

Text Books:

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. 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 books:

1. Christina Smolke *ed*., The Metabolic Pathway Engineering Handbook: Fundamentals, CRC Press, 2009.
2. S. Cortassa, M.A.Aon, A.A.Iglesias and D.Llyod, " An Introduction to Metabolic and Cellular Engineering", 2nd Edition, World Scientific Publishing Co. Pte. Ltd, 2012.

19BT3018	CLINICAL TRIALS AND BIOETHICS	L	T	P	C
		3	0	0	3

Course Objectives:

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 Outcomes:

1. Understands the principles and methodology of clinical trials
2. Comprehend the theory and practical aspects of important techniques
3. Develop analytical skills and expertise to formulate and implement a research oriented real time problem.
4. Asses in major high throughput statistical methods in clinical research.
5. Evaluate experimental component to undertake interdisciplinary work.
6. Equips skills to pursue a career either in academia or industry.

Module 1: Introduction to Drug Discovery and Development (9 hrs)

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 2: Ethical Regulation (8 hrs)

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 3: Regulation in Clinical Research (7 hrs)

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 4: Clinical trial important Documentation (7 hrs)

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 5: Clinical Trial Data Management (8 hrs)

Project management in clinical trials -principles of project management; Application in clinical trial management; Risk assessment Pharmacovigilance, Project Auditing, Inspection.

Module 6: Clinical Data Monitoring (7 hrs)

CRF Review & Source Data Verification, Drug Safety Reporting, Drug Accountability Work, Routine Site Monitoring, Site Close Out Visit.

Total Hours: 45

Text Books:

1. Methodology of Clinical Drug Trials, 2ndEdition.Spriet A., Dupin-Spriet T., Simon P. Publisher: Karger. 1997
2. Design and Analysis of Clinical Trials: Concepts and Methodologies , 3rdEdition.Shein-Chung Chow, Jen-Pei Liu. Publisher: Wiley. 2014
3. Principles and Practice of Pharmaceutical Medicine, 3rdEdition. Lionel D. Edwards, Anthony W. Fox, Peter D. Stonier. Publisher: Wiley-Blackwell. 2011

Reference Books:

1. Lee, Chi -Jen; etal.,"Clinical Trials or Drugs and Biopharmaceuticals." CRC / Taylor &Francis, 2011
2. Oxford Handbook of Clinical Medicine, 9 thEdition. Murray Longmore, Ian Wilkinson, Andrew Baldwin, and Elizabeth Wallin.Oxford Medical Handbooks.2014.

19BT3019	SUSTAINABLE BIOPROCESS DEVELOPMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on design and operation of fermentation processes with all its prerequisites.
2. To familiar the students with the basics of microbial kinetics and reactor design
3. To develop bioengineering skills for the production of value added product using integrated biochemical processes

Course Outcome:

1. Develop growth model based on the microbial characteristics
2. Understand Immobilization techniques
3. Analyze the mass transfer during different biochemical reactions
4. Evaluate enzyme reaction and its kinetics
5. Understand different configurations of bioreactors
6. Understand the involvement of bioprocess engineering in other related areas

Module 1: Introduction (6 hrs)

Microbial diversity, Cell construction, Major products of biological processing, Component parts of fermentation process, Concept of Upstream, downstream processing and scale up.

Module 2: Microbial Growth and Quantifying Growth Kinetics (8 hrs)

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 3: Enzyme Engineering (7 hrs)

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

Module 4: Bioreactor Design (9 hrs)

Mixing, Mixing Equipment, Flow pattern, Mechanism of Mixing, Power requirement for mixing, Bioreactor Configurations (Different Bioreactors), Membrane bioreactor

Module 5: Reactor Operation (8 hrs)

Batch Operation of a Mixed Reactor, Fed-Batch Operation of a Mixed Reactor, Continuous Operation of a Mixed Reactor, Chemostat Operation, Operation of Plug-Flow reactor

Module 6: Advanced Bioprocessing (7 hrs)

Bioprocess Consideration in plant cell cultures, Bioprocess Consideration in animal cell cultures, Bioprocessing in environmental engineering, Industrial Bioprocess.

Total Hours: 45

Text Book:

1. *Pauline M. Doran*, Bioprocess Engineering Principles, Elsevier Science & Technology Books, 2nd edition, May 1995

Reference 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.

19BT3020	ADVANCED ANIMAL BIOTECHNOLOGY AND TISSUE CULTURE	L	T	P	C
		3	0	0	3

Course Objectives:

1. To Provide insights into 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:

1. Describe basic concepts in Animal Biotechnology and its importance in Livestock improvement
2. Understand the role Cryopreservation of embryos and embryo sexing
3. Relate and evaluate the genetic defects in animal embryos through molecular defects.
4. Discuss the significance of transgenesis with respect to animal models
5. Comprehend the fundamental concepts of mammalian cell and generation of cell line and to demonstrate tissue engineering applications for implantable materials.
6. Relate to the social, cultural, economic, legal issues associated and comprehend the need Bioethics and IPR in biotechnological research.

Module 1: Introduction (8 hrs)

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 2: Transgenic Animals (7 hrs)

Transgenic manipulation of animal embryos, different applications of transgenic animal technology, Animal cloning from- embryonic cells and adult cells, cloning for conservation for conservation endangered species, Ethical, social and moral issues related to cloning

Module 3: Germplasm Preservation (7 hrs)

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 4: Live Stock Improvement (8 hrs)

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 5: Cell Culture (8 hrs)

Commercial scale production of animal cells, Application of animal cell culture for in vitro testing of drugs, Cytotoxicity and viability assays, Cell line preservation and authentication.

Module 6: Tissue Engineering (7 hrs)

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 seeding of implantable materials.

Total Hours: 45

Text Books:

1. Ianfreshney B. 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. Portner R. 2007. *Animal Cell Biotechnology*. Humana Press.

Reference Books:

1. Sasidhar B. Animal Biotechnology MJP publishers. 2006
2. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. *New Generation Vaccines*. 3rd Ed. Informa Healthcare
3. Animal Cell Culture by John R.W. Masters 3rd Edition, Oxford University Press, 2000.

19BT3021	MOLECULAR DIAGNOSTICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know the history and Traditional diagnostics in genetic disease.
2. To learn principles and performance of DNA and RNA isolation, amplification, hybridization, and analysis.
3. To analyze the applications in microbiology, diagnosis, cancer, transplantation, and forensic medicine.

Course Outcomes:

1. Understand the basic principles of molecular diagnosis
2. Demonstrate the working mechanism of different traditional and molecular diagnostic methods
3. Categorize genetic diseases and metabolic disorders
4. Apply appropriate diagnostic methods for the diagnosis of genetic and molecular diseases
5. Develop a new diagnostic kits for the emerging diseases
6. Adapt ethical guidelines for molecular test results

Module 1: Introduction to Diagnostics (7 hrs)

Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission of infections, Clinical Sample collection- method of collection, transport and processing of samples and Interpretation.

Module 2: Traditional Diagnostic Methods (9 Hours)

Diagnosis of infection caused by Bacteria: *Staphylococcus*, *Streptococcus, Mycobacterium E.coli, Salmonella, Shigella, and Vibrio,* Fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. DNA and RNA viruses- Pox viruses, Rhabdo Viruses, Hepatitis Viruses and Retroviruses. Protozoan diseases: Amoebiosis, Malaria, Leishmaniasis. Helminthic diseases- *Ascaris lumbricoides*, Filariasis- *Wuchereria bancrofti*

Module 3: Major Metabolic and Genetic Disorders (7 hrs)

Traditional methods for the diagnosis of metabolic errors, genetic disorders, identifying human disease genes. 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, Cystic Fibrosis.

Module 4: Molecular Diagnosis (7 hrs)

Nucleic acid amplification methods and types of PCR: Reverse Transcriptase-PCR, Real-Time PCR, Inverse PCR, Multiplex PCR, Nested PCR, Hot-start, In situ PCR, Long-PCR, PCR-ELISA, Ligase Chain Reaction. Proteins and Amino acids, Qualitative and quantitative techniques: Protein stability, denaturation; amino acid sequence analysis

Module 5: Hybridization and Sequencing (8 hrs)

Southern, Northern, in situ FISH, microarrays types and applications; Protein extraction and analysis PAGE, Western Blot. Automated DNA sequencing Principles, Methods and Instrumentation Advances in DNA sequencing New Generation sequencing Methods, Pyrosequencing, Microarrays Personalised Medicine- Pharmacogenomics (ADMET)

Module 6: New Trends in Diagnostics (7 hrs)

DNA chips in diagnosis of genetic disorders, Diagnosis of neonatal genetic disorders, human genome project, ethical considerations. Good Laboratory Practices. Different Levels of Biosafety and Containment. Forensic Medicine. Ethical and legal issues in genetic counselling.

Total Hours: 45

Text Book:

1. Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007). Lele Buckingham and Maribeth L. Flaws

Reference Books:

1. Bailey & Scott's Diagnostic Microbiology (2012), Betty A. Forbes , Daniel F. Sahm, Alice S. Weissfeld , Ernest A. Trevino, Published by C.V. Mosby
2. Fundamentals of Molecular Diagnostics (2010). David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Saunders Group.
3. Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, W.B. Coleman. Humana Press.

19BT3022	DRUG DESIGN AND DISCOVERY	L	T	P	C
		3	0	0	3

Course Objectives:

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-throughput screening.
3. To develop skills in specialized areas related to bioavailability, clinical trials, and the essentials of patent law

Course Outcomes:

1. Describe the process of drug discovery and development
2. Discuss the challenges faced in each step of the drug discovery process
3. Classify the computational methods used in drug discovery
4. Organize information into a clear report
5. Demonstrate their ability to work in teams and communicate scientific information effectively
6. Construct, review and evaluate preclinical and clinical pharmaceutical studies.

Module 1: Drug and their Interaction (8 hrs)

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 2: Drug Design Pipeline (8 hrs)

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 3: Fundamental of Drug Actions (8 hrs)

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 4: Drug Toxicity, Assays and Testing (7 hrs)

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 5: Drug Regulatory Agencies (8 hrs)

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 6: Intellectual Property Rights (IPR) (8 hrs)

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).

Total Hours: 45

Text Books:

1. Drugs: From discovery to approval 2nd Ed by Rick NG. Wiley Blackwell (2009)
2. Essentials of Medical Pharmacology, 6the Edition , by Tripathi Kd. Publisher: Jaypee Brothers (2013)
3. Burger's Medicinal Chemistry and Drug discovery. Volume 2, Wiley-Interscience; Volume 2 edition (January 23, 2003)
4. Intellectual Property Rights In India: General Issues And Implications by Prankrishna Pal. Publisher: Deep & Deep Publications Pvt.Ltd (2008)

Reference Books:

1. Stromgaard, Kristian, Povl Krogsgaard-Larsen, and Ulf Madsen. *Textbook of drug design and discovery*. CRC Press, 2009.
2. Katzung, Bertram G., Susan B. Masters, and Anthony J. Trevor. *Basic and Clinical Pharmacology (LANGE Basic Science)*. McGraw-Hill Education, 2012.
3. Spriet, Alain, et al. *Methodology of clinical drug trials*. Basel: Karger, 2004.

19BT3023	TRANSPORT PHENOMENA	L	T	P	C
		3	0	0	3

Course Objectives:

1. To give an overview of mass, momentum and energy transport, present the fundamental equations and illustrate how to use them to solve problems.
2. To describe mass, momentum and energy transport at molecular, microscopic and macroscopic level, to determine velocity, temperature and concentration profiles.
3. To focus on how operations related with fluids and how temperature plays a pivotal role in a drug or a chemical plant.

Course Outcomes:

1. Understand the molecular transport of momentum, heat, and mass.
2. Interpret and solve shell momentum, heat, and mass balances for one dimensional steady state problems.
3. Develop dimensional analysis and knowledge of the dimensional numbers that are important in momentum, heat, and mass transfer applications.
4. Analyse inter phase transport problems which involve friction factors, drag coefficients, heat and mass transfer coefficients.
5. Evaluate the problems related with diffusivities and convection.
6. Construct molecule energy related phases in bioengineering.

Module 1: Rheology of Fluids (9 hrs)

Phenomenological Equations and Transport properties, Rheological behaviour of fluids, Balance Equations – Differential and Integral equations.

Module 2: Laminar and Turbulent Behavior of Fluids (7 hrs)

Applications in laminar and turbulent transport in compressible and incompressible fluids. Boundary layer theory.

Module 3: Isothermal and Non Isothermal Systems (7 hrs)

Macroscopic balance for isothermal and nonisothermal systems and their applications in Momentum, Heat and Mass transport problems.

Module 4: Flow Patterns of Fluid Systems (8 hrs)

Friction factor, Fluid –Fluid systems, Flow patterns in vertical and horizontal pipes, Formulation of bubbles and drops and their size distribution, Solid – fluid systems, Forces acting on stagnant and moving solids, Flow through porous medium, capillary tube model and its applications.

Module 5: Convections, Diffusivity (8 hrs)

Heat Transfer coefficient, Forced convection in tubes, around submerged objects, Heat Transfer by free convection, film type and dropwise condensation and equations for heat 19 transfer, Heat transfer in boiling liquids.

Module 6: Design of Heat Transfer Equipment (6 hrs)

Transfer by forced convection in laminar and turbulent flow. Heat exchange equipment's- principles and design.

Total Hours: 45

Text Books:

1. Welty, J.R., Wicks, C. E. and Wilson, R. E., "Fundamentals of Momentum, Heat Mass Transfer", 5th Edn., John Wiley and Sons, 2007.
2. Brodkey, R. S. and Hershey, H. C., "Transport Phenomena – A Unified Approach", Brodkey Publishing, 2003.

Reference Books:

1. Bird R.B., Stewart, W. E. and Lightfoot, E. N., "Transport Phenomena", 2nd Edn.John Wiley and Sons, 2002.

19BT3024	PHARMACEUTICAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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 enable the student to gain in-depth knowledge in fundamental and applied aspects of Microbiology and Immunology.

Course Outcomes:

1. Understand and evaluate different pharmaceutical parameters for the current and future biotechnology related products on the market.
2. Aanalyze Screening, isolation, characterization and scale-up of Biological products.
3. Understand the legal steps involved in progressing a new drug to market and their science
4. Develop skills in molecular immunotherapeutics and immunotherapy.
5. Expertise in pharmaceutical drug delivery methods and analysis.
6. Gain knowledge in physicochemical properties, pharmacology and the formulation

Module 1: Introduction to Biopharmaceuticals and Biogenerics (9 hrs)

Introduction to Biopharmaceuticals and pharmaceutical biotechnology, Biopharmaceuticals: current status and future prospects, generic and branded biopharmaceuticals, overview of life history for development of biopharmaceuticals. Discovery of protein or peptide based therapeutics: In-silico, pharmaco-informatics. Pre-clinical toxicity assessment, Clinical trial phases and design, clinical data management, concept of Pharmacovigilance

Module 2: Impact of Omics in Drug Discovery (7 hrs)

Pharmacogenetics, Pharmacogenomics and proteomics, structural, functional and comparative genomics, DNA & oligonucleotides microarrays, genetically engineered animals, Integration of personalized and systems medicines, pharmacogenomics in preclinical and clinical development of drugs

Module 3: Pharmacokinetics and Pharmacodynamics of Biopharmaceuticals (7 hrs)

Definition, rationales, absorption, distribution and metabolism pathway. Factors governing absorption of drug. Pharmacokinetics and Pharmacodynamics of therapeutic peptides. Dose response relationship, interspecies scaling, and heterogeneity of therapeutic proteins.Chemical modification of therapeutic proteins

Module 4: Immunotherapeutic & Immunodiagnostics (7 hrs)

Overview of antibody based therapeutics, biologics for autoimmunity and inflammation, vaccine-adjuvant technology, genetically engineered vaccines.Principles of immunodiagnostic assay based on solid phase system: Malarial & HIV diagnostic kits as case study. Fluorescent ligands and radio-isotope tracers, principles and instrumentation for molecular diagnostics (Time resolved fluorescence immunoassay, light scattering principles), PCR and nucleic acid based diagnostics, imaging techniques.

Module 5: Biopharmaceuticals Based Delivery Systems (7 hrs)

Novel drug delivery systems for biopharmaceuticals (rate controlled and site specific), Nanotechnology based miniaturization of biopharmaceuticals and therapeutics, peptides for intracellular targeting, delivery of nucleic acids and therapeutic peptides, concept of responsive or smart drug delivery system.

Module 6: Formulation of Biopharmaceuticals (7 hrs)

Rational for formulation of bio therapeutics, formulation recipients: solubility enhancers, anti-aggregating agents, buffers, cryoprotectants, antioxidants and preservatives etc significance with relevant examples. Methods to enhance shelf life protein based therapeutics. Packaging techniques and quality analysis of product

Total Hours: 45

Text Books:

1. Gary Walsh (2003) Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition, John Wiley & Sons, Inc. 2.Daan J A Crommelin (2010),
2. Pharmaceutical Biotechnology, 2nd Edition, Taylor & Francis Group. 3.Rodney J. Y. Ho (2013)
3. .Gary Walsh (2007) Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, Inc.
4. .Oliver Kayser, Heribert Warzecha (2012) Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, 2nd Edition. John Wiley & Sons, Inc.

Reference Books:

1. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, 2ndEdition, John Wiley & Sons, Inc, 2013.

19BT3025	BIOREACTOR ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. Aims to understand the principles and concepts of Bioreactor engineering.
2. To understand structured models of growth and product formation
3. To understand the oxygen transfer parameters to be monitored and controlled in bioreactors

Course Outcomes:

1. Acquire knowledge on various bioreactors.
2. Classify modern biotechnological process in host vector systems.
3. Devise methods to calculate oxygen and mass transfer coefficients in bioreactors.
4. Assess on-line data analysis for measurement of important physico-chemical and biochemical parameters in bioreactors.
5. Analyze structured models for analysis of various bioprocesses.
6. Design of various instrumentation for monitoring and control of bioreactors.

Module 1: Design and Analysis of Bioreactors (7 hrs)

Design and operation of novel bioreactors-Air-lift loop reactors, Fluidized bed-bioreactors, packed bed reactor, Bubble column reactor, stability analysis of bioreactors

Module 2: Bioreactor Scale-Up (7 hrs)

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 3: Monitoring of Bioprocesses (7 hrs)

On-line data analysis for measurement of important physico-chemical and biochemical parameters; State and parameter estimation techniques for biochemical processes.

Module 4: Modern Biotechnological Processes (8 hrs)

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 5: Modelling and Simulation of Bioprocesses (8 hrs)

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 6: Bioreactor Instrumentation and Control (8 hrs)

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.

Total Hours: 45

Text Book:

1. Michael Shuler, Fikret Kargi, “Bioprocess Engineering Principles”,Second edition, Prentice Hall, 2008.

Reference Books:

1. P.Stanbury, A.Whitaker,SJ Hall “Principles of fermentation technology”, Second edition, Elsvier Pergamon Press,2010.
2. Pauline Doran,”Bioprocess Engineering Principles”, Academic Press, 2010.
3. Elmar Heinzle, Arno P.Biwer, “Development of Sustainable Bioprocess: Modelling and Assessment”, Wiley, 2007.
4. Bjorn K.Lyderson, Nancy Ade’lia and Kim Nelson, ”Bioprocess engineering *(handcover)”,*Wiley Interscience, 2014.

19BT3026	STEM CELL THERAPEUTICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know the history and future of the emerging field of Stem Cell Therapy
2. To analyze the impact of Stem Cell therapy in health care system.
3. To analyze the impact of Stem Cell Therapy in Human civilization.

Course Outcomes:

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 1: Introduction (4 hrs)

Introduction to The Syllabus, Overview of Stem Cells, Introduction and history of Stem cells, Stem cells for therapeutics and research.

Module 2: Culturing Cells in the Laboratory (5 hrs)

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 3: Stem Cell-Types (6 hrs)

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 4: Location, Nature & Culturing of Stem Cells (10 hrs)

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 5: Applications of Stem Cell Technology (10 hrs)

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 6: Ethical Implications of Stem Cell Therapeutics (10 hrs)

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.

Total Hours: 45

Text Books:

1. Paul Knoepfler, Stem Cells - An Insider's Guide ", 2013
2. Robert Lanza and Anthony Atala, Essentials of Stem Cell Biology", 2013
3. Satish Totey and Kaushik D. Deb, Stem Cell Technologies: Basics and Applications, 2010
4. Warburton David, Stem Cells, Tissue Engineering and Regenerative Medicine, 2015

19BT3027	NANOBIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know 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 Outcomes:

1. Define basic terminology and describe concepts in Nanobiotechnology
2. Discuss the principle of various applications in Nanobiotechnology.
3. Interpret the properties of Nanomaterials in Biotechnology.
4. Test the Application of Nanodevices in Biological systems.
5. Design the Application of Molecular recognition elements and transducing.
6. Evaluate New trends in Nanobiotechnology and Defence.

Module 1: History and Concept of Nanobiotechnology (7 hrs)

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 2: Nanomaterials in Biotechnology (9 hrs)

Drug Nanoparticles- Structure and Preparation, Liposomes, Cubosomes and Hexosomes, Lipid based Nanoparticles-Liquid nanodispersions- Solid Lipid Nanoparticles (SLP)- Biofunctionalsiation of SLP, Characterization- 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 3: DNA-Protein Nanostructures (9 hrs)

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 4: Nanodevices and Tools used in Nanotechnology (5 hrs)

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 5: Biological Nanoparticles (8 hrs)

Production - plants and microbial. Nanobiotechnological applications in health and disease - infectious and chronic. Nanobiotechnological applications in Environment and food - detection and mitigation.

Module 6: New Concepts in Nanobiotechnology (7 hrs)

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.

Total Hours: 45

Text Books:

1. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications. R.S. Greco, F.B.Prinz and R.L.Smith, Nanoscale Technology in Biological Systems, CRC press, 2005.
2. B. Bhushan , Springer Handbook of Nanotechnology: Volume 1&2, Springer-Verlag. Second ed., (2007)

Reference Books

1. Sandra J Rosethal, David W Wright, Nanobiotechnology Protocols, Series Methods in Molecular Biology (2005).
2. Christof M. Neimeyer, Chad.A.Mirkin (eds.,) Nanobiotechology II: More Concepts, and Applications, Wiley VCH Weinheim (2007).
3. Nanofabrication towards Biomedical Applications, Techniques, Tools, Applications, and Impact. C. S. S. R. Kumar, J. Hormes, C. Leuschner, 2005, WILEY -VCH Verlag GmbH & Co. KGaA, Weinheim, ISBN-13 978-3-527-31115-6.

19BT3028	ADVANCED PLANT BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know plant genetic materials and molecular biology techniques
2. To know plant metabolic engineering and its importance
3. To know the plant transformation techniques and GM crops

Course Outcome:

1. Understand the plant genome and its molecular mechanisms
2. Interpret additional genomic materials in plant cells
3. Comprehend on metabolic engineering of plant cell metabolites
4. Summarize plant transformation techniques
5. Interpret on mechanisms of plant virus vectors
6. Comprehend on GM crops and its ethical issues

Module 1: Introduction to Plant Molecular Biology (8 hrs)

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 2: Chloroplast and Mitochondria (9 hrs)

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 3: Plant Metabolism and Metabolic Engineering (7 hrs)

Nitrogen fixation, Nitrogenase activity, nod genes, nif genes, bacteroids, plant nodulins, production of secondary metabolites, flavanoid synthesis and metabolic engineering

Module 4: Agrobacterium Mediated Gene Transfer (5 hrs)

Pathogenesis, crown gall disease, genes involved in the pathogenesis, Ti plasmid –TDNA, importance in genetic engineering

Module 5: Plant Viruses (9 hrs)

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 6: Applications of Plant Biotechnology (7 hrs)

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 Hours: 45

Text Book:

1. Slater A et al. Plant Biotechnology : The Genetic Manipulation of Plants, Oxford University Press, (1st and 2nd edition), 2008

Reference Book:

1. Athar Ali, Usha Kiran, Malik Zainul Abdin.Plant Biotechnology: Principles and Applications Springer Publications, 2017

19BT3029	CANCER MANAGEMENT TECHNIQUES	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the pathology, grades and molecular biology of cancer
2. To analyze cancer type specific symptoms and early diagnostic markers
3. To learn the cancer management techniques like detection, treatment, prevention and palliative care

Course Outcomes:

1. Understand the pathology and metabolism of cancers and their reporting systems.
2. Recall the molecular pathways and relate them in cancer development, progression, detection and therapy.
3. Identify the potential molecular and cellular targets for diagnosis and therapy
4. Evaluate the technologies available for early diagnosis-prevention, targeted therapy and for effective management of post therapy – palliative care
5. Analyze the challenges in the present cancer management methods
6. Apply the knowledge and discuss new means of cancer management, prevention strategies and modes of palliative care to prolong the life of cancer cases.

Module 1: Pathology and types of cancer (8 hrs)

Benign and cancer tumor; Characteristics and hallmarks of cancer; Cancer malignancy – spread, invasion and metastasis; Histopathology of cancer; Cancer staging and grading; Cancer classes and types; Cancer metabolism, Cancer death - obstructions.

Module 2: Molecular Cell Biology of Cancer (8 hrs)

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 3: Cancer Symptoms and Markers (7 hrs)

Cancer Symptoms – 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 4: Cancer Detection Methods and Techniques (8 hrs)

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 5: Cancer Therapeutics (7 hrs)

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 6: Cancer Prevention and Palliative Care (7 hrs)

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.

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

Reference Books:

1. Macdonald F and Ford CHJ. "Molecular Biology of Cancer", Bios Scientific Publishers, 2002.
2. Richard Pazdur, Kevin A. Camphausen, Lawrence D. Wagman, William J. Hoskins, Cancer Management: A Multidisciplinary Approach**,** 11th illustrated edition, Oncology Publishers, 2003
3. Thomas N. Sayfried, Cancer as a Metabolic Disease: On the Origin, Management, and Prevention of Cancer 1st Edition, Wiley Publications; 2012

19BT3030	GENOMICS AND PROTEOMICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know the genomics, and proteomics using model organisms representing plants and animals.
2. To cover recent developments in genetics, epigenetics, small RNAs, proteomics, gene expression, mutagenesis and mapping genes.
3. To 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:

1. Gain knowledge in genomics and proteomics techniques and analysis.
2. Develop skills in applied bioinformatics, comparative, evolutionary, human genomics and functional genomics.
3. Acquire knowledge on genome sequencing and 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. Demonstrate the knowledge during the course would be helpful to those students who want to work in core facilities and commercial biological and medical laboratories

Module 1: Introduction to Genomics (8 hrs)

Introduction to Genomics, Genome Organization of prokaryotes and Eukaryotes, Gene Structure of Bacteria, Archaebacteria and Eukaryotes, Human Genome Project

Module 2: DNA Sequence and Mapping (8 hrs)

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 3: Functional Genomics and its Applications (7 hrs)

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 4: Introduction to Proteomics (7 hrs)

Proteomics- Introduction, The proteome, Genomics vs Proteomics, Proteomics and the new biology

Module 5: Analytical Proteomics (8 hrs)

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 6: Applications of Proteomics (7 hrs)

Applications of Proteomics- Mining Proteomes, Protein Expression Profiling, Mapping Post-translational Modification, Peptide Mass Fingerprinting.

Total Hours: 45

Text Books:

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

Reference Books:

1. HEYER, L. CAMPBELL, A. *Discovering Genomics, Proteomics and Bioinformatics.* USA: Cold Spring Harbor Lab. Press, 2006. 352 p. ISBN 0-8053-4722-4.
2. Arthur M Lesk, Introduction to Genomics, 2007, Oxford University Press.
3. Twyman R.M., Principles of Proteomics, BIOS Scientific Publishers, 2004.
4. P.Michael Conn, Handbook of Proteomic Method. Humana Press, Totowa, New Jersay, USA, 2003.
5. Stryer L., Biochemistry, W. H. Freeman and Co., New York, 2007.

19BT3031	ADVANCED ENVIRONMENTAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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:

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 1: Introduction (8 hrs)

Current status of biotechnology in environmental protection and its future prospects. Characteristics of wastewater, Classification of pollutants, Impact of pollutants on biotreatment.

Module 2: Environmental Pollution (7 hrs)

Types, causes and its effects on environment of Soil pollution, Water pollution, Air pollution**,** Oil pollution, Heavy metal pollution

Module 3: Bioreactors for Wastewater Treatment (7 hrs)

Design and evaluation of suspended growth reactors, Activated sludge, Biological nutrient removal, Bio filtration, Aerobic digestion, anaerobic processes and lagoons , Design and evaluation of attached growth reactors, Trickling filter, Rotating Biological Contactor, Fluidized bed biological reactors, Up flow anaerobic sludge blanket reactor ,Hybrid reactor, Sequential batch reactor , Techniques for Evaluating Kinetics and Stoichiometric parameters.

Module 4: Biotreatment of Industrial Wastewater (8 hrs)

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 5: Bioremediation and Biodegradation (8 hrs)

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 6: Novel Biotechnology Methods for Pollution Control (7 hrs)

Application of nanobiotechnology in environment, Vermitechnology, Genomic tools in bioremediation, Development of biodegradable and ecofriendly products, Biosensor, Global environmental problems: Ozone depletion, UV-radiation, Greenhouse gases, acid rain and biotechnological approaches of their management.

Total Hours: 45

Text Books:

1. Metcalf and Eddy, "Waste water Engineering Treatment, Disposal and Reuse". McGraw Hill, 2013.
2. Prescott, Harley and Klein, "Microbiology", 5th edition, McGraw Hill, 2014.
3. Graty. C.P.L., Daigger, G and Lim, H.C, "Biological Wastewater Treatment". 4th Edition, Marcel Dekker, 2011

Reference Books:

1. Jogdand, S.N. "Environmental Biotechnology". Himalaya Publishing House, New Delhi, 2012.
2. Karnely D. Chakrabarty K. Ovnen G.S. "Biotechnology and Biodegradation, Advances in Applied Biotechnology series", Gulf Publications Co. London 2011
3. R. C. Dubey A Textbook of Biotechnology, S.Chand publications, 4th edition, 2014
4. Indu Shekhar Thakur, "Environment Biotechnology basic concepts and applications", IK International, 5th edition, 2016

19BT3032	ENTREPRENEURSHIP AND MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

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 1: Introduction (8 hrs)

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 2: Product Design (7 hrs)

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 3: Innovation And Prototype (7 hrs)

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 4: IPR and copyright (8 hrs)

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 5: Biosafety (8 hrs)

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 6: Start Up Process (7 hrs)

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.

Total Hours: 45

Text Books:

1. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt. Ltd., 2007.
2. "Entrepreneurship: Theory", Process and Practice, Donald F. Kuratko, 9th Edition, Cengage Learning, 2011.
3. 4. S.S.Kanka Entrepreneurship Development, S.Chand and Co, New Delhi 2007.

Reference Books:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd., 2007.
2. Anupam Singh and Ashwani Singh. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), NPH, New Delhi (2010)
3. "Entrepreneurial Development", Jayshree Suresh, 5th Edition, Margham Publications, 2008.
4. "Entrepreneurship", Robert D. Hisrich, 6th Edition, Tata McGraw Hill Publications.2009.

19BT3033	INDUSTRIAL WASTE MANAGEMENT	L	T	P	C
		3	0	0	3

Course Objectives:

1. To know problems of different kind of hazardous waste from industrial process.
2. To Engineer and technical options for site specific waste management
3. To know cleaner Industrial process and zero waste sustainable initiatives

Course Outcomes:

1. List out different industrially relevant waste and their challenges in management
2. Infer suitability of available treatment options depending on nature of waste
3. Make use of bio-chemical reactions to develop optimal treatment system
4. Examine energy and eco-efficiency of solid waste and waste-water treatment
5. Recommend advanced treatment technologies with different Industrial Scenarios
6. Formulate cleaner production and waste management technologies

Module 1: Introduction to Industrial Waste Management System (9 hrs)

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 2: Pollution Prevention (5 hrs)

Prevention vs. control of Industrial Pollution, Benefits and Barriers-Source reduction techniques, Waste audit; Evaluation of Pollution Prevention options, CO_2 mitigation in industrial environment.

Module 3: Industrial Waste Water Treatment (10 hrs)

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 4: Solid Waste Treatment and Disposal (7 hrs)

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 5: Case Studies with Different Industrial Scenarios (7 hrs)

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 6: Cleaner Production and Newer Management Strategies (7 hrs)

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.

Total Hours: 45

Text Book:

1. Woodard Frank (2001) *Industrial Waste treatment Handbook*, Butterworth Heinemann

Reference Books:

1. Nelson Leonard Nemerow (2010) *Industrial Waste Treatment: Contemporary Practice and Vision for the Future*, Elsevier
2. Wang Lawrence K., Hung Yung-Tse, Lo Howard H., Constantine Yapijakis (2006) *Hazardous Industrial Waste Treatment*, CRC Press
3. John Pichtel, *Waste Management Practices: Municipal, Hazardous, and Industrial*, Second Edition, CRC Press, 2014.
4. Wang Lawrence K., Hung Yung-Tse, Shammas Nazih K. (2009) *Handbook of Advanced Industrial and Hazardous Wastes Treatment*, CRC Press

19BT3034	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide a general concept in the dimensions of disasters caused by nature beyond the human control
2. To know 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 Outcomes:

1. Learn the different safety aspects in industries and daily life
2. Learn safety procedure followed in industries
3. Learn the different types of rescues
4. Know the procedure for risk analysis
5. Know different type of disaster
6. Know procedure for damage assessment

Module 1: Safety Management (8 hrs)

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 2: Disaster Management (8 hrs)

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 3: Risk Analysis (8 hrs)

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 4: Responsibility of Engineers (8 hrs)

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 5: Reconstruction and Recovery (7 hrs)

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 6: Safety Awareness (6 hrs)

Education and Awareness, Dealing with Victims' Psychology, Long-term Counter Disaster Planning, Role of Educational Institute.

Total Hours: 45

Text Book:

1. Crowl D A, Louvar J F, " Chemical Process Safety Fundamentals with applications", 2nd Prentice Hall, NJ (2002).

Reference Books:

1. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services2005
2. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
3. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
4. Cheremisinoff, N. P., Practical Guide to Industrial Safety: Methods for Process Safety Professionals, CRC Press, 2001.