DEPARTMENT OF BIOTECHNOLOGY

B. Tech (Biotechnology) - 2020 Batch
PROGRAMME STRUCTURE

S. No.	Category	Credits
1	Humanities and Social Sciences including Management courses	9
2	Entrepreneurship	10
3	Basic Science Courses	16
4	Engineering Science courses including workshop, drawing, basics of electrical/mechanical/computer etc.	15
5	Professional Core Courses	68
6	Project work, seminar and internship in industry or appropriate work place/ academic and research institutions in India/abroad	#15/9
7	Professional Elective courses relevant to chosen specialization/branch	18/24
8	Open subjects – Electives from other technical and /or emerging Courses	9
9	Online Courses	5*
10	Mandatory Courses [Environmental Studies, Induction Program, Indian Constitution, Value Education, etc.]	(non-credit)
	Total	**160+5***

#Project- Full Semester-12 credits or Half Semester-6 credits + Internship - 3

**The students shall earn 5 credits through online courses between 2nd and 7th semester (both inclusive)*

CURRICULUM COMPONENTS

Category 1: Humanities, Social Sciences and Management Courses

No.	Course Code	Course Title	Credit
1	20MS2005	Soft Skills	1:0:01
2		Technical Communication / Other Languages • A Stream - Foreign Languages • B Stream - Online Course • C Stream - Classroom teaching including lab	2:0:0:2
3	20BT2057	Bioethics, IPR and Biosafety	3:0:0:3
4	18MS2004	Total Quality Management	3:0:0:3
		Total	**9**

Category 2: Entrepreneurship

No.	Course Code	Course Title	Credit
1	20MS2003	Concepts of Entrepreneurship	1:0:0:1
2	20MS2004	Entrepreneurship and Product Development	3:0:0:3
3	20MS2007	Business Plan	3:0:0:3
4	19CS2012	Artificial Intelligence for Biotechnology	3:0:0:3
		Total	**10**

Category 3: Basic Sciences

No.	Course Code	Course Title	Credit
1	20MA1015	Basic Mathematics for Biotechnology	2:0:2:3
2	20MA1016	Numerical Computing using Matlab	2:0:2:3
3	12MA2009	Probability, Statistics using R Programming	2:0:2:3
4	20PH1017	Applied Physics for Biotechnology Engineering	2:0:2:3
5	20BT2001	Chemistry of Biomolecules	3:0:0:3
6	20BT2002	Chemistry of Biomolecules Laboratory	0:0:2:1

			16

Category 4: Engineering Sciences

No.	Course Code	Course Title	Credit
1	20BT1001	Engineering Design and Drawing Lab	0:0:2:1
2	20BT2004	Workshop Practices in Biotechnology	0:0:2:1
3	20EE1003	Sensors and Measurement Techniques in Biotechnology	2:0:2:3
4	20CS1003	Fundamentals of Programming for Problem Solving	3:0:2:4
5	20BT2005	Basics of Industrial Biotechnology	3:0:0:3
6	20BT2015	Bioprocess Principles	3:0:0:3
		Total credits	**15**

Category 5: Professional Core

No.	Course Code	Course Title	Credit
1	20BT1002	Basics of Python Programming	2:0:2:3
2	20BT2003	Cell Biology	3:0:0:3
3	20BT2007	Bio-analytical Techniques	3:0:0:3
4	20BT2008	Bio-analytical Techniques Lab	0:0:3:1.5
5	20BT2009	Biochemistry	3:0:0:3
6	20BT2010	Biochemistry Lab	0:0:3:1.5
7	20BT2011	Microbiology	3:0:0:3
8	20BT2012	Microbiology Lab	0:0:3:1.5
9	20BT2013	Fluid Mechanics	3:1:0:4
10	20BT2014	Fluid Mechanics and Heat transfer Lab	0:0:3:1.5
11	20BT2016	Bioprocess Lab	0:0:3:1.5
12	20BT2017	Molecular Biology	3:0:0:3
13	20BT2018	Genetic Engineering	3:0:0:3
14	20BT2019	Molecular Biology and Genetic Engineering Lab	0:0:3:1.5
15	20BT2020	Bioprocess Engineering	3:0:0:3
16	20BT2021	Enzyme Engineering and Technology	3:0:0:3
17	20BT2023	Downstream Processing	3:0:0:3
18	20BT2024	Downstream Processing Lab	0:0:3:1.5
19	20BT2025	Immunology	3:0:0:3
20	20BT2026	Cell Biology and Immunology Lab	0:0:3:1.5
21	20BT2029	Biochemical Thermodynamics	3:0:0:3
22	20BT2030	Concepts of Bioinformatics	2:0:2:3
23	20BT2052	Plant and Animal Tissue Culture Lab	0:0:4:2
24	20BT2054	Environmental Biotechnology	3:0:0:3
25	20BT2059	IoT in Biotechnology	2:0:0:2
26	20BT2068	Principles of Plant Biotechnology and Applications	3:0:0:3
27	20BT2069	Advances in Animal Biotechnology	3:0:0:3
		Total Credits	**68**

Category 6: Professional Electives

No.	Courses	Credit
1	Professional Electives – 1	3:0:0:3
2	Professional Electives – 2	3:0:0:3
3	Professional Electives – 3	3:0:0:3

4	Professional Electives – 4	3:0:0:3
5	Professional Electives – 5	3:0:0:3
6	Professional Electives – 6	3:0:0:3
	Total Credits	**18**

Category 7: Open Electives

No.	Courses	Credit
1	Open Elective 1	3:0:0:3
2	Open Elective 2	3:0:0:3
3	Open Elective 3	3:0:0:3
	Total Credits	**9**

Category 8: Online Courses

No.	Courses	Credit
1	The students shall earn 5 credits through online courses between 2nd and 7th semester (both inclusive)	**5**

Category 9: Internships, Projects, Patent and Products

No.	Courses	Credit
1	Industry Internships (Sem. II – VI)	3
2	Projects, Patent and Products	12
	Total	**15**

Category 10: Mandatory Courses

No.	Courses	Credit
1	Constitution of India	0
2	Environmental Studies	0
3	Induction Program	0
4	Value Education	0

SEMESTERWISE CURRICULUM

Semester-1

S.No	Course Code	Course Title	Hours/Week			Credits
			L	T	P	
1	20MA1015	Basic Mathematics for Biotechnology	2	0	2	3
2	20PH1017	Applied Physics for Biotechnology Engineering	2	0	2	3
3	20EE1003	Sensors and Measurement Techniques in Biotechnology	2	0	2	3
4	20BT2001	Chemistry of Biomolecules	3	0	0	3
5	20BT2002	Chemistry of Biomolecules Laboratory	0	0	2	1
6		Mandatory Course- I				0
7		Technical Communication English/French/German/Spanish	2	0	0	2
Total						**15**

Semester-2

S.No	Course Code	Course Title	Hours/Week			Credits
			L	T	P	

1	20MS2003	Concepts of Entrepreneurship	1	0	0	1
3	20MA1016	Numerical Computing using MATLAB	2	0	2	3
4	20CS1003	Fundamentals of Programming for Problem Solving	3	0	2	4
5	20BT1001	Engineering Design and Drawing Lab	0	0	2	1
6	20BT2004	Workshop Practices in Biotechnology	0	0	2	1
7	20BT1002	Basics of Python Programming	2	0	2	3
8		Mandatory Course - II				0
Total						**13**

Semester-3

S.No	Course Code	Course Title	Hours/Week			Credits
			L	T	P	
1	12MA2009	Probability and Statistics using R programming	2	1	0	3
2	20BT2015	Bioprocess Principles	3	0	0	3
3	20BT2009	Biochemistry	3	0	0	3
4	20BT2011	Microbiology	3	0	0	3
5	20BT2005	Basics of Industrial Biotechnology	3	0	0	3
6	20BT2012	Microbiology Lab	0	0	3	1.5
7	20BT2010	Biochemistry Lab	0	0	3	1.5
8	20MS2004	Entrepreneurship and Product Development	3	0	0	3
		Open Elective I	3	0	0	3
Total						**24**

Semester-4

S.No	Course Code	Course Title	Hours/Week			Credits
			L	T	P	
1	20MS2005	Soft Skills	3	0	0	1
2	20BT2003	Cell biology	3	0	0	3
3	20BT2007	Bio-analytical Techniques	3	0	0	3
4	20BT2013	Fluid Mechanics	3	1	0	4
5	20BT2029	Biochemical Thermodynamics	3	0	0	3
6	19CS2012	Artificial Intelligence for Biotechnology	3	0	0	3
7	20BT2008	Bio-analytical Techniques Lab	0	0	3	1.5
8	20BT2014	Fluid mechanics and Heat transfer Lab	0	0	3	1.5
		Professional Elective – 1	3	0	0	3
Total						**23**

Semester-5

S.No	Course Code	Course Title	Hours/Week			Credits
			L	T	P	
1	20BT2020	Bioprocess Engineering	3	0	0	3
2	20BT2017	Molecular Biology	3	0	0	3
3	20BT2068	Principles of Plant Biotechnology and Applications	3	0	0	3
4	20BT2025	Immunology	3	0	0	3
5		Professional Elective-2	3	0	0	3
6		Professional Elective-3	3	0	0	3
7	20BT2016	Bioprocess Lab	0	0	3	1.5
8	20BT2026	Cell Biology and Immunology Lab	0	0	3	1.5
9	20BT2059	IoT in Biotechnology	2	0	0	2
Total						**23**

Semester-6

S.No	Course Code	Course Title	Hours/Week			Credits
			L	T	P	
1	20BT2018	Genetic Engineering	3	0	0	3
2	20BT2057	Bioethics, IPR and Biosafety	3	0	0	3
3	20BT2021	Enzyme Engineering and Technology	3	0	0	3
4	20BT2069	Advances in Animal Biotechnology	3	0	0	3
5		Professional Elective-4	3	0	0	3
6		Open Elective-2	3	0	0	3
7		Open Elective-3	3	0	0	3
8	20BT2019	Molecular biology and Genetic Engineering Lab	0	0	3	1.5
9	20BT2052	Plant and Animal Tissue Culture Lab	0	0	4	2
Total						**24.5**

Semester-7

S.No	Course Code	Course Title	Hours/Week			Credits
			L	T	P	
1	20BT2023	Downstream processing	3	0	0	3
2	18MS2004	Total Quality Management	3	0	0	3
3		Professional Elective-5	3	0	0	3
4		Professional Elective-6	3	0	0	3
5	20BT2054	Environmental Biotechnology	3	0	0	3
6	20BT2030	Concepts of Bioinformatics	2	0	2	3
7	20BT2024	Downstream processing Lab	0	0	3	1.5
8	20MS2007	Business Plan	3	0	0	3
Total						**22.5**

Semester-8

S.No	Course Code	Course Title	Hours/Week			Credits
			L	T	P	
1	20BT2999 / 20BT2998	Full Semester Project / Half Semester Project	0	0	12 / 6	12 / 6
Total			**0**	**0**	**12**	**12 / 6**

M.Tech. (Biotechnology) 2020 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)
7	Online Courses	2*
	Total Credits	**68+2***

**The students shall earn 2 credits through online courses between 1st and 3rd semester (both inclusive)*

COURSE COMPONENTS
Table 1

PROFESSIONAL CORE COURSES

S. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	18MA3005	Foundations of Mathematics and Statistics	3	0	0	3
2	20BT3001	Advances in Biopolymer and Applications	3	0	0	3
3	20BT3002	Genetic Engineering and Recombinant Products	3	0	0	3
4	20BT3003	Bioprocess Modelling and Simulation	3	0	0	3
5	20BT3004	Lab – I Biochemical Analysis Lab	0	0	4	2
6	20BT3005	Lab – II Animal and Plant Tissue Culture Lab	0	0	4	2
7	20BT3006	Lab – III Advanced Process Equipment Design and Drawing Lab	0	0	4	2
8	20BT3007	Lab – IV Genetic Engineering 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	20BT3998	Project – Phase I	0	0	20	10
12	20BT3999	Project – Phase II	0	0	32	16
		Grand Total				**50**

Table 2

PROFESSIONAL ELECTIVE COURSES

S. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
Elective – I						
1	20BT3008	Enzyme Technology and Industrial Applications	3	0	0	3
2	20BT3009	Microbial Biotechnology	3	0	0	3
3	20BT3010	Agriculture and Food Biotechnology	3	0	0	3
4	20BT3011	Big Data Analytics	3	0	0	3
5	20BT3012	Bioethics and Biosafety	3	0	0	3
Elective – II						
1	20BT3013	Chemical Process Technology	3	0	0	3
2	20BT3014	Immunotechnology	3	0	0	3
3	20BT3015	Computational Biology	3	0	0	3
4	20BT3016	Metabolic Regulation and Engineering	3	0	0	3
5	20BT3017	Clinical trials and Bioethics	3	0	0	3
Elective – III						
1	20BT3018	Sustainable Bioprocess Development	3	0	0	3
2	20BT3019	Advanced Animal Biotechnology & Tissue Culture	3	0	0	3
3	20BT3020	Molecular Diagnostics	3	0	0	3
4	20BT3021	Drug Design and Discovery	3	0	0	3
5	20BT3022	Introductory AI in Biotechnology	3	0	0	3
Elective – IV						
1	20BT3023	Transport Phenomena	3	0	0	3
2	20BT3024	Pharmaceutical Biotechnology	3	0	0	3

3	20BT3025	Bioreactor Engineering	3	0	0	3
4	20BT3026	Stem Cell Therapeutics	3	0	0	3
5	20BT3027	Nanobiotechnology	3	0	0	3
Elective – V						
1	20BT3028	Advanced Plant Biotechnology	3	0	0	3
2	20BT3029	Cancer Management Techniques	3	0	0	3
3	20BT3030	Genomics and Proteomics	3	0	0	3
4	20BT3031	Advanced Environmental Biotechnology	3	0	0	3
5	20BT3032	Entrepreneurship and Management	3	0	0	3

Table 3
OPEN ELECTIVE COURSES

S. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	20BT3033	Industrial Waste Management	3	0	0	3
2	20BT3034	Industrial Safety	3	0	0	3

Table 4
AUDIT COURSE (MANDATORY COURSES) – 2 COURSE

S. No.	Course Code	Course Title	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

Table 5
Online Course (2 credits)

The students shall earn 2 credits through online courses between 1st and 3rd semester (both inclusive)

SEMESTER WISE CURRICULUM
SEMESTER I

S. No.	Course Code	Course Title	Hours/Week			Credits
			L	T	P	
1	18MA3005	Foundations of Mathematics and Statistics	3	0	0	3
2	20BT3001	Advances in Biopolymer and Applications	3	0	0	3
3		Elective I	3	0	0	3
4		Elective II	3	0	0	3
5	20BT3004	Lab - I Biochemical Analysis Lab	0	0	4	2
6	20BT3005	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 1	2	0	0	0
		Total	**16**	**0**	**8**	**18**

SEMESTER II

S. No.	Course Code	Course Title	Hours/Week			Credits
			L	T	P	
1	20BT3002	Genetic Engineering and Recombinant Products	3	0	0	3
2	20BT3003	Bioprocess Modelling and Simulation	3	0	0	3
3		Elective III	3	0	0	3
4		Elective IV	3	0	0	3
5	20BT3006	Lab - III Advanced Process Equipment Design and Drawing Lab	0	0	4	2
6	20BT3007	Lab – IV Genetic Engineering Lab	0	0	4	2
7	ITP3901/ MP3951	Industrial Training/ Mini Project	0	0	4	2
8		Audit course 2	2	0	0	0
		Total	**14**	**0**	**12**	**19**

SEMESTER III

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

SEMESTER IV

S. No.	Course Code	Course Title	Hours/Week			Credits
			L	T	P	
1	20BT3999	Project – Phase II	-	-	32	16
		Total	**-**	**-**	**32**	**16**

M.Sc. (Biotechnology) 2020 Batch
PROGRAMME STRUCTURE

S. No.	Category	Credits
1	Professional Core courses	35
2	Professional Elective courses	33
3	Online courses	2*
4	Industrial Training / Mini Project	4
5	Project	16
6	Audit courses	(non-credit)
	Total Credits	**90**

**The students will earn 2 credits through online courses between 1st and 3rd Semester (both inclusive)*

COURSE COMPONENTS

Table 1

PROFESSIONAL CORE COURSES

S. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	20BT3051	Biochemistry	3	0	0	3
2	20BT3052	Plant secondary metabolites and pharmaceutics	3	0	0	3
3	20BT3053	Molecular Biology and Cell Signaling	3	0	0	3

4	20BT3054	Microbiology and Molecular genetics	3	0	0	3
5	20BT3055	Animal Biotechnology and immunology	3	0	0	3
6	20BT3056	Research Methodology and Applied Statistics	2	0	0	2
7	20BT3057	Bioprocess and Downstream processing	3	0	0	3
8	20BT3058	Molecular Medicine and Diagnostics	3	0	0	3
9	20BT3004	Lab - I Biochemical Analysis Lab	0	0	4	2
10	20BT3005	Lab – II Animal and Plant Tissue Culture Lab	0	0	4	2
11	20BT3059	Lab- III Microbial Technology Lab	0	0	4	2
12	20BT3007	Lab-IV Genetic Engineering Lab	0	0	4	2
13	20BT3060	Lab- V Bioprocess and Downstream processing Lab	0	0	4	2
14	20BT3061	Lab-VI Immunological Techniques Lab	0	0	4	2
		Total				**35**
15	ITP3902	Industrial Training	0	0	2	1
16	MP3951	Mini Project	0	0	6	3
17	20BT3999	Project	0	0	32	16
		Grand Total				**55**

Table 2

PROFESSIONAL ELECTIVE COURSES

S. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	20BT3062	Industrial Biotechnology	3	0	0	3
2	20BT3063	Pharmaceutical Technology and clinical trial	2	0	2	3
3	20BT3064	Bioinformatics and Basics of R programming	2	0	2	3
4	20BT3065	NGS Data Analysis	3	0	0	3
5	20BT3022	Introductory AI in Biotechnology	3	0	0	3
6	20BT3030	Genomics and proteomics	3	0	0	3
7	20BT3032	Entrepreneurship and Management	3	0	0	3
8	20BT3066	Algae Biotechnology	2	0	2	3
9	20BT3067	Tissue Engineering and Stem Cell Technology	3	0	0	3
10	20BT3010	Agricultural and Food Biotechnology	3	0	0	3
11	20BT3027	Nanobiotechnology	3	0	0	3
12	20BT3031	Advanced Environmental Biotechnology	3	0	0	3
13	20BT3012	Bioethics and Biosafety	3	0	0	3
14	20BT3068	Metabolic Engineering for Industrial Production	3	0	0	3
15	20BT3069	Human anatomy, physiology and health education	3	0	0	3
16	20BT3070	Vaccine Technology	3	0	0	3

Table 3

AUDIT COURSE (MANDATORY COURSES)

S. No.	Course Code	Course Title	Hours per Week			Credits
			L	T	P	
1	18VE3001	Value Education	0	0	2	0

Table 4

Online Course (2 credits)
**The students will earn 2 credits through online courses between 1st and 3rd Semester (both inclusive)*

SEMESTER WISE CURRICULUM

SEMESTER I

S. No.	Course Type/ Code	Course Title	Hours/Week			Credits
			L	T	P	
1	20BT3051	Biochemistry	3	0	0	3
2	20BT3052	Plant secondary metabolites and pharmaceutics	3	0	0	3
3	20BT3053	Molecular Biology and Cell Signaling	3	0	0	3
4	20BT3054	Microbiology and Molecular genetics	3	0	0	3
5	20BT3055	Animal Biotechnology and immunology	3	0	0	3
6	20BT3056	Research Methodology and Applied Statistics	2	0	0	2
7	20BT3004	Lab - I Biochemical Analysis Lab	0	0	4	2
8	20BT3005	Lab – II Animal and Plant Tissue Culture Lab	0	0	4	2
9	20BT3059	Lab- III Microbial Technology Lab	0	0	4	2
10	MP3951	Mini Project	0	0	2	1
		Total	**19**	**0**	**12**	**24**

SEMESTER II

S. No.	Course Type/ Code	Course Title	Hours/Week			Credits
			L	T	P	
1	20BT3057	Bioprocess and Downstream processing	3	0	0	3
2		Elective –I	3	0	0	3
3		Elective –II	2	0	1	3
4		Elective –III	2	0	1	3
5		Elective –IV	3	0	0	3
6		Elective –V	3	0	0	3
7	20BT3007	Lab – IV Genetic Engineering Lab	0	0	4	2
8		Audit course	2	0	0	0
9	ITP3902	Industrial Training	0	0	2	1
10	MP3951	Mini Project	0	0	2	1
		Total	**18**	**0**	**8**	**22**

SEMESTER III

S. No.	Course type/code	Course Title	Hours/Week			Credits
			L	T	P	
1	20BT3058	Molecular Medicine and Diagnostics	3	0	0	3
2		Elective –VI	3	0	0	3
3		Elective –VII	3	0	0	3
4		Elective –VIII	3	0	0	3
5		Elective –IX	3	0	0	3
6		Elective –X	3	0	0	3
7		Elective –XI	3	0	0	3
8	20BT3060	Lab V-Bioprocess and Downstream processing Lab	0	0	4	2

9	20BT3061	Lab VI-Immunological Techniques Lab	0	0	4	2
10	MP3951	Mini Project	0	0	2	1
		Total	**18**	**0**	**18**	**26**

SEMESTER IV

S. No.	**Course code**	**Course Title**	**Hours/Week**			**Credits**
			L	T	P	
1	20BT3999	Project	-	-	32	16
		Total	**-**	**-**	**32**	**16**

LIST OF NEW COURSES

Sl.No	**Course Code**	**Course Title**	**Credits [L:T:P:C]**
1.	20BT1001	Engineering Design and Drawing Lab	0:0:2:1
2.	20BT1002	Basics of Python Programming	2:0:2:3
3.	20BT2001	Chemistry of Biomolecules	3:0:0:3
4.	20BT2002	Chemistry of Biomolecules Laboratory	0:0:2:1
5.	20BT2003	Cell Biology	3:0:0:3
6.	20BT2004	Workshop Practices in Biotechnology	0:0:2:1
7.	20BT2005	Basics of Industrial Biotechnology	3:0:0:3
8.	20BT2007	Bio-analytical Techniques	3:0:0:3
9.	20BT2008	Bio-analytical Techniques Lab	0:0:3:1.5
10.	20BT2009	Biochemistry	3:0:0:3
11.	20BT2010	Biochemistry Lab	0:0:3:1.5
12.	20BT2011	Microbiology	3:0:0:3
13.	20BT2012	Microbiology Lab	0:0:3:1.5
14.	20BT2013	Fluid Mechanics	3:1:0:4
15.	20BT2014	Fluid Mechanics and Heat transfer Lab	0:0:3:1.5
16.	20BT2015	Bioprocess Principles	3:0:0:3
17.	20BT2016	Bioprocess Lab	0:0:3:1.5
18.	20BT2017	Molecular Biology	3:0:0:3
19.	20BT2018	Genetic Engineering	3:0:0:3
20.	20BT2019	Molecular Biology and Genetic Engineering Lab	0:0:3:1.5
21.	20BT2020	Bioprocess Engineering	3:0:0:3
22.	20BT2021	Enzyme Engineering and Technology	3:0:0:3
23.	20BT2023	Downstream Processing	3:0:0:3
24.	20BT2024	Downstream Processing Lab	0:0:3:1.5
25.	20BT2025	Immunology	3:0:0:3
26.	20BT2026	Cell Biology and Immunology Lab	0:0:3:1.5
27.	20BT2029	Biochemical Thermodynamics	3:0:0:3
28.	20BT2030	Concepts of Bioinformatics	2:0:2:3
29.	20BT2052	Plant and Animal Tissue Culture Lab	0:0:4:2
30.	20BT2054	Environmental Biotechnology	3:0:0:3
31.	20BT2057	Bioethics, IPR and Biosafety	3:0:0:3
32.	20BT2059	IoT in Biotechnology	2:0:0:2

33.	20BT2068	Principles of Plant Biotechnology and Applications	3:0:0:3
34.	20BT2069	Advances in Animal Biotechnology	3:0:0:3
35.		**Professional Electives**	
36.	20BT2006	Bioprocess Calculations	3:0:0:3
37.	20BT2022	Heat and Mass Transfer	3:1:0:4
38.	20BT2027	Chemical Reaction Engineering	3:1:0:4
39.	20BT2028	Mass Transfer and Chemical Reaction Engineering Lab	0:0:3:1.5
40.	20BT2032	Industrial safety and Hazard analysis	3:0:0:3
41.	20BT2033	Environmental Pollution Control Engineering	3:0:0:3
42.	20BT2034	Process Equipment Design and Economics	3:0:0:3
43.	20BT2035	Process Dynamics and Control	3:0:0:3
44.	20BT2036	Mechanical Operations	3:0:0:3
45.	20BT2037	Mechanical Operations Lab	0:0:3:1.5
46.	20BT2038	Biochemical Engineering Lab	0:0:2:1
47.	20BT2039	Cancer Biology	3:0:0:3
48.	20BT2040	Clinical Database Management	3:0:0:3
49.	20BT2041	Clinical Database Management Lab	0:0:3:1.5
50.	20BT2042	Plant and Animal Biotechnology	3:0:0:3
51.	20BT2043	Stem Cell Technology	3:0:0:3
52.	20BT2044	Biopharmaceutical Technology	3:0:0:3
53.	20BT2045	Agricultural Biotechnology	3:0:0:3
54.	20BT2046	Metabolic Engineering.	3:0:0:3
55.	20BT2047	Research Methodology	3:0:0:3
56.	20BT2048	Molecular Forensics	3:0:0:3
57.	20BT2049	Protein Engineering	3:0:0:3
58.	20BT2050	Plant Tissue Culture	3:0:0:3
59.	20BT2051	Animal Biotechnology and Cell Culture	3:0:0:3
60.	20BT2053	Biomass and Bioenergy	3:0:0:3
61.	20BT2055	Matlab Programming	3:0:0:3
62.	20BT2056	Entrepreneurship for Bioengineers	3:0:0:3
63.	20BT2058	Tissue Engineering	3:0:0:3
64.	20BT2060	Developmental Biology	3:0:0:3
65.		**Open electives**	
66.	20BT2061	Biology for Engineers	3:0:0:3
67.	20BT2062	Role of Biotechnology in Environment	3:0:0:3
68.	20BT2063	Fundamentals of Biochemistry	3:0:0:3
69.	20BT2064	Pathology and Microbiology	3:0:0:3
70.	20BT2065	Human Anatomy and Physiology	3:0:0:3
71.	20BT2066	Cell Biology and Immunology	3:0:0:3
72.	20BT2067	Molecular Biology for Biomedical Engineers	3:0:0:3
73.		**M.Tech.Biotechnology**	
74.	20BT3001	Advances in Biopolymer and Applications	3:0:0:3
75.	20BT3002	Genetic Engineering and Recombinant Products	3:0:0:3
76.	20BT3003	Bioprocess Modelling and Simulation	3:0:0:3
77.	20BT3004	Biochemical Analysis Lab	0:0:4:2

78.	20BT3005	Animal and Plant Tissue Culture Lab	0:0:4:2
79.	20BT3006	Advanced Process Equipment Design and Drawing Lab	0:0:4:2
80.	20BT3007	Genetic Engineering Lab	0:0:4:2
81.		**Professional Electives**	
82.	20BT3008	Enzyme Technology and Industrial Applications	3:0:0:3
83.	20BT3009	Microbial Biotechnology	3:0:0:3
84.	20BT3010	Agriculture and Food Biotechnology	3:0:0:3
85.	20BT3011	Big Data Analytics	3:0:0:3
86.	20BT3012	Bioethics and Biosafety	3:0:0:3
87.	20BT3013	Chemical Process Technology	3:0:0:3
88.	20BT3014	Immunotechnology	3:0:0:3
89.	20BT3015	Computational Biology	3:0:0:3
90.	20BT3016	Metabolic Regulation and Engineering	3:0:0:3
91.	20BT3017	Clinical trials and Bioethics	3:0:0:3
92.	20BT3018	Sustainable Bioprocess Development	3:0:0:3
93.	20BT3019	Advanced Animal Biotechnology & Tissue Culture	3:0:0:3
94.	20BT3020	Molecular Diagnostics	3:0:0:3
95.	20BT3021	Drug Design and Discovery	3:0:0:3
96.	20BT3022	Introductory AI in Biotechnology	3:0:0:3
97.	20BT3023	Transport Phenomena	3:0:0:3
98.	20BT3024	Pharmaceutical Biotechnology	3:0:0:3
99.	20BT3025	Bioreactor Engineering	3:0:0:3
100.	20BT3026	Stem Cell Therapeutics	3:0:0:3
101.	20BT3027	Nanobiotechnology	3:0:0:3
102.	20BT3028	Advanced Plant Biotechnology	3:0:0:3
103.	20BT3029	Cancer Management Techniques	3:0:0:3
104.	20BT3030	Genomics and Proteomics	3:0:0:3
105.	20BT3031	Advanced Environmental Biotechnology	3:0:0:3
106.	20BT3032	Entrepreneurship and Management	3:0:0:3
107.		**Other Electives**	
108.	20BT3033	Industrial Waste Management	3:0:0:3
109.	20BT3034	Industrial Safety	3:0:0:3
110.		**M.Sc. Biotechnology**	
111.	20BT3051	Biochemistry	3:0:0:3
112.	20BT3052	Plant secondary metabolites and pharmaceutics	3:0:0:3
113.	20BT3053	Molecular Biology and Cell Signaling	3:0:0:3
114.	20BT3054	Microbiology and Molecular genetics	3:0:0:3
115.	20BT3055	Animal Biotechnology and immunology	3:0:0:3
116.	20BT3056	Research Methodology and Applied Statistics	2:0:0:2
117.	20BT3057	Bioprocess and Downstream processing	3:0:0:3
118.	20BT3058	Molecular Medicine and Diagnostics	3:0:0:3
119.	20BT3059	Lab- III Microbial Technology Lab	0:0:4:2
120.	20BT3060	Lab- V Bioprocess and Downstream processing Lab	0:0:4:2
121.	20BT3061	Lab-VI Immunological Techniques Lab	0:0:4:2
122.		**Professional Electives**	

123.	20BT3062	Industrial Biotechnology	3:0:0:3
124.	20BT3063	Pharmaceutical Technology and clinical trial	2:0:2:3
125.	20BT3064	Bioinformatics and Basics of R programming	2:0:2:3
126.	20BT3065	NGS Data Analysis	3:0:0:3
127.	20BT3066	Algae Biotechnology	2:0:2:3
128.	20BT3067	Tissue Engineering and Stem Cell Technology	3:0:0:3
129.	20BT3068	Metabolic Engineering for Industrial Production	3:0:0:3
130.	20BT3069	Human anatomy, physiology and health education	3:0:0:3
131.	20BT3070	Vaccine Technology	3:0:0:3

20BT1001	**ENGINEERING DESIGN AND DRAWING LAB**	**L**	**T**	**P**	**C**
		0	**0**	**2**	**1**

Course Objectives:

1. To learn engineering design and its place in society
2. To get exposure to the visual aspects of engineering design and graphicsstandards
3. To design plant layout using AutoCAD

Course Outcome:

The student will be able to

1. Remember the unit operation symbol, letters and plant layout
2. Understand a system, component, or process to meet desired needs within realistic constraints and sustainability.
3. Apply techniques, skills, and engineering design tools necessary for engineering practice
4. Optimize material required in fabrication of parts.
5. Analyze assembly of system with fewer parts.
6. Create drawings on plant layout in biochemical industries

List of Experiments:

1. User interface
2. Customization and drawing aids, page setup and printing
3. Engineering Letters
4. Lines and numbering
5. Drawing polylines, ellipses, polygons
6. Basics of various unit operation symbols
7. Plant layout of a biotechnology Industry
8. Plant layout of a biochemical Industry
9. Text fonts, formatting text and setting title box for drawing template.
10. Design of a Batch reactor
11. Design of a Airlift Fermenter
12. Demonstration of a simple team design project

Reference Books:

1. Ganesan G., "Basic Computer Aided Design and Drafting using AutoCAD 2015", McGraw Hill, 2018.
2. Sham Tickoo, "AutoCAD 2015 for Engineers and Designers", Dream Tech Press, 2014.
3. Elliot Gidis, "Up and Running with AutoCAD 2015", 2D and 3D Drawing and Modeling. Academic Press,2014
4. Gary R. Bertoline and Eric n. Wiebe, "Fundamentals of Graphics Communication", McGraw Hill, 2002.
5. Mccabe, W. L.,Smith, J. C., and Harriott,P., "Unit Operations of Chemical Engineering", McGraw Hill,NewYork,6thEdition,2004

20BT1002	BASICS OF PYTHON PROGRAMMING	L	T	P	C
		2	0	2	3

Course Objectives:

To impart knowledge on

1. Fundamental programming constructs such as variables, arrays, loops, subroutines and input/output in Python.
2. Concepts of modules in Python and Biopython.
3. Utilization of Biopython packages in big data analytics

Course Outcomes:

The students will be able to

1. Understand, write, compile, and run Python programs.
2. Analyze Python structures that implement decisions, loops, and store arrays and use these structures in a well designed, OOP program.
3. Create Python programs that make use of various modules and packages
4. Understand regular expressions and extract required information from file and databases.
5. Relate and arrange information from multiple files
6. Apply the principles of object-oriented programming and well-documented programs in the Python language, including use of the Bio-python packages in big data analytics

Module 1: Install and run Python program (8 Hours)

System command lines and files, module imports and reloads. The IDLE user interface, Numeric type's basis, Numbers in action, Comparison, Decimal and Fraction type, Sets, Booleans

Module 2: Strings (8 Hours)

String literals, Strings in action, String methods, the original string module, String formatting expressions

Module 3: Lists and files (8 Hours)

Lists, Lists in action, basic operations, comprehensions, indexing, slicing, matrixes

Module 4: Tuples (6 Hours)

Tuples in action, compare list and tuples, files and examples.

Module 5: Control statement in python (8 Hours)

If statement, Python syntax rules, truth test, while loop, break, continue, pass, for loops, loop coding techniques, examples.

Module 6: Modules and package (7 Hours)

Module creation, module usage, package import basics and examples, Bio-python.

Lists of Experiments:

1. Demonstrate the working of 'id' and 'type' functions.
2. Write a Python program to find all prime numbers within a given range
3. Write a Python program to print 'n terms of Fibonacci series using iteration
4. Write a Python program demonstrate use of slicing in string.
5. Write a Python program to compute the frequency of the words from the input.
6. Write a Python program that accepts a comma separated sequence of words as input and prints the words in a comma-separated sequence after sorting them alphabetically.
7. Write a Python program to get a string from a given string where all occurrences of its first char have been changed to '$', except the first char itself
8. Write a Python program to demonstrate use of list & related
9. Write a Python program to demonstrate use tuple, set & related
10. Biopython packages uses in big data analytics

Text Book:

1. Alex Martelli and David Ascher, "Python cookbook", O'Reilly,USA, 2ndEdition 2002.
2. Randal L. Schwartz, brian d foy, Tom Phoenix, "Learning Perl" O'Reilly Media, Inc., 2016

3. Mark Lutz, “Learning Python” "O'Reilly Media, Inc.", 2013

Reference Book:

1. Jason Kinser, “Python for bioinformatics” Jones and Bartlett Publishers,UK,1st edition, 2009
2. Martin Jones, “Python for Biologists: A programming course of complete beginners” Copyright © 2013

20BT2001	CHEMISTRY OF BIOMOLECULES	L 3	T 0	P 0	C 3

Course Objectives:

1. To gain knowledge on structure, composition, bonding and function of various biomolecules.
2. To illustrate the basic nature and properties of biomolecules which are involved in the metabolic pathways
3. To articulate the significance of these biomolecules and to apply these fundamentals in biotechnology

Course Outcomes:

The students will be able to

1. Recall the chemical bonding and properties of biomolecules
2. Understand the biochemistry at the atomic level, and to draw the basic structures of biomolecules.
3. Recognize the significance of biomolecules in the proper functioning of living cells
4. Illustrate the structure and functions of conjugated biomolecules – proteoglycans, glycoproteins and glycolipids.
5. Discuss the applications of biomolecules in biotechnology industries
6. Analyze the clinical and biological significance of biomolecules

Module 1: Chemical bonding (5 hrs)

Matter and its nature, Dalton’s atomic theory, concept of atom, molecule, element and compound. Principles of Chemical Bonding, Water- chemical properties, function as medium of cellular reactions and activities. Acids and Bases, Buffer systems of the blood, Buffering against pH changes in Biological Systems.

Module 2: Carbohydrates (8 hrs)

Classification, structure, properties and functions of carbohydrates: Monosaccharides –classes, examples, Disaccharides – classes- homo and hetero, examples. Oligosaccharides-examples; Polysaccharide – classes, examples; complex and conjugated carbohydrates- proteoglycan, glycoprotein, glycolipid. Industrial and clinical significance of carbohydrates- a review

Module 3: Lipids and fatty acids (8 hrs)

Fatty acids- basic structure, types, properties, functions and essential fatty acids; ketone bodies, Classes, structure, properties and functions of lipids: Simple lipid- examples, Compound lipid- examples, ether lipid, Derived lipid – cholesterol. Review on industrial and clinical significance of fatty acids and lipids.

Module 4: Amino acids and Proteins (8 hrs)

Amino acids- basic structure, classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides. Review on industrial and clinical significance of amino acids, peptides and proteins.

Module 5: Nucleic acids (8 hrs)

Nucleotides- composition, structure, properties and functions; Nucleic acids- types (RNA, DNA), DNA structure-composition, RNA types, structure and functions, properties of nucleic acids

Module 6: Significance of Vitamins, Minerals and Nutraceuticals (8 hrs)

Classification of Vitamins; biological functions of Vitamins – roles in metabolism and regulatory pathways, anti-oxidant roles; clinical symptoms of Vitamin deficiency;Biological significance of minerals; Vitamin and mineral supplementations-nutraceuticals.

Text Books

1. Lehninger, A.L, Nelson D.L and Cox, M.M, “Principles of Biochemistry”, Freeman Publishers, New York, 7th edition, 2017.

2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 2008.

References Books

1. Lubert Stryer, "Biochemistry", WH Freeman & Co., 4th edition, 2000.
2. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.
3. Jain and Jain "Biochemistry", Chand publication, 4th edition, 2008.

20BT2002	CHEMISTRY OF BIOMOLECULES LAB	L	T	P	C
		0	0	2	1

Course Objectives:

1. To understand the basic units and measurements of biochemical solutions
2. To acquaint students with the concepts in biochemical analysis
3. To articulate the skills of quantifying the 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 the various tests and identify the different carbohydrate, amino acid and lipid molecules present in the given sample solution.
5. Explain the suitable extraction methods for the estimation of different biomolecules.
6. Evaluate the level of biomolecules in different food materials

List of Experiments:

1. Study of biochemical solutions, units and measurements
2. Preparation of buffers
3. Qualitative analysis of carbohydrates
4. Tests for lipids: - Fats and cholesterol
5. Qualitative analysis of amino acids
6. Tests for phytochemicals
7. Dry ashing of food materials and colorimetric estimation of phosphorus
8. Estimation of ascorbic acid content in foods
9. Analysis of nucleic acid by spectrophotometer
10. Estimation of beta carotene in carrot
11. Titration of amino acid
12. Analysis of clinical samples- Blood sugar

Reference Book:

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

20BT2003	CELL BIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To acquaint students with the concepts in Cell Biology.
2. To appraise on cellular processes and regulation
3. To familiarize the recent trends in cell and molecular research

Course Outcome:

1. Exhibit a knowledge base in cell structure, organelles and their functions
2. Outline the process that control cell cycle, and cell death
3. Relate how cell movement and cell to cell communication occur and discuss mechanisms of signal transduction
4. Link the rapid advances in cell and molecular biology to a better understanding of diseases including cancer

5. Evaluate and apply knowledge of recent techniques in cellular biology
6. Crtique and professionally present literature articles in cell and molecular biology

Module 1: Cell and Molecular Organization of Cell Membrane (8)

Brief overview of cell and cell organelles, Membrane organization of cell membrane-Functions and Models, Components of membrane - lipids and protein, Fluid and Dynamic membrane, Diffusion across membranes

Module 2: Membrane Transport (8)

Facilitated diffusion and active transport, Voltage gated channels and transmission of action potential in neurons. Endomembrane systems - Protein synthesis, targeting and trafficking, Glycosylation, Quality control and vesicular transport. Endocytosis and Exocytosis, Entry of virus and toxins into the cells.

Module 3: Cell Mobility (7)

Cytoskeleton and Microtubule based movement, Intracellular transport, Motile appendages, Microfilament based movement, Actin filament based movement – Sliding filament theory and Actin myosin interactions in muscular contractions.

Module 4: Cellular Communications (10)

Modes of signal transmission, ECM, Cell-ECM interactions, ECM and cancer metastasis, Cell-cell interactions, Cell signaling and signal transduction - Signaling molecules, Cytosolic, nuclear and membrane bound receptors. G-protein coupled receptor - Role of cyclic AMP, cyclic GMP and Inositol triphosphate (IP3) in signal transduction, Enzyme linked receptors -Receptor Tyrosine kinases andTGFβ signaling.

Module 5: Cell Cycle and Cancer (6)

Cell cycle and molecules that control cell cycle, Regulation of cell cycle. Cell aging and apoptosis, Properties of cancer cells, Transformation of cells in culture.

Module 6: Current Trends in Cell Biology (6)

Stem cells and progress in stem cell therapy. Cell imaging techniques: Fluorescence microscopy and Confocal microscopy, FACS. Breakthrough in cell biology – review on the research of Nobel prize winners 2015-2019

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.

20BT2004	WORKSHOP PRACTICES IN BIOTECHNOLOGY	L	T	P	C
		0	0	2	1

Course Objectives:

1. To impart knowledge ongood 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

20BT2005	BASICS OF INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To ensure students have a base on the History of Biotechnology and its source of origin and the analysis on the different kinds of microorganisms which could be deployed for industrial biotechnology.
2. To facilitate knowledge for the various production strategies of bio products employed for sustainable bioprocess development
3. To ensure the need to know various production strategies of bio products employed for better sustainable bioprocessdevelopment on an industrial scale.

Course Outcome:

At the end of the course students will be able to

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. Analyze 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)

Historical overview of industrial bioprocess: Fermentation – Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology – A brief survey of organisms, reactors, processes, products, media- design of experiment. Basic concepts of upstream and downstream processing, process flow sheeting – block diagrams, pictorial representation and the future perspectives in Industrial Biotechnology.

Module 2: Production of Primary Metabolites (9)

Primary metabolites; Industrial production of commercially important organic acids, amino acids, alcohols and Vitamins.

Module 3: Production of Secondary Metabolites (9)

The production of secondary metabolites of high commercial value like antibiotics and steroids: Penicillin V, Streptomycin and Ampicillin sodium salt and steroids.

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

Production of industrial enzymes such as lipases, cellulase, lysozyme, bio preservatives (Nisin), cheese, biopolymers (xanthan gum, PHB), bio-flavours and bio-pigments-luciferin, carotene,antioxidant – glutathione.

Module 5: Production of Modern Biotechnological Products (5)

Production of recombinant fine bio products for pharmaceutical applications like monoclonal antibodies and vaccines. Products from plant and animal cells.

Module 6: Production of Target Specific Fine Bioproducts: (4)

Production of Single Cell Proteins; Bio-fertilizers, Plant Products of Industrial Importance-Synthetic Seeds, Arbutin. Animal Products of Industrial importance-Gelatin, spray dried yolk powder. Bioremediation and Bioenergy-fuel from biomass, biogas, bio-refineries, Microbial Enhanced Oil Recovery (MEOR).

Text Books

1. Prescott and Dunn, Industrial Biotechnology, Agro bios (India), 2005.
2. A.H.Patel, Industrial Microbiology, 2nd Edition, 2011.
3. 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.
4. Poonam Kushwaha, Handbook of Pharmaceutical Technology, Jaypee Digital, 2015.

20BT2006	BIOPROCESS CALCULATIONS	L	T	P	C
		3	0	0	3

Course Objective:

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

Course Outcome:

The students will be able to

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)

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

Module 2:Stoichiometry (9)

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)

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)

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

Module 5:Energy Balance (5)

Basic Energy Concepts, types of Energy, Internal energy, Enthalpy, General Energy-Balance Equations, Heat Transfer, Heat transfer equipment.

Module 6:Material Balance Involving Recycle (3)

Flow sheet, Bypass, Recycle,Purge, closed and open system.

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

20BT2007	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 concepts of calibration and testing
2. Illustrate the different methods of analytical techniques for quantitative analysis
3. Explain importance of centrifugation and chromatography as analytical techniques
4. Demonstrate the gel electrophoresis and thermal analytical techniques
5. Analyze the methods of structural elucidation of different compounds
6. Illustrate importance of radioactive isotopes in modern research

Module 1:Basics of Bio-Analytical Techniques (9)

Classification of instrumental methods; Concepts of accuracy, precision and limits of detection (LOD); Types of errors–random and systematic; Calibration of instrumental methods comparison with standards, Buffers, pH – pH meter and applications, Extraction techniques–Principle of solid extraction (Soxhlet)

Module 2:Spectroscopy Techniques (9)

Basic principle of Spectroscopy -Beer-Lambert's law, Principle, Instrumentation and applications of colorimeter, Fluorimeter, Flame photometer, Nephelometer, Conductivity meter, spectrofluorometric and Spectrophotometer: types– UV – visible – NIR spectroscopy, Raman spectroscopy.

Module 3:Analytical Centrifugation (6)

Basic principle of centrifugation- centrifugal force, sedimentation coefficient, Svedberg units (S), Instrumentation for centrifugation- ultracentrifuges. Application of centrifugation, analytical and preparative centrifugation, Comparison of differential, zonal and isopycnic centrifugation methods, Safety and rules of operation.

Module 4:Chromatography Techniques (9)

Principle, types and applications of analytical chromatography- Thin layer, Normal phase chromatography, reversed phase chromatography, Ion exchange chromatography, gel permeation chromatography, Chiral chromatography, Bioaffinity chromatography, hydrophobic interaction chromatography, Chromatogram analysis for quantitation GC and HPLC.

Module 5:Electrophoresis &Thermal Analytical Techniques (7)

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

Module 6:Structural Elucidation and Radioisotope Methods (5)

Mass spectrometry–principle, instrumentation (electron spray ionization [ESI] & chemical ionization [CI]) and applications; nuclear magnetic resonance (NMR) –principle, instrumentation and applications, Radioactive isotopes, GM counter, Scintillation counter, Applications in Medicine & Diagnosis.

Text Books:

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

20BT2008	BIO ANALYTICAL TECHNIQUES LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

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

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

List of Experiments

1. Verification of Beers Law and Construction of Beers Law plot
2. Determination of analytical wavelength for given sample
3. Calculation of LOD and LOQ of an analytical technique
4. Estimation of Polyphenol by Colorimetric method
5. Preparation of buffer solution with Henderson-Hasselbach equation and its verification with pH meter
6. Titration curves of Acetic acid and Citric Acid using pH meter
7. Determination of protein molecular weight by SDS-PAGE
8. Identification of amino acids by ascending paper chromatography
9. Determination of turbidity by nephelometry
10. Conductivity measurement in titration
11. Separation of secondary metabolites by Silica gel column chromatography and quantification using spectrophotometer
12. Extraction of secondary metabolites from plant samples using Soxhlet apparatus and quantification using spectrophotometer

References:

1. R. Mahesh, Sajeev C, N. Sridhar, Laboratory manual on "Instrumental Methods of Analysis" – EDD Notes. 4 thEdition. 2003.
2. B. K. Sharma. "Instrumental Methods of Chemical Analysis", 27th Edition. Goel Publishing House, Meerut. 2011

20BT2009	BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To facilitate strong knowledge on metabolic pathways and their regulations
2. To articulate the importance of bioenergetics
3. To gain knowledge on the various inborn errors of metabolism.

Course Outcomes:

The students will be able to

1. Acquire knowledge on the metabolic pathways
2. Summarize the biosynthesis and degradation pathways of amino acids
3. Explain the importance of bioenergetics and energy rich compounds.
4. Understand the metabolic reactions of nucleotides
5. Learn the various inborn errors of metabolism
6. Analyze the anabolic and catabolic reactions of lipids

Module 1: Carbohydrate metabolism (8 hrs)

Introduction to metabolism and bio-catalysis, Glycolysis, TCA cycle Pentose phosphate pathway, Glycogenesis and Glycogenolysis; Glycogen storage diseases; Photosynthesis – C3,C4 and CAM.

Module 2: Amino acid metabolism (8 hrs)

Transamination and urea cycle. Biodegradation of selected amino acids- Ala, Thr, Leu, Ile, Tyr, Phe, Trp. Biosynthesis of amino acids- tyrosine. phenylalanine and tryptophan and inborn errors of amino acid metabolism.

Module 3: Fatty acid metabolism (8 hrs)

Biosynthesis and oxidation of fatty acids, ketogenesis, energetics of Beta oxidation, cholesterol biosynthesis and degradation, inborn errors of lipid metabolism

Module 4: Nucleic acid metabolism (8 hrs)

Anabolism of purines and pyrimidines, catabolism of purines and pyrimidines, regulatory pathways, inborn errors of purine and pyrimidine metabolism

Module 5: Bioenergetics (5 hrs)

Definition, redox biochemistry. Energy rich compounds. Respiratory chain and Oxidative phosphorylation.

Module 6: Integration of metabolic pathways and regulation (8 hrs)

Overview of integrated metabolic pathways – primary and secondary metabolites; Coordinated Regulation of Glycolysis and Gluconeogenesis, The Metabolism of Glycogen, Coordinated Regulation of Glycogen Synthesis and degradation.

Text Book:

1. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 4th edition, 2008.

Reference Books

1. Lehninger, David L. Nelson & Michael M. Cox, "Principles of Biochemistry", Freeman Publishers,7th edition, 2017.
2. Lubert Stryer, "Biochemistry", WH Freeman & Co., 4th edition, 2000.
3. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.

20BT2010	BIOCHEMISTRY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To acquire knowledge on the various biochemical analysis
2. To facilitate for understanding the skills of the students in Qualitative and Quantitative Analysis of biomolecules.
3. To articulate the various estimation techniques

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. Analyse the various tests and identify the different carbohydrate, amino acid and lipid, DNA, RNA, enzymes and antioxidant 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. Estimation of total carbohydrate by Anthrone method
2. Estimation of reducing sugars by Di Nitro Salicylic acid method
3. Estimation of cholesterol by Zak's method
4. Estimation of protein by Lowry's/ Bradford's method
5. Enzyme assay – Alkaline phosphatase
6. Enzyme assay - Amylase
7. Estimation of amino acid by Ninhydrin method
8. Estimation of DNA by diphenylamine method
9. Estimation of RNA by orcinol method
10. Antioxidant assay
11. Estimation of starch
12. TLC separation of phytochemicals

Reference Book:

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

20BT2011	MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

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

Course Outcome:

The students will be able to;

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: History and Classification (9)

Historical perspectives of microbiology, Classification-systemic and numerical classification, 16Sr RNA classification, 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 and spore staining.

Module 2: Microbial Structure and Multiplication (7)
Cell Morphology and Structure of Prokaryotes-bacterial cell wall, Multiplication of bacteria, Life cycles-viruses (bacteriophage), algae (Chamydomonas), protozoa (Plasmodicum vivax), fungi (Rhizopus stolonifer), yeast (Neurospora crassa) and actinomycetes, Lichen symbiosis.

Module 3: Microbial Nutrition, Growth and Control (7)
Nutritional requirements of microorganisms, factors affecting the growth of microorganisms, Bacterial Growth- Growth curve pattern, measuring the bacterial growth, Growth kinetics, mathematical nature and expression of growth, concept of geometric & arithmetic nature of growth, asynchronous and synchronous cultures, diauxic growth-

Module 4: Control of Microorganisms (6)
Prevention of bacterial growth- Physical and chemical control of organisms, Antibiotics- antibacterial agents, anti-fungal agents and anti-viral agents, Antibiotic susceptibility test. -

Module 5: Medical Microbiology (8)
Normal flora of human healthy host, Common diseases caused by microbes: Bacterial diseases: Typhoid, Diphtheria, Cholera, Tuberculosis, Leprosy, Plague, Syphilis, Gonorrhea; Viral diseases: Herpes, Polio, Hepatitis, AIDS, Rabies, SARS, H1N1, Ebola and Covid-19; Protozoan diseases: Malaria: common types of fungal infections-Candidiasis.

Module 6: Soil, Environmental and Food Microbiology (8)
Soil microflora and biogeochemical cycles, Bio fertilizers: VAM and Rhizobium, Aerosols, fresh water microflora, Microbiology of potable water, purification and sewage disposal, Significance of microbes in food- Probiotics and fermented products-sauerkraut, cheese.

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.

20BT2012	MICROBIOLOGY LAB	L	T	P	C
		0	0	3	1.5

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. Lab safety method and Regulations, Sterilization techniques- Autoclave, Hot air oven, Filter sterilization

2. Media preparation- Nutrient broth, Nutrient agar, slants, soft agar
3. Culturing of microorganisms– in broth and in plates (pour plates, streak plates)
4. Staining Techniques (Simple, Gram staining and negative staining)
5. Exposing the Sabouraud's agar plate in different location -Fungal identification by LPCD mount
6. Motility test by Hanging drop method
7. Antibiotic sensitivity assay – Disc and Well diffusion method
8. Effect of Disinfectants- Phenol Coefficient
9. Enumeration of micro-organisms- Serial dilution plating
10. Biochemical test -Gram negative –Indole test, Methyl red test, Voges Proskauer test, Citrate test, Triple sugar iron test
11. Biochemical test -Gram positive – Catalase test, Coagulase test, Starch hydrolysis test
12. Growth Curve in Bacteria and preservation of bacterial culture

Reference Books:

1. James G. Cappuccino, Microbiology: A Laboratory Manual, 5th Edition, Benjamin Science Publishing, 2009.
2. Amita Jain, Jyotsna Agarwal and Vimala Venkatesh, Microbiology Practical Manual, First Edition, Elsevier, 2018

20BT2013	FLUID MECHANICS	L	T	P	C
		3	1	0	4

Course Objective:

1. To develop skills of students related to the fundamental calculations involved to measure the properties of fluids, measurement of fluid flow
2. To ensure students to have a strong knowledge related to types of fluids, instrument used in fluid flow mechanism
3. To make student understand the fluid flow processes involved in different sections in industrial operations

Course Outcomes

The students will be able to

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 to understand fluid flow phenomena

Module 1: Properties of Fluid (12)

Fluid definition- compressible, in compressible fluids, fluid properties – Density, specific weight, specific volume, Specific gravity, Viscosity, Newtonian and Non-Newtonian fluids**,** Types of fluids, Surface Tension and Capillarity, Hydrostatic Equilibrium, Hydrostatic Equilibrium in a centrifugal field-application in centrifugation mechanism

Module 2: Fluid pressure at a ppoint and nature of fluid flow (12)

Different types of pressure – Absolute Pressure, Gauge Pressure, Vacuum Pressure, Measurement of Pressure, Instruments used for measurement of pressure- Manometers-Piezometer, U-tube Manometer, Single Column Manometer, Differential Manometer, turbulence, boundary layer, Differential analysis of fluid motion – continuity, Fluid flow phenomena- laminar flow-application in determination of fluid flow pattern in reactor system

Module 3: Dynamics of Fluid Flow (12)

Equation of motions, Reynold's equation of motion, Navier –Stokes Equitation, Euler's equation of motion, Bernoulli's equation from Euler's Equation, Bernoulli's equation for real fluid, Practical

application of Bernoulli's Equation- Venturimeter, Orifice meter, Pitot tube, Classifications of Orifices, Hydraulic Coefficients and relationship between them , application in determination fluid flow rate in pipe line

Module 4: Flow through pipes (8)

Loss of energy in Pipes, Loss of energy due to friction, Chezy's Formula for loss of head due to friction, Minor Energy (Head) Losses – Losses of head due to sudden Enlargement, Losses of Head due to sudden Contraction, Loss of head due to different obstruction like bend in pipe, pipe fittings, Velocity measurement techniques; pipes, fittings, Types, characteristics and sizing of valves- application how to regulate valve to control fluid flow rate

Module 5: Agitation and Mixing of Liquids (8)

Agitated vessels, Blending and mixing, Agitator selection and scale up, application in reactor designing

Module 6: Dimensional Analysis and Similitude (8)

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 (example : reactor)

Text Books

1. Bansal, RK," Fluid Mechanics and Hydraulic Machines", Revised 9th Edition, Laxmi Publications, 2015
2. Munson, B. R., Young, D.F., Okiishi, T.H. "Fundamentals of Fluid Mechanics", 5th Edition", John Wiley, 2006
3. Noel de Nevers, "Fluid Mechanics for Chemical Engineers ", Second Edition, McGrawHill, (1991).

References

1. White, F.M., "Fluid Mechanics ", IV Edition, McGraw-Hill Inc., 1999
2. James O Wilkes and Stacy G Bike, "Fluid Mechanics for Chemical Engineers' Prentice Hall PTR (International series in Chemical Engineering) (1999)
3. McCabe W.L, Smith, J C and Harriot. P "Unit operations in Chemical Engineering", McGraw Hill, VII Edition, 2005

20BT2014	FLUID MECHANICS & HEAT TRANSFER LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

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

Course Outcome:

The students will be able to

1. Understand the heat transfer concept and its applications.
2. 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. Estimation of Coefficient of Discharge of Venturimeter
3. Calculation of Darcy's Friction Factor
4. Determination of Friction Factor Losses Coefficient in Helical Pipe

5. Estimation of Friction Factor in Annular Pipe
6. Determinations of Minor Losses in Pipes Due to Sudden Contraction
7. Calculation of Coefficient of Discharge of Orifice Meter
8. Estimation of Coefficient of Discharge of Rotameter
9. Estimation of Thermal Conductivity of Composite Wall
10. Determine the overall heat transfer coefficient in Double pipe Heat Exchanger (Parallel and Counter Flow)
11. Evaluate the overall heat transfer coefficient in Shell and Tube Heat Exchanger
12. Flow measurement using pitot tube

Reference Books:

1. McCabe W, Smith J and Harriot P "Unit operations in Chemical Engineering", McGrawHill,VII Edition, 2005

20BT2015	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:

The students will be able to

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 parameters to control during fermentation process
6. Evaluate the process of sterlization by filtration

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: Parameters to be Monitored and Controlled in Fermentation Processes (6 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 3: Medium Formulation and Optimization (12 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

Module 4: Sterilization Kinetics (9 hrs)

Thermal death kinetics of microorganisms, Death kinetics problems, Design of sterilization time- batch and continuous heat sterilization of liquid media, design of sterilization equipment - batch and continuous.

Module 5: Filter Sterilization of Air and Media (6 hrs)

Filter sterilization of liquid media, air sterilization and design of depth filters and problems

Module 6: Selection of Seed Culture for Industrial Fermentation (6 hrs)

Screening and selection of industrially important microbes- primary screening- Crowded plate technique, Auxonography, enrichment culture and indicator dye, screening based on desired characteristics, preservation and storage of industrially important microbes, Quality control of preserved stock cultures.

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

20BT2016	BIOPROCESS LAB	L	T	P	C
		0	0	3	1.5

Co-requisite: 20BT2012- 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:

The students will be able to

1. Acquire knowledge in the process of fermentation.
2. Demonstrate enzyme assay qualitatively and quantitatively
3. Examine specificity of enzyme activity.
4. Apply methods to estimate mass transfer coefficient
5. Utilize solid state fermentation for production of fermented products
6. Assess the growth kinetics of microbes.

List of Experiments:

1. Inoculation and culturing of Different Types of Microorganism in broth
2. Estimation of Biomass Production by wet weight and dry weight method
3. Comparative study between Free & Immobilized Enzyme
4. Determine the substrate dependent enzyme specificity using α-Amylase
5. Estimation of volumetric mass transfer coefficient using sulphite oxidation method.
6. Study of thermal death kinetics
7. Plackett Burmann method
8. Citric acid production by Solid State Fermentation
9. Qualitative Enzyme Assay- Starch Plate Technique
10. Quantitative Enzyme Assay
11. Production of Wine
12. Growth kinetics of Baker's Yeast

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, 2014.
2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2016.

20BT2017	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 impart an overview on the regulation of gene expression

Course Outcomes:

The students will be able to

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 and RNA, Forms of DNA and RNA; 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, Regulation at transcription and Translation

Review on loss of regulation and defect in DNA repair system leading to genetic disorders and diseases.

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.

20BT2018	GENETIC ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

1. Acquaint students with the concepts in Genetic engineering.
2. Develop technical skills about different types of restriction enzymes, types of vectors used for cloning.
3. Impart knowledge in the applications in genetic engineering through transgenesis

Course Outcome:

The students will be able to

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 importance of transgenesis in biotechnological research.

Module 1: Restriction Enzymes (9)

Restriction enzymes- Classification-nomenclature;Endonucleases, Exonucleases, Ligases- Modifying enzymes; Linkers, Adapters and Homopolymer tailing.

Module 2: Cloning and Expression Vectors (9)

Properties of ideal vectors, Plasmids as vectors- PBR322- pUC vectors--M13-Lambda phage vectors, Cosmid vectors, Phagemids, Shuttle vectors, Expression vectors, YAC, BAC, Mammalian cells-SV40

Module 3: Polymerase Chain Reaction and Hybridization Techniques (9)

Mechanism of Polymerase chain reaction, types of PCR, Inverse PCR, Nested PCR, Molecular beacons, RACE PCR, RAPD, RFLP. Probe Preparation and methods of Labeling, Southern hybridization-Northern hybridization; Western blotting, Autoradiography; DNA finger printing.

Module 4: Construction of Recombinant DNA (5)

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

Module 5: Gene Sequencing, Libraries and rDNA Applications (9)

Gene Sequencing, Chromosome Walking, Gene Editing- CRISPR-CAS, Genomic Libraries, cDNA libraries, DNA Finger printing.

Module 6: Transgenesis and Bioethics (4)

Transgenic principles in Plant and Animal, Ethical, moral and societal issues pertaining to rDNA technology

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.

20BT2019	MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. Develop comprehensive understanding in the salient features involved in the isolation of Nucleic acids
2. Provide technical skills about cloning methods in genetic engineering
3. Impart knowledge about recombinant molecules and its applications

Course Outcomes:

1. Define the basic concepts involved in the nucleic acid isolation from plant, animal and microorganism sources
2. Explain the principles of quantification of nucleic acids and molecular weight analysis
3. Demonstrate the methods involved in restriction digestion, ligation and transformation
4. Interpret and report the data both quantitatively and qualitatively
5. Knowledge in the amplification of DNA using PCR

6. Design experiments for basic research in rDNA technology and adapt biosafety rules of the labortory

List of Experiments:

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

Reference

1. Michael R. Green, Joseph Sambrook, Molecular Cloning a Laboratory Manual, 4th ed., Chsl Press, New York.2018.

20BT2020	BIOPROCESS ENGINEERING	L	T	P	C
		3	0	0	3

Course Objective:

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

Course Outcome:

The students will be able to

1. Understand various methods of isolation and preservation of Industrially important microbes
2. Remember principles of stoichiometry and concepts of bioreactor engineering.
3. Understand kinetic models of growth and product formation.
4. Apply methods to calculate volumetric mass transfer coefficients in bioreactors
5. Analyze various bioreactors for fermentation process.
6. Evaluate application of various reactors in fermentation processes.

Module 1: Inoculum Development (7 hrs)

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

Module 2: Simple Kinetic Models For Growth (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: Stoichiometry Of Cell Growth And Product Formation (10 hrs)

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

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 cells (5 hrs)

Bioreactors for free cells – batch, continuous, fed batch, chemostat with recycle and multi stage chemostat systems, air lift loop reactor. Applcation of free cell bioreactor in industries

Module 6: Bioreactors for Immoblized cells (5 hrs)

Bioreactors for immobilized cells: packed – bed, fluidized bed and hollow – fibre membrane bioreactors. Application of immobilized bioreactors in fermentation industry.

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.

20BT2021	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 quantification of enzymes, and their immobilization.

Course outcome

The students will be able to

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 the enzyme 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;

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, 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: Principles of Enzyme Assays (7 hrs)

Detection and Estimation methods-Suitability of a Detection Method, Direct or Indirect Detection, Enzyme Reaction Time Course, Precautions and Practical Considerations- Purity of Assay Components, Stability of Assay Components, Quantification of Catalysis and Measures of Enzyme Purity- Enzyme Units, Specific Activity, and Turnover Number, Enzyme Purification and Characterization, Interpreting a Purification Table: Criteria of Enzyme Purity

Module 4: Immobilization of Enzymes (7 hrs)

Physical and chemical techniques for enzyme immobilization – adsorption, matrix entrapment, Encapsulation, cross-linking, covalent binding - 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 (6 hrs)

Enzyme based biosensors and their application: electrochemical enzyme-based biosensor, optical enzyme-based biosensors.

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, Nanobiocatylyst designing strategies, application of nanobiocatylyst

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. Punekar, N. S. (2018). *Enzymes: catalysis, kinetics and mechanisms*. Springer.Shuler, M.L. and Kargi, F, "Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd., 2nd edition, 2002.

20BT2022	HEAT AND MASS TRANSFER	L	T	P	C
		3	1	0	4

Course Objective:

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

Course Outcome:

At the end of the course students will be able to

1. Understand the basic principles of heat transfer and mass transfer
2. Apply the principles of heat and mass transfer in bioprocess
3. Analyze the performance of heat exchanger and evaporator
4. Design and analyze reactor cooling and heating systems
5. Analyze and design distillation and absorption coloumns
6. Evaluate the performance of heat transfer and mass transfer operations

Module 1: Conduction (9 hrs)

Introduction- Modes of heat transfer- physical origins and rate equation, relevance of heat transfer. Conduction-Heat transfer by conduction-General heat conduction equation -Thermal diffusivity and thermal conductivity -Linear one-dimensional steady state conduction, conduction through plane walls, cylinders, spheres and composite walls.

Module 2: Convection and Radiation (12 hrs)

Convection– Types of convection-Individual and overall heat transfer coefficient Natural convection– Forced convection, dimensional analysis, heat transfer in condensation of single vapours, Radiation-blackbody radiation-Planck's Distribution Law , wien's law, Stefan Boltzman Law, Absorption, reflection and transmission by real surfaces, Kirchoff's Law , gray surface

Module 3:Heat Exchanger and Evaporators (8 hrs)

Heat exchanger-Types of heat exchange equipment and overall heat transfer coefficient, heat exchanger analysis–Logarithmic mean temperature difference, fouling factor, the effectiveness- NTU method Concept of evaporation-types of evaporators - single effect evaporator, performance of tubular evaporators- evaporator capacity, evaporator economy and effectiveness.

Module 4:Mass Transfer (6 hrs)

Theory of Diffusion,Fick's Law of diffusion, steady state molecular diffusion in fluids under stagnent and laminar flow conditions, mass transfer coefficient, mass transfer theories, equimolar counter diffusion of A& B, correlation of convective mass transfer coefficient.

Module 5: Distillation (6 hrs)

Vapor Liquid Equillibria, single stage operation, differential or simple distillation, continuous rectification, , McCabe –Thiele methods.

Module 6: Absorption (6 hrs)

Theories of absorption and design. packings and packed tower design, absorption in plate coloumns

Text Book

1. Incropera, F. P., & DeWitt, D. P. "Fundamentals of heat and mass transfer*"*. New York: J. Wiley, (2002).
2. Robert Treybal, Mass Transfer Operations, McGraw Hill Education; 3 edition (1 July 2017)

Reference Book

1. Mccabe,W.L.,Smith,J.C., andHarriott,P. Unit Operations of Chemical Engineering, McGraw Hill,NewYork, 6th Edition,2004
2. Geankoplis, J., Transport Processes and Separation Process Principles (Includes Unit Operations), Prentice Hall of India, New Delhi, 4th Edition, 2003
3. Holman, J. P., Heat Transfer, 9th Edition, McGrawHill, Singapore, 2002
4. Donald Q. Kern,ProcessHeatTransfer,TataMcGrawHill, New Delhi,1997

20BT2023	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 Outcome:

The students will be able to

1. Understand the fundamentals of product isolation and separation techniques.
2. Distinguish various techniques for product recovery and isolation.
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 Bioseparations (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, case studies related to choose cell-disruption techniques

Module 2:Product Recovery (10 hrs)

Filtration: Equipments for conventional filtration- filter media, pretreatment methods, general filtration theory- Darcy's law, compressible and incompressible filter cakes, filtration cycle. Continuous filtration equipments in industries, Sedimentation: Mechanisms of theory, thickeners, classifiers, applications in downstream processing. Centrifugal bio separations: Theory of Tubular-bowl centrifuges- maximum efficiency, centrifuge selection-RCF, scale up of centrifuges- sigma factor analysis, equivalent time, efficiency.

Module 3:Isolation of Bioproduct (11 hrs)

Adsorption: Adsorption kinetics, isotherm, assessment of adsorption capacity, Extraction, aqueous two-phase extraction, Extraction efficiency in multi-stage extractor, NH4SO4 based protein fractionation, Membrane separation processes: Membrane, materials and fabrication, reverse osmosis

Module 4:Purification (7 hrs)

Chromatographic separations, Classification of techniques, elution chromatography- retention theory, Ion exchange chromatography, gel permeation chromatography, gel filtration techniques for molecular weight determination, affinity chromatography, Reverse phase, hydrophobic interaction chromatography

Module 5: Product Polishing and Stabilization (5 hrs)

Crystallization: Basic principles- nucleation and crystal growth- supersaturation theory- commercial crystallizers Product drying: Heat and mass transfer in drying- types of commercial dryers- vacuum dryers, freeze dryers, spray dryers

Module 6: Process Simulation and Case Study (6 hrs)

Insulin Case Study: State-of-the-art in downstream processing of monoclonal antibodies, citric acid, penicillin, lactic acid, Process trends in design and validation

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. Harrison, Paul Todd, Scott R. Rudge, Demetri P. Petrides, “Bioseparations science and Engineering” Oxford University Press, 2015.
2. Krishna Kant Prasad, Nooralabettu “Downstream Process Technology: A new Horizon in Biotechnology” PHI learning Private Limited, 2010.
3. Coulson JM and Richardson JF, 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.

20BT2024	DOWNSTREAM PROCESSING LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

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

Course Outcome

The students will be able to

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. Calculation of area of thickener using batch sedimentation data.
2. Estimation of Sigma-factor in batch centrifuge.
3. Calculation of specific cake-resistance in batch Filtration process
4. Estimation of degree of cell disruption in physical techniques (sonication, homogenizer)
5. Estimation of protein recovery involving solvent precipitation technique.

6. Determination of partition coefficient of organic acid between water-chloroform
7. Estimation of protein recovery in ammonium sulfate precipitation technique
8. Determination of equilibrium moisture content in batch drying technique.
9. Separation of phytochemicals using column chromatography
10. Analysis of isotherm parameters for citric acid adsorption onto charcoal
11. Effect the coagulant dose in flocculation efficiency
12. Determination of theoretical plates equivalent in packed-bed 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 Richardson Chemical Engineering volume 2: Particle Technology and Separation Processes" Butterworth-Heinemann, 2006

20BT2025	IMMUNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

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

Course Outcome:

The students will be able to

1. Learn the history and development and controversies of the field of immunology.
2. Recognizes 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 of the applications of immunology in diagnosis and treatment of diseases.

Module 1: Immune System (7)

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)

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)

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

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

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

Module 5:Immune Function and Dysfunction (8)

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

Module 6: Application and Impact of Immunology (7)

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

Total Hours: 45

Text Books:

1. Roitt I, Male, Brostoff, "Immunology", Elsevier Saunders, 17th September 2012
2. S.R. Ramesh "Immunology", McGraw Education -Hill, 2017
3. Kuby J, "Immunology", WH Freeman & Co., January 2019

Reference Books:

1. Richard Coico, Geoffrey Sunshine, Immunology: A Short Course 7th Edition, Wiley-Blackwell; 7 edition (April 27, 2015)
2. Kenneth Murphy and Casey Weaver, Janeways Immunobiology 9th Edition by Kenneth Murphy and Casey Weaver, Garland Exclusive, June 2016

20BT2026	CELL BIOLOGY AND IMMUNOLOGY LAB	L	T	P	C
		0	0	3	1.5

Course Objectives:

1. To enable the students to understand the principles of immunology through experimentation.
2. To impart practical knowledge about the working of the immune system using fish as a model system.
3. To impart the knowledge on the application of immunology in diagnostic and therapeutics.

Course Outcomes:

1. Understand the behaviour of cells
2. Demonstrate the basic skill in preparation of antigen and administering
3. Demonstrate the skill in collecting blood and separating serum.
4. Evaluate the generation of antibodies through different experimental methods.
5. Analyze the effect of adverse immune reactions.
6. Apply skill in screening epitopes and production of antibodies.

List of Experiments

1. Blood Grouping
2. Detection of Typhoid Antigens using Widal Test
3. Stages of Mitosis & Meiosis
4. Study of Tonicity using RBC model
5. Maintenance of Fish & Dissection of Lymphoid organs
6. Preparation and Administration of Antigen.
7. Drawing Blood and separation of Serum.
8. Estimation of specific Antibodies using Haemagglutination.
9. Estimation of specific Antibodies using immunodiffusion
10. Graft Rejection
11. Delayed type hypersensitivity in Fish
12. Immunoinformatics & Epitope Prediction using online software.

Reference:

1. Dinakaran Michael R, Immunological Techniques Using Fish Model- A Laboratory Manual, Year, Notion Press.

20BT2027	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:

The students will be able to

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 reactors
5. Explain adsorption and desorption phenomena in heterogeneous systems.
6. Design of various fermenter / bioreactors

Module 1: Homogeneous Reactions in Ideal Reactors (10)

Overview of Chemical Reaction Engineering; Homogeneous Reactions, The Rate Equation, The reaction rate and reaction mechanisms, Temperature-Dependent and concentration dependent Term of a Rate Equation,

Module 2: Reaction mechanism (10)

Searching for a Mechanism- reaction mechanisms and rate laws, reactive intermediate and steady state approximation in reaction mechanisms, rate limiting step.

Module 3: Interpretation of Batch reactor data (12)

Constant volume batch reactor - integral method of analysis of data, differential method of analysis of data.

Module 4: Performance of Bioreactors (10)

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

Module 5: Single reactions and multiple reactor systems (10)

Size comparison of single reactions, plug flow reactors in series or in parallel, mixed flow reactors in series, autocatalytic reactions

Module 6: Non ideal flow reactors (10)

The residence time distribution, State of aggregation of the flowing stream, Earliness of mixing, Experimental methods (Nonchemical) for finding E, conversion in non-ideal flow reactions, reactor performance with non-ideal flow, Tank in seres model

Text Books:

1. Levenspiel, Octave "Chemical Reaction Engineering", 3rd Edition, John – WileySons, 2006.
2. Fogler, H. Scott. *Essentials of Chemical Reaction Engineering*, Pearson Education, 2010.

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*. Courier Corporation, 2013.
3. Li, Shaofen, Feng Xin, and Lin Li. *Reaction engineering*. Butterworth-Heinemann, 2017.

20BT2028	MASS TRANSFER AND CHEMICAL REACTION ENGINEERING LAB	L	T	P	C
		0	0	3	1.5

Course Objective:

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

Course Outcome:

The students will be able to

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. Extraction of acetic acid by Liquid –liquid Extraction
2. Leaching of oils from solids
3. Study on drying characteristics of sample using light.
4. Precipitation of Casein from milk
5. Determination the HETP of the packed column by McCabe Thiele method
6. Efficiency Analysis of simple distillation
7. Analyze the efficiency of Absorption column
8. Determination of rate constant for the saponification of Ethyl acetate in a batch reactor
9. Determination of rate constant for a Semi batch reactor
10. Estimation of reaction kinetics in a Continuous stirred tank reactor
11. Estimation of reaction kinetics in a Plug flow reactor
12. Residence time distribution in a PFR

Reference Books:

1. Robert Treybal, Mass Transfer Operations, McGraw Hill Education; 3 edition, 2017.
2. Mccabe,W.L.,Smith,J.C., andHarriott,P. Unit Operations of Chemical Engineering, McGraw Hill,NewYork, 6th Edition,2013
3. Levenspiel Octave "Chemical Reaction Engineering", 3rd Edition, John – WileySons, 2012.

20BT2029	BIOCHEMICAL THERMODYNAMICS	L	T	P	C
		3	0	0	3

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:

The students will be able to

1. Explain the basic concepts of thermodynamics in process industry.
2. Recognize the significance of laws of thermodynamics.
3. Explain concepts of thermodynamic properties of fluids & demonstrate various equations of state & their applications
4. Illustrate the importance of partial molar properties & the concepts of phase equilibrium
5. Solve mathematical problem involving volumetric, thermodynamic properties of real fluids

6. Illustrate the concepts of chemical reaction equilibrium.

Module 1:Basic Concepts & Laws of Thermodynamics: (8)

System, Surrounding & Processes, Closed and Open systems, State Properties, Intensive & Extensive Properties, State and Path functions, Enthalpy, Internal Energy, specific heat capacities at constant pressure, constant volume; Reversible and Irreversible processes. General statement of First law of Thermodynamics, General statements of the second law of thermodynamics, Heat engines, Entropy, Entropy changes of an ideal gas. Numericals.

Module 2: PVT Behaviour and Heat Effects: (6)

PVT Behavior of pure fluids, equations of state & ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic & polytrophic processes, Equations of state for real gases: Vander Waals equation, virial equation, Numericals. Heat Effects: Sensible Heat Effects, Internal Energy of ideal gases, Latent heat of pure substances, Standard heat of reaction, formation, combustion, Heat of reaction at higher temperature, Heat effects of Industrial reactions.

Module 3: Properties of Pure Fluids (6)

Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, modified equations for internal energy (U) & enthalpy (H), Effect of temperature on U, H & Entropy (S). Numericals.

Module 4: Properties of Solutions (7)

Chemical potential –effect of temperature and pressure, Partial molar properties of solution and its determination, Numericals.

Concept of Fugacity, Fugacity coefficient, Determination of fugacity of pure gases, solids and liquids, Activity: Effect of temperature and pressure on activity. Numericals.

Fugacity in solutions: lewis–randall rule, Raoults law for ideal solutions, Activity in solutions, Activity coefficients, calculation of activity coefficients using Gibbs-Duhem equation. Numericals.

Module 5:Phase Equilibria (10)

Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibria, Pahse diagram in binary solutions, P-x-y diagram, VLE in ideal solutions, Non-Ideal solutions, Consistency test for VLE data, Azeotropes. Activity coefficient calculation: van Laaar, Margules, Wilson equations. Numericals.

Module 6:Chemical and Reaction Thermodynamics (8)

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. Standard heat of reaction, formation, combustion, effect of temperature on standard heat of reaction, Coupled reactions and energy rise compounds, Le – chatelier's principle, liquid phase reactions, heterogeneous bioreaction equilibria.

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.
3. Biochemical Calculations, by Irwin H.Segel, John Wiley & Sons, 2nd Ed,(1976)

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.

20BT2030	CONCEPTS OF BIOINFORMATICS	L	T	P	C
		2	0	2	3

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:

Students are able to

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. Analyse different types of Biological databases and resources.
5. Evaluate the vital role drugs interacting to the target.
6. Constructphylogenetic tree based on Molecular data

Module 1: Introduction to Bioinformatics (5)

Introduction to Bioinformatics, Importance and uses of Bioinformatics Scope of Bioinformatics. Genebank file format, SwissProt File format, Protein Databank file format

Module 2: Biological Databases (5)

Introduction to Biological databases, organization and management of databases, Primary sequence databases, Secondary databases- nucleic acid sequence databases - Protein sequence data bases.

Module 3:Sequencing Alignment and Dynamic Programming (5)

Sequence Alignment, Local alignment, Global alignment, pairwise Alignment, multiple sequence alignments. Dynamic programming in sequence alignment: Needleman-Wunsch Algorithm, Smith Waterman Algorithm, Amino acid Substitution matrices (PAM, BLOSUM).

Module 4: Applied Bioinformatics Tools and Data Resources (5)

Entrez, ExPASy, EMBL-EBI tools and Data Resources: DNA/RNA Sequence Analysis tools, Gene Expression, Protein Sequence Analysis, Primer Design, Tools for Primer Design, Primer Design Application.

Module 5: Computational Genomics and Proteomics (6)

Genomics databases, Proteomics databases, Comparative genomics and Proteomics; Understanding DNA microarrays and protein arrays, Gene and protein prediction strategies, Molecular Evolution and Phylogeny, Molecular data of Phylogenetic Tree, Distance Based Treen Reconstruction Methods, UPGMA, Neighbor Relation, Neighbor joining, Character based Tree Reconstruction method, Maximum Parsimony Method, Maximum Likelihood method.

Module 6: Molecular Modeling and Simulation (4)

Basic concepts of Homology, threading, ab-initio protein structural modeling, Energy Minimization methods and Applications, Molecular simulation methods and applications, target identification and validation.

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.
3. D.W. Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbour Laboratory Press, New York, 2012.

References Books:

1. Andreas D. Baxevanis, B. F. Francis Ouellette, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, 3rd Edition, Wiley and Sons, 2012

2. S.C. Rastogi and N. Mendiratla and P.Rastogi. Bioinformatics methods and applications-Genomics, Proteomics and Drug Discovery. Prentice Hall India, 2013
3. A.M. Lesk. Introduction to Bioinformatics. Oxford University Press India, 2017.

List of experiments:

1. NCBI Database
2. ExPASy Database
3. EMBOSS pairwise Sequence Alignment
4. Freiburg RNA Tools Smith-Waterman
5. Swiss-Prot Database
6. Gene Prediction
7. Protein Familes –SCOP,Pfam and CATH
8. Secondary Structure prediction
9. EMBL-EBI database
10. Analysing the geometry of protein and visualize the protein using protein databank and swiss-pdb viewer.
11. Homology Modelling Using Modeller Protein
12. Tree Reconstruction based on Molecular Phylogeny Data

Reference Books:

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

20BT2032	INDUSTRIAL SAFETY AND HAZARD ANALYSIS	L	T	P	C
		3	0	0	3

Course Objective:

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 Outcome:

The students will be able to

1. Understand plant safety in selection and layout of process plants and the usage of safety codes.
2. Distinguish different types of 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 measures

Module 1:Need for Safety (9)

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

Module 2:Safety Procedures (9)

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

Module 3:Hazard Identification (4)

Process hazard checklist, hazard surveys, hazard and operability studies

Module 4:Risk Assessment (5)

Event trees, fault trees, Quantitative risk assessment - rapid and comprehensive risk analysis; Layer of protection analysis, Risk due to Radiation, explosion due to over pressure.

Module 5:Hazard Control (9)

Eliminate or substitute hazard, Engineering controls, Administrative controls, Personal Protective Equipment

Module 6:Process Safety in Bioprocess Manufacturing Facilities (9)

The Need for Bioprocess Safety Management Systems, Bioprocessing Safety Management Practices**,** Identifying Bioprocess Hazards- Key Considerations for Assessing Risk to Manage Bioprocess Safety**,** Bioprocess Risk Assessment**,** The Effects of Emerging Technology on Bioprocessing Risk Management

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. American Institute of Chemical Engineers. Center for Chemical Process Safety. *Guidelines for process safety in bioprocess manufacturing facilities*. Wiley-AIChE, (2011).
3. Lees, F. *Lees' Loss prevention in the process industries: Hazard identification, assessment and control*. Butterworth-Heinemann, (2012).

References:

1. King, R. W., & Magid, J. (2013). *Industrial Hazard and Safety Handbook:(Revised Impression)*. Elsevier.
2. Heinrich, H.W. Dan Peterson, P.E. and Rood, N., "Industrial Accident Prevention", McGraw-Hill Book Co., 1980.
3. Deshmukh, Y. S. (2006). Hazard identification and risk control–industrial safety management.

20BT2033	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:

The students will be able to

1. Understand basics of environmental pollution
2. Remember Pollution control acts and regulations.
3. Apply bio safety principles in pollution control.
4. Evaluate cleaner technology on pollution control.
5. Evaluate various approaches for biomedical waste treatment and disposal
6. Analyse various biosafety measures

Module 1: Pollution Control Acts (8)

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 2: Environment Protection (9)

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

Module 3: Environment Protection Act (8)

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 4: Cleaner Technologies (6)

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

Module 5: Biosafety (7)

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 6: Biomedical Waste Disposal (7)

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

20BT2034	PROCESS EQUIPMENT DESIGN & ECONOMICS	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

The students will be able to

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 bioreactors and their applications
6. Evaluate process economics

Module 1: Introduction to Process Design (5)

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

Module 2: Heat Exchangers, Evaporators (9)

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

Module 3:Design of Separation Processes (9)

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

Module 4:Design of flow measuring and control Device (9)

Design of venturimeter, double pipe heat exchanger, Design of gate, design of globe valve

Module 5:Economics (4)

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: Design and Applications of Bioreactors (9)

The use of equipments designed for biotechnology industry for different purposes: Bioeactors, Airlift, Fluidized Bed, Packed bed reactor, CSTR

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.

20BT2035	PROCESS DYNAMICS & 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:

The students will be able to

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)

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

Module 2:First Order Systems (8)

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

Module 3: Second Order Systems (8)

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

Module 4: Controllers and Final Control Elements (8)

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

Module 5: Controller Design and Stability (8)

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

Module 6: Process control in Bioprocess (4)

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. B. Ogunnaike and W.H. Ray, Process Dynamics, Modelling and Control, Prentice Hall. Oxford University Press, (1994).
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.

20BT2036	MECHANICAL OPERATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To ensure students have strong fundamental knowledge about various unit operations
2. To introduce them to 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:

The students will be able to

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

Module 1: Size Reduction and Solid Particles (15)

Particle size and shape: Measurement and analysis; Screening and screen analysis; Screen effectiveness; Design of industrial screening equipment. Size Reduction: Crushing, grinding, pulverization, ultrafine grinding, grindability; Crushing efficiency, power requirement and equipment selection.

Module 2: Transportation and Conveying (11)

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. Solid handling: Storage of solids- bins, cellos, hoppers; Transport of solids- screw and belt conveyors, pneumatic and hydraulic transport.

Module 3: Classification of Solid Particles (9)

Particle separation: Sedimentation; Free and hindered settling; Thickeners and settling chambers; Characteristics of rotating fluids; Centrifuges, cyclone separators, bag filters; Electrostatic precipitator. Flow through porous media; Constant pressure and constant rate filtration; Compressible and incompressible cakes; Filtration rate calculation; Filtration equipment

Module 4:Mixing Blending (5)

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

Module 5:Filteration and Devices (5)

Filtration - Batch and continuous filtration, compressible and incompressible filter cakes. Flow through porous media; Constant pressure and constant rate filtration; Compressible and incompressible cakes; Filtration rate calculation;

Module 6:Theories on Filter Resistances (5)

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

Total Hours: 45

Text Books:

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

Reference Book:

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

20BT2037	MECHANICAL OPERATIONS LABORATORY	L	T	P	C
		3	0	0	1.5

Course Objectives:

1. The students are provided knowledge on properties of solids
2. To determine and analyze on various size reduction techniques
3. To introduce the students to know all the aspects of Downstream operations of Mechanical Equipments and to infer the results obtained by experimentation.

Course Outcomes:

The students will be able to

1. To Understand the properties of solids and analyses the best screening equipment necessary in chemical industries.
2. To acquire knowledge on different types of size reduction principles and various types of equipment used in it.
3. To gain knowledge in the working principle of filtration equipment.
4. Imparting knowledge on solid transportation processes.
5. To evaluate the parameters necessary to process the various stages of packing material.
6. To apply the analytical method to estimate batch operation modes.

List of Experiments

1. Calculation of the Mixing index using a Ribbon mixer
2. Calculation of the Mixing index using a Sigma mixer
3. To evaluate water removal capacity using a dewatering centrifuge.
4. To evaluate drying efficiency using a Cross Flow Dryer.
5. To evaluate drying efficiency using a Through Flow Dryer.
6. To evaluate size reduction of solid particles by Ball mill and to evaluate surface area.
7. Analyzing the angle of repose of food products.

8. To evaluate cake resistance using a plate and frame filter press.
9. To calculate HETP in packed distillation process.
10. To evaluate energy balances in a continuous CSTR operation.
11. To calculate the screening efficiency of different sieve sizes for solid particles
12. Sparkling Filter (Demo)

Text Books:

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

Reference Book:

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

20BT2038	BIOCHEMICAL ENGINEERING LAB	L	T	P	C
		0	0	2	1

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:

The students will be able to

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 amylase by submerged fermentation
2. Effect of Substrate Concentration on Growth of E-coli
3. Effect of pH on Enzyme Activity
4. Effect of Temperature on Enzyme Activity
5. Immobilization of Enzyme and microbe by entrapment method
6. Production of single cell protein in solid state fermentation of rice bran
7. Determination of MM Parameters
8. Estimation of growth kinetics of E-coli
9. Estimation of volumetric mass transfer coefficient using oxygen balance technique
10. Estimation of OTR using sulphite oxidation method

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, 2014.
2. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" , Prentice Hall of India Pvt. Ltd., 2nd edition, 2016.

20BT2039	CANCER BIOLOGY	L	T	P	C

		3	**0**	**0**	**3**

Course Objectives:

1. To understand the complexity and regulatory networks involved in cancer development process
2. To impart knowledge on 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:

The students will be able to

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, Characteristics, Benign Vs Cancer – Nomenclature, and classification-incidence; Cell Cycle: Regulation of cell cycle, cell proliferation, differentiation and apoptosis, Apoptosis pathways, Modulation of cell cycle in cancer, Cancer metabolism, Cancer inflammation & immunology, Cancer death.

Module 2: Principles of Carcinogenesis (6 hrs)

Theory of carcinogenesis- Multi-stage theory of carcinogenesis, Chemical carcinogenesis, Physical carcinogenesis- UV, X-ray, Biological carcinogenesis; 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, Retroviruses and oncogenes – Tumor suppressor genes: Rb, p53, APC, BRCA paradigms, Role of signal transduction pathways and signal switches in apoptosis, 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 (7 hrs)

Cancer screening – sampling methods: Tumor markers; Physical Examination, Symptoms, Bioassays, Imaging techniques, Biopsy examination, Clinical interpretation on stages/grades, Cancer screening and early detection, Advances in cancer detection: Molecular markers-oncogenes activity detection method, tumour suppressors and other molecular markers.

Module 6: Cancer Therapy (8 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. Review on any one type of cancer; Recent advancements in cancer management.

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.

20BT2040	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:

The students will be able to

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)

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)

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)

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)

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)

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)

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

Text Book

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 Book

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

20BT2041	CLINICAL DATABASE MANAGEMENT LAB	L	T	P	C
		0	0	3	1.5

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:

The students will be able to

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 skilful 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, and 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

Reference Books:

1. Leiner, Florian, Wilhelm Gaus, G. Wagner, Reinhold Haux, and Petra Knaup-Gregori, eds. *Medical data management: a practical guide*. Springer Science & Business Media, 2003.
2. Prokscha, Susanne. *Practical guide to clinical data management*. CRC Press, 2011.
3. Leiner, Florian, Wilhelm Gaus, G. Wagner, Reinhold Haux, and Petra Knaup-Gregori, eds. *Medical data management: a practical guide*. Springer Science & Business Media, 2003.

20BT2042	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 techniques (9 hrs)

Tissue Culture media, Callus and suspension culture, Somoclonal Variation, Micro propagation, Organogenesis, Somatic embryogenesis, transfer and establishment of whole plants in soil, green house technology

Module 2: Plant Genetic Transformation (7 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 3: Application of Plant Genetic Transformation (6 hrs)

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

Module 4: Design of gene construct and advanced technologies (9 hrs)

Factors influencing transgene expression – designing gene constructs - Promoters and polyA signals; Protein targeting signals; Plant selectable markers; Reporter genes; Positive selection; Selectable marker elimination; Transgene silencing; Strategies to avoid transgene silencing; Analysis of transgenic plants - Advanced technologies – cis genesis and intragenesis; RNAi technology, genome editing technology, CRISPR/Cas.

Module 5: Introduction to Animal Cell Culture (9 hrs)

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

Module 6: Micromanipulation and Transgenic Animals (9 hrs)

Embryo transfer- Micromanipulation technology, germ cell manipulation, sperm and embryo sexing, *In Vitro* fertilization, 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. Chawala. H.S., 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

20BT2043	STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

The students will be able to

1. Explore the technique and the pros and cons of animal cell culture.
2. Understand the definition of stem cell and the features that distinguish it from other cells.
3. Recognize the different types of stem cells and their properties.
4. Analyze the residence of the stem cells and the factors that affect its function.
5. Learn the isolation and application of stem cells.
6. Explores the ethical aspects of stem cell technology.

Module 1: Introduction (4)

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)

Aseptic Technique and Cell culture Lab equipments & etiquette.

Module 3: Types of Stems Cells (9)

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

Module 4: Isolation of Stem Cells (9)

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

Module 5: Applications of Stem Cell Technology (9)

Use of stem cells in Neurological disorders; Use of stem cells in cardiac disease; Use of stem cells in Cancer; Stem cells for organ generation; Use of stem cells in tissue engineering & Gene therapy.

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

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

Total Hours: 45

Text Book

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

References Books:

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

20BT2044	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:

The students will be able to

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)

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)

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)

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)

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

Module 5:Antibiotics and rDNA Products (5)

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

Module 6:Trials & Regulations (9)

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

Text Books :

1. Brahmankar D M, 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. Lippincott, “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.

20BT2045	AGRICULTURAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

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

Course Outcome:

The students will be able to

1. Acquire knowledge on plant breeding
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: Plant Biotechnology Concepts (9)

Basic concepts and history of biotechnology, Different branches of biotechnology, Tools of Genetic Engineering: Cloning vehicles, Restriction enzymes, Modifying enzymes, DNA ligase, Polymerase etc. Cloning Vectors, Recombinant DNA technology

Module 2: Plant Breeding Techniques (9)

Significance of plant breeding in crop development. Methods of plant breeding in self and cross pollinated crops. Clonal selection, population improvement programme. Heterosis, Genetical and physiological basis. Interspecific/ Intergeneric hybridization, Heterosis inbreeding depression. Polypliody its types. Mutation breeding Gene actions, heritability, genotype and environmental interactions.

Module 3: Plant Cell and Tissue Culture (9)

Scope and importance of tissue culture in crop improvement , totipotency and morphogeneis, Organogenesis, Rhizogeneisis, Embryogenesis, Nutritional requirement of in vitro cultures, Different techniques of in-vitro culture. Protoplast isolation, culture Manipulation and fusion. Cybrids, Products of somatic hybridization, Cryopreservation of germplasm. Secondary metabolites production

Module 4: Biodiversity Conservation (6)

Geographical causes of diversity. Types of diversity. Biodiversity and centers of origins of plant. Hot spots in India. Principles of conservation biology. Biosphere concept, Genetical and evolutionary principles of conservation. Collection Maintenance and conservation of biodiversity. endangered plants, endemism and Red Data Book

Module 5: Intellectual Property Rights (3)

Intellectual Property Rights and legal concerns of Bio-resources. Case study on Basmati Rice, Turmeric and Neem

Module 6: Genome Analysis (9)

Genome projects, Genome Annotation, Biological Data Bases, Data base search engines, Sequence Analysis and Molecular Phylogeny. Gene analysis using DNA sequence data

Text Books:

1. Chawla H S, Introduction to Plant Biotechnology, 3Ed Oxford & IBH Publishing 2020
2. B.D.Singh, Plant Breeding Principles and Methods, Kalyani Publisher 2018
3. Razdan M K, Introduction to Plant Tissue Culture, Oxford & IBH Publishing 2019
4. Satish Kumar Sinha, Plant Tissue Culture: Theory and Practice, Oxford Book Company 2012
5. Jeyabalan Sangeetha, Devarajan Thangadura, Goh Hong Ching, Saher Islam . Biodiversity and Conservation, Apple Academic Press (2019)
6. Ram Kumar, Intellectual Property Rights-Demystified, New India Publishing House, New Delhi. (2008).
7. Satish Kumar Sinha, Elementary Bioinformatics , Oxford Book Company (2012)

Reference Books:

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

20BT2046	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 impart basic knowledge in the field of synthetic biology
3. To learn advanced 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. Construct suitable metabolic flux models using available metabolic engineering tools
4. Identify the appropriate host and/or metabolic pathways to produce a desired product
5. Compare the potential metabolic engineering strategies using quantitative metabolic modelling
6. Apply the concept of synthetic biology in interdisciplinary research

Module 1: Cell Metabolic Engineering (6 Hours)

Improvement of cellular properties, altering transport of nutrients including carbon and nitrogen; Methods for metabolic characterization: Genome, Transcriptome, Proteome

Module 2: Regulation of Metabolic Pathways (7 Hours)

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, purine nucleotides; trophophase- idiophase relationship; secondary metabolites- Antibiotics, Mycotoxins

Module 3: Manipulation of Metabolic Pathways (8 Hours)

Pathway manipulation strategies for overproduction of various metabolites, examples of ethanol overproduction, overproduction of intermediates in main glycolytic pathway and TCA cycle like pyruvate, succinate; Tools for multiple genomic modifications examples- TALENS CRISPR-Cas systems as well as traditional systems of gene knock ins and knock outs and promoter engineering.

Module 4: Metabolic Flux Analysis (10 Hours)

Metabolic flux analysis; Building stoichiometric matrix; Steady state and pseudo steady state assumptions; Methods for experimental determination of metabolic fluxes by isotope labeling metabolic fluxes using various separation-analytical techniques; GC-MS for metabolic flux analysis

Module 5: Basics of Synthetic Biology (6 Hours)

Synthetic biology - definitions and concepts. History and evolution of synthetic biology and engineering perspectives. Natural vs Engineering systems. Tools of synthetic biology -Key enabling technologies in synthetic biology. BioBricks - Definition of a BioBrick

Module 6: Applications of Metabolic Engineering and Synthetic Biology (8 Hours)

Product over production examples: amino acids, By-product minimization of acetate in recombinant *E. coli*, Extension of substrate utilization range for organisms such as *S. cerevisae* for ethanol production; Application of synthetic biology with a case study.

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. Cortassa S., Aon M.A., Iglesias A.A. and Llyod D., "An Introduction to Metabolic and Cellular Engineering", World Scientific Publishing Co. Pte. Ltd, 2002.
3. Smolke, C.S. (2010) Metabolic Pathway Engineering Handbook: Fundamentals. 1st ed. New York: CRC Press.

Reference Books:

1. Freemont, P.S and Kitney, R.I. (2012). Synthetic Biology – a Primer. World Scientific Publishing Co pvt Ltd
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 3rd edition, 2016

3. Crueger W. and Crueger A., “A Text Book of Industrial Microbiology”, Panima Publishing Corporation, 2005
4. Cheng Q. “Microbial Metabolic Engineering: Methods and Protocols”, Humana Press, First Edition (2011).
5. Lehninger, A. L, Nelson D. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, Seventh edition, 2017.

20BT2047	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 (7 hrs)

Foundations of Research: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process. Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance

Module 2: Research Design and Experimental Design (7 hrs)

Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables.

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

Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches. Concept of measurement– what is measured? Problems in measurement in research – Validity and Reliability. Levels of measurement – Nominal, Ordinal, Interval, Ratio. Sampling: Concepts of Statistical Population, Sample, Sampling Frame, Sampling Error, Sample Size, Non-Response. Characteristics of a good sample. Probability Sample – Simple Random Sample, Systematic Sample, Stratified Random Sample & Multi-stage sampling. Determining size of the sample – Practical considerations in sampling and sample size.

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

Data Preparation – Univariate analysis (frequency tables, bar charts, pie charts, percentages), Bivariate analysis – Cross tabulations and Chi-square test including testing hypothesis of association. SPSS.

Module 5: Manuscript/Thesis Writing (9 hrs)

Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Bioscience, Impact factor of Journals, When and where to publish? Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of Encyclopedias, Research Guides, Handbook etc., Academic Databases for Bioscience discipline. Impact factor

Module 6: Use of tools / techniques for Research (7 hrs)

Methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism **Total Hours: 45**

Text Book:

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

Reference Books:

1. Donald Cooper & Pamela Schindler,Business Research Methods – TMGH, 9th edition
2. Alan Bryman & Emma Bell, Business Research Methods – Oxford University Donald
3. H. McBurney, "Research methods", Thomson Asia Pvt. Ltd. 2002
4. Ranjit Kumar, "Research methodology", Sage Publications, London, 2006.
5. Raymond – Alain, "Doing Management research", Sage publications, 2001.

20BT2048	MOLECULAR FORENSICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. Provide knowledge in the field of forensic science and crime scene investigations.
2. To ensure students gain knowledge about the recovery of human remains.
3. Impart technical skills to know the procedures involved in the identification of the criminals using molecular tools

Course Outcomes:

1. Explain the steps involved in forensic investigation
2. Identify the methods involved in the collection of biological samples for molecular analysis
3. Interpret the results of molecular techniques for the identification of the criminals and the victims
4. Appraise the knowledge in paleo biology and anthropology and its importance in Forensics
5. Design experiments in molecular techniques and implementation in forensic science
6. Analyze forensic case studies

Module 1: Introduction to Forensic Science (9)

Introduction to crime laboratories, Responsibilities of the forensic scientist, Securing and Searching the Crime Scene, Recording and collection of crime scene evidence, Document examination, Ethics and Integrity

Module 2: Discovery and Recovery Of Human Remains (9)

History of Forensic Genetics, Biological sample collections, 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 (8)

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: Methods of Identification (9)

Methods used in forensic for human identification: Autosomal STR Profiling, Analysis of Y chromosome, Analysis of Mitochondrial DNA, Autosomal single-nucleotide polymorphisms (SNP) typing, Biomarkers in forensic identification, Polymorphic Enzymes, DNA Finger Printing- RFLP.

Module 5: Sequencing Methods in Forensics (5)

PCR directed Y chromosome sequences, PCR Amelogenein Gene, Next generation Sequencing

Module 6: Forensic Case Studies (5)

Case studies of Royal Romanov Family, Study of Kinship by DNA Profiling, Paternity disputes, Illegal hunting case identification using Molecular markers; detection of narcotics in body fluids.

Text Books:

1. Lincoln PJ & Thomson J, “Forensic DNA Profiling Protocols”, Humana Press. 2011.
2. Sandy B. Primrose, Richard Twyman “Principles of Gene Manipulation and Genomics” Backwell Scientific Publications 2010

References Books:

1. Rudin N & Inman K. “An Introduction to Forensic DNA Analysis”, 2nd Ed. CRC Press. 2002.
2. Brown T.A, Gene Cloning and DNA Analysis, 6th Edition, Blackwell Publishing Ltd 2010

20BT2049	PROTEIN ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To ensure the strong knowledge in protein architecture to understand the protein structure and function relationship.
2. To use the knowledge for structure prediction and design of novel proteins.
3. To learn different techniques for the protein engineering and its application in biotechnology Industry.

Course Outcome:

The students will be able to,

1. Understand the basic protein structure and various interactions affecting it.
2. Review of factors significant for protein folding processes and stability
3. Utilize the computational methods to understand and predict unknown protein structure and its characteristics.
4. Apply the knowledge and techniques of protein engineering to design and production of new proteins with enhanced stability and enzymatic activity.
5. Analyse and characterize the new protein with modern analytical techniques like NMR etc.
6. Understand and use advanced biophysical techniques for protein analysis, including the capacity to discuss their relative merits and interpret data from those techniques.

Module 1: Introduction to Protein Structure 9

Primary structure (peptid bonds, polypeptide chains), secondary structure (helices (α, 310, Π) , β sheets, β turns & loops/coil; Ramachandran plots), tertiary structure (fold, domain & motif; classification – globular (myoglobin) membrane (collagen) & fibrous (bacteriorhodopsin)), quaternary structure (protein assembly; globular arrangement; symmetry considerations- cyclic, dihedral & cubic symmetry; helical quaternary structures). Amino acids and its properties (size, solubility, charge, pKa), Different interactions in protein (ionic, hydrophobic, hydrogen bonding, covalent, vander wall, co-ordinate bonds), Protein folding, molten globule structure, characterization of folding pathways. Post translation modification (involving amino, carboxyl, hydroxyl, thiol, imidazole groups).

Module 2: Protein Structure Prediction and Design 9

Strategies for design of novel proteins-strategies for the design of structure and function: computer methods in protein modelling. Protein sequence comparison, multiple sequence alignment, data bank scanning, pattern matching; sequence structure comparison. secondary structure prediction, surfaces & volumes, molecular dynamics simulations, free energy perturbation. Incorporation of Binding Sites into de Novo Proteins, Design of Catalytically Active Proteins.

Module 3: Approaches of Protein Engineering 6

Introduction and scope of Protein Engineering. Different approaches of protein engineering: Random mutagenesis, Mutagenesis by rational design. Effect of mutation on protein structure, stability and folding, phi value analysis. Invitro mutagenesis- principles & variations, invitro chemical mutagenesis, Oligonucleotide based mutagenesis, Cassette Mutagenesis, PCR-based mutagenesis, Types of template, Saturation mutagenesis, Applications of mutagenesis

Module 4: Strategies for the Production of Novel Proteins 6

Site and strategies for heterologous expressions: methods for expressing recombinant proteins in yeast, in vitro mutagenesis. Proteolytic processing, Alteration in the chain termini, Genetic considerations in

expression, post translational modifications, Sites of expression. Advantages of using yeast for protein production, Methods for expressing recombinant protein in yeast. Analysis of Yeast Transformants Expressing Heterologous Proteins, Optimization of Protein Production, Recovery and Processing.

Module 5: Analysis and Characterization of Proteins 9

Protein identification Protein structural and biochemical characterization using NMR (Principles, Types of NMR), FTIR, mass spectrometry, Protein Crystallography- X-Ray Diffraction Pattern, Crystallization of proteins, Phase determination, Electron Density Map Interpretation, Spectroscopic - Circular dichroism, CD spectrum of proteins, Near-UV Circular Dichroism of Proteins, FT-IR spectroscopy, Raman spectroscopy Calorimetric methods- differential scanning calorimetry- reversible & irreversible transitions

Module 6: Application of Protein Engineering 6

Design of polymeric biomaterials, nicotinic acetylcholine receptors as a model for a super family of ligand - gated ion channel proteins. oxidation-resistant proteases, Engineered TPA (Tissue Plasminogen Activator), Recombinant insulin (Engineered Fast and Slow Acting Insulin)

Text books

1. Cleland and Craik, Protein Engineering, Principles and Practice, Vol 7, Springer Netherlands 1998.
2. Paul R Carey, Protein Engineering and Design, 1996, Elsevier publisher.
3. Permington S R , Dunn M J,"Proteomics from Protein sequence to function" , Viva Books Pvt. Ltd.,New Delhi, 2002
4. Walsh G, "Proteins Biochemistry and Biotechnology" John Wiley and sons (2003).

Reference book

1. Park S. J. and Cochran J. R., Protein Engineering and Design, 1st Edn., CRC, 2009. Oxford, UK
2. Gregory A. Petsko and Dagmar Ringe—Protein Structure and Function, second Edition, OxfordUniversity Press USA, 2004
3. Koehrer, Caroline, RajBhandary, Uttam L., Protein Engineering, Springer, 2009

20BT2050	PLANT TISSUE CULTURE TECHNIQUES	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, Gemini 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: Secondary metabolite production in tissue culture: **(5 hrs)**

Culture initiation, biotransformation, elicitation, hairy root culture, immobilization, permeabilization.

Module 5: **Green house operation and management**: **(4 hrs)**

Hardening and acclimatization of tissue cultured plants

Module 6: **Transgenics – Biotic Factors (9 hrs)**

Bioreactors: In-Process control (IPC), determination of plant cell growth: Illumination, Types of bioreactors for plant cell suspension culture, Re- and multi usable bioreactors for plant cell suspension culture, Single-use and disposable bioreactors for plant cells and tissue cultures, Re- and multi usable bioreactors for root culture, Single use vs re- and multiusable bioreactors. Advantages and disadvantages.

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.

20BT2051	ANIMAL BIOTECHNOLOGY AND CELL CULTURE	L	T	P	C
		3	0	0	3

Course Objective:

1. Develop skills of the students in the area of animal biotechnology
2. To impart technical knowledge in cell culture techniques
3. Provide knowledge in the various applications in cell culture and tissue engineering

Course Outcome:

1. Define the basic concepts in cell culture techniques
2. Recognize the importance of scaling up of cell culture for production of products
3. Interpret the applications of Tissue engineering and 3D cell culture techniques
4. Relate the need of genetic screening for *In vitro* fertilization
5. Appraise the knowledge of live stock improvement using transgenesis
6. Assess the scope, applications and ethical issues in animal biotechnology

Module 1: Introduction to Cell Culture (9)

Layout of cell culture laboratory, Introduction to basic culture techniques, chemically defined, serum and serum free media. Primary cell culture and types of primary culture, Establishment of cell line, Maintenance and preservation of cell line. Types of cell line, Availability of cell line

Module 2: Cell Separation and Characterization (9)

Cell separation by density gradient, Fluorescent activated cell sorting, Characterization: Morphology, Chromosome analysis, Isoenzymes

Module 3: Scaling Up of Cell Cultures and Tissue Engineering (9)

Scaling up of Adherence and Suspension Cultures, Continuous flow culture, Cell culture as a source of various Products- Vaccine Production, 3D culturing, Protocols for 3D culturing of cells, Tissue Engineering applications with examples and Protocols

Module 4: Micromanipulation of Embryos (9)

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

Module 5: Transgenic Animals (5)

Molecular Diagnosis of animal diseases, Concepts of Transgenic Animal technology: Strategies for the development of Transgenic animals and their importance in Biotechnology,

Module 6: Stem Cell Technology and Ethics (4)

Stem cells growth and maintenance, Stem cells in the development 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. Advances in Animal Biotechnology by Birbal Singh, Gorak Mal, Sanjeev K Goutam. Springer; 1st ed. 2019 edition

Reference Books:

1. Animal Biotechnology 1**.** Niemann**,** Heiner, Wrenzycki, Christine .ed., Springer Publishing. 2018.
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 ed., Oxford University Press, 2009.

20BT2052	PLANT AND ANIMAL TISSUE CULTURE LAB	L	T	P	C
		0	0	4	2

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. Passaging of cell line
4. Cryopreservation
5. Membrane integrity assay- Trypan Blue Staining
6. Metabolic activity assay- LDH assay
7. Media preparation and sterilization techniques.
8. Callus induction from explant
9. Shoot induction by axillary bud breaking method
10. Establishment of hairy root culture from explant
11. Cell Suspension Culture for metabolite production and growth kinetic studies
12. Preparation of synthetic seeds.

References:

1. Satish Kumar Sinha, Plant Tissue Culture: Theory and Practice, Oxford Book Company 2012
2. Bojwani, S.S. “Plant Tissue Culture: Applications and Limitations”, Elsevier science publishers, 2001.
3. Ian Freshney R.. Introduction to Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.

20BT2053	BIOMASS & BIOENERGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To make aware of various renewable feedstocks available for bioenergy
2. To elaborate on the concept of biofuel production from biomass
3. To analyze the policies & legislation in bioenergy sector

Course Outcome:

The students will be able to

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

Module 1:Energy Concepts (9)

Fundamental concepts in understanding biofuel/bioenergy production, Renewable feedstocks and their production, Feedstocks availability, characterization and attributes for biofuel/bioenergy production,

Module 2: Biomass Feedstocks and Processing (9)

Biomass Conversion Technologies - Biorefinery Concept , Hydrolysis, enzyme & acid hyrolysis – Fermentation, Anaerobic digestion - Trans-esterification, Various biofuels/bioenergy from biomass

Module 3: Biomass Conversion Technologies (9)

Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion, Biomass conversion to biofuel: thermochemical conversion, syngas fermentation, Biochemical conversion to ethanol: biomass pretreatment, Different enzymes, enzyme hydrolysis, and their applications in ethanol production

Module 4:Biodiesel (9)

Biodiesel production from oil seeds, waste oils and algae, Environmental impacts of biofuel production Value-added processing of biofuel residues and co-products, Emissions of biomass

Module 5:Waste to Energy (5)

Waste composition and Classification: Organic municipal waste, clinical waste, sewage sludge, agricultural waste, Waste& biomass materials handling.

Module 6:Policies and Legislation (4)

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 Books:

1. Vaughn C. Nelson, Kenneth L. Starcher, Introduction to Renewable Energy. CRC Press; 2 edition 2016
2. Simona Ciuta, Demetra Tsiamis, Gasification of Waste Materials. Marco J. Castaldi. Academic Press (2017)
3. P. Chartier G.L. Ferrero U.M. Henius S. Hultberg J. Sachau M., Biomass for Energy and the Environment. Wiinblad. Pergamon (1997)
4. Bioenergy and Biochemicals Production from Biomass and Residual Resources, Editors: DimitarKarakashev and Yifeng Zhang MDPI Publisher 2018

Reference Books:

1. Jianzhong Sun, Shi-You Ding, Joy D. Peterson, Laurie Peter, Heinz Frei, Ferdi Schuth, Tim S. Zhao, Tao Ling. Biological Conversion of Biomass for Fuels and Chemicals: Explorations from Natural Utilization Systems. Royal Society of Chemistry; 1 edition (2013).

2. Jens Holm-Nielsen, Ehiaze Augustine Ehimen Biomass Supply Chains for Bioenergy and Biorefining.. Woodhead Publishing (2016).

20BT2054	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:

The students will be able to

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

Module1: Environmental Monitoring (8 hrs)

Major types of environmental pollutants, Sampling, physical, chemical and biological analysis, Removal of toxicants from contaminated sources by bioadsorption techniques.

Module2: 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.

Module3: 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.

Module4: 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, vermicomposting, land filling, conversion of solid waste into useful products: *in situ and ex situ* bioremediation, Reuse, Recycle and Recovering (3Rs).

Module5: 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

Module6: 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, quorum sensing.

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. 3rdEdition, Marcel Dekker, 2008
3. Piasecki, B.W., Fletcher, K. A. and Mendelson, F. J. 2010. Environmental Management and Business Strategy John Wiley & Sons, 2010.

20BT2055	MATLAB PROGRAMMING	L	T	P	C
		3	0	0	3

Course Objective:

1. To impart knowledge on matlab installation, configuration and basic syntax.
2. To introduce them to various matrix, vector, data and string operations, functions and advanced matlab operations for multivariate data analysis, modelling, optimization tool
3. To understand the applications of Matlab for various biological data analysis.

Course Outcome:

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)

Matlab Local Environment Setup, Different window interface: script, and command prompt; working directory, Variables, Naming Variables, Workspace variables, clearing variables, and command windows, output formats, Creating Vectors - Creating Matrices. Basic structure of matlab scripts, main function

Module 2:Matlab Commands (9)

Commands for Managing a Session - Commands for Working with the System-Input and Output Commands (on screen input output for text, numeric data), data import from txt, xls, website data, exporting data into txt file, structure, Vector, Matrix and Array creation, manipulation, searching, arithmetic operation, statistical summary, Cell array, M-Files Creating and Running Script File. Data input and output to and from matlab script, environment.

Module3:Data Types, Operators (6)

Data Types Available in MATLAB (Cell, character, datetime, floating-point, integer, logical, string, structure, table, timetable) Data Type Conversion - Determination of Data Types, storing data into cell and extracting from cell, Operators, Arithmetic, relational, and logical operators, Data structure, Table operation

Module4:Control Structures (6)

Control structures - Decision Making, Loops and conditional Statements, ‘for’, ‘if else’, ‘while’ Switch Case. String comparison, terminating control structure: Continue, pause, break, return

Module 5:Advanced Matlab (7)

Functions, anonymous function, function without input or output arguments, specialized inbuild functions (e.g. crossval, bootstrp). Primary and Sub-Functions, Nested Functions, Private Functions, Global Variables, Matlab Plotting: line, scatter, bar plot, histogram, box-plot, subplot, figure attributes and properties

Module 6:Matlab for Biological Applications (10)

Processing biological sequences with MATLAB– Sequence acquisition, Operations on nucleotide sequences, Joining sequences, Restriction site detection, Information retrieval from biological databases. Application example: detect cancer using mass spectrometry data on protein profiles using ANN, Accessing NCBI Data from the MATLAB® Workspace, Exploring Primer Design, https://in.mathworks.com/solutions/biological-sciences/genomics.html

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.

20BT2056	ENTERRENEURSHIP IN BIOENGINEERING	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 Outcomes:

The students will be able to

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

Module 1: Concept of Entrepreneurship (7 hrs)

Concept and theories of Entrepreneurship, Entrepreneurial traits and motivation, Nature and importance of Entrepreneurs, types of Entrepreneurship, stages in entrepreneurial process, entrepreneurship in India, Creativity and Entrepreneurial personality, Entrepreneurship in Biotechnology.

Module 2: Societal Role in Entrepreneurship (6 hrs)

Role of society and family in the growth of an entrepreneur. Challenges faced by women in entrepreneurship, Role of SSI in economic development, Government support for SSI. pillars of bio-entrepreneurship and major start-ups in Biotechnology, Government schemes for commercialization of technology (eg. Biotech Consortium India Limited).

Module 3: Product Design and Prototype (8 hrs)

Identification of business opportunities, project selection, contents, formulation, guidelines by planning commission for project report. Product design, product development process, sources of ideas for designing new products, stages in product design. Creativity and innovation, generation of ideas, technical and market feasibility study, business plan preparation, execution of business plan, conversion of ideas to prototype. IPs of relevance to biotechnology and few case studies

Module 4: Start up support and financial analysis (8 hrs)

Case study on Startup village, Kochi; 10000 Start-ups of NASSCOM and Silicon Valley, USA, Startup policies of Central Government and some leading State Governments Technology Business Incubator (TBI), Role of National Science and Technology Entrepreneurship Development Board (NSTEDB), DBT-BIRAC, DST guidelines for Seed Support System (SSS) for Startups in Incubators. Ratio analysis, Investment process, Break even analysis, Profitability analysis, Budget and planning process.

Module 5: Funding of biotech business (8 hrs)

Financing alternatives, Venture Capital funding, funding for biotech in India, Exit strategy, licensing strategies, valuation, support mechanisms for entrepreneurship, Bioentrepreneurship efforts in India, difficulties in India experienced, organizations supporting biotech growth, areas of scope, funding agencies in India, biotech policy initiatives.

Module 6: Biotech enterprises (8 hrs)

Desirables in start-up, Setting up Small, Medium and Large scale industry, Quality control in Biotech industries, Location of an enterprise, steps for starting a small industry, incentives and subsidies, exploring export possibilities, import- export license of biotech and agro products.

Total Hours: 45

Text Books:

1. Jayshree Suresh, "Entrepreneurial Development", 5th Edition, Margham Publications, 2011.
2. Robert D. Hisrich, "Entrepreneurship", 6th Edition, Tata McGraw Hill Publications.2012.

Reference Books:

1. Donald F. Kuratko, "Entrepreneurship: Theory", Process and Practice 9th Edition, Cengage Learning, 2011.
2. Craig Shimasaki Biotechnology Entrepreneurship, Academic Press is an imprint of Elsevier, 2014
3. Hyne D. and John Kapeleris, Innovation and entrepreneurship in biotechnology: Concepts, theories and cases, 2006.

20BT2057	BIOETHICS, IPR AND BIOSAFETY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand Biosafety regulations and IPR
2. To know ethical reasons behind transgenics and human genome projects
3. To know ethical issue of organ transplantation and transgenic animals

Course Outcomes:

The students will be able to

1. Recall different rDNA technology of transgenic in animals, humans and microorganisms
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: Biosafety (6 hrs)

Introduction – biosafety issues in biotechnology - historical background. Biological Safety Cabinets, Primary Containment for Biohazards. Biosafety Levels - Levels of Specific Microorganisms, Infectious Agents and Infected Animals.

Module 2: Biosafety Guidelines(8 hrs)

Guidelines and regulations (National and International including Cartegana Protocol) – operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs. Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture. Environmental release of =GMOs - Risk - Analysis, Assessment, management and communication

Module 3: Intellectual Property Rights (9 hrs)

Introduction to IPR, Types of IP - Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications. Importance of IPR – patentable and non patentables, patenting life, legal protection of Biotechnological inventions. Agreements and Treaties - History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments. IPR and WTO regime - Consumer protection and plant genetic resources

Module 4: Patents and Patent Laws (9 hrs)

Objectives of the patent system - Basic, principles and general requirements of patent law. Biotechnological inventions and patent law - Legal development - Patentable subjects and protection in Biotechnology. Patent Filing Procedures - National & PCT filing procedure, Time frame and cost, Status of the patent applications, Precautions while patenting, disclosure/ nondisclosure, financial assistance for patenting, introduction to existing schemes. Patent licensing and agreement. Patent infringement - meaning, scope, litigation, case studies

Module 5: Bioethics (9 hrs)

Bioethics: Introduction to ethics and bioethics, framework for ethical decision making. Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. Ethical implications of GM crops, GMO's, human genome project, human cloning, designer babies, biopiracy and biowarfare. Eugenics and its possible approaches. Animal right activities - Blue cross in India- society for prevention of cruelty against animals. Ethical limits of Animal use. Green peace - Human Rights and Responsibilities

Module 6: Organs Transplantation in Human Beings (5 hrs)

Organs Transplantation in Human Beings, Ethics in Xenotransplantation, Bioethical Issues.

Total Hours: 45

Text Books:

1. Sree Krishna. Bioethics and Biosafety in Biotechnology. New Age International Publishers, New Delhi, 2007
2. Sateesh, M.K., Bioethics and Biosafety, IK International Publishers (2008)

Reference Books:

1. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
2. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).

20BT2058	TISSUE ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. Provide knowledge about cell culture, cell signaling and growth factors
2. Inculcate the importance of characterization in cell culture for the identification
3. Impart technical skills in tissue implants and tissue engineering

Course Outcomes:

The students will be able to

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

Module 1: Introduction to Tissue Culture :(9)

Introduction, Cell Culture Media, Quantification of Cells, Cell cycle Time, Cell Migration, Microbial Contamination

Module 2: Characterization and Differentiation: (9)

Characterization: Morphology, Chromosome Analysis, Enzyme Activity. Differentiation: Proliferation, Lineage, Markers of Differentiation, Genetic Instability

Module 3: Biomaterials and Organs for Transplants (9)

Scaffolds, Biomaterials for Tissue Engineering, Collagen, Silk and Polylactic Acid, Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells in tissue engineering

Module 4: Specialized cells and 3D Culturing (9)

Epithelial Cells, Mesenchymal Cells, Neuroectodermal cells, Hematopoietic cells, 3D cell culture of different types of cells, cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering.

Module 5: Applications in Medical Fields (5)

Product development using tissue Engineering, Current scope of development of tissue engineering in therapeutics and in-vitro testing, Artificial blood vessel, Artificial Liver tissue engineering.

Module 6: Regulatory Issues (4)

Ethical, FDA and regulatory issues of tissue engineering,

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. Bernhard Palsson, Jeffery A. Hubbell, Robert Plonsey, Joseph D. Bronzino, Tissue Engineering, CRC Press, 2019**.**

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, 4th ed. 2014
3. Palsson B., Hubbell J.A., Plonsey R.& Bronzino J.D., Tissue Engineering, CRC- Taylor & Francis, 2006.

20BT2059	IoT IN BIOTECHNOLOGY	L	T	P	C
		2	0	0	2

Course Objectives:

1. To learn the basics of IOT.
2. To identify the various components and application of Biotechnology in IOT.
3. To integrate concepts for research and development in biotechnology using IOT.

Course Outcomes:

The students will be able to

1. Understand the history and basic concepts of IOT.
2. Identify the various components of IOT.
3. Use IOT for different biotechnological applications.
4. Categorize IOT to different pharmaceutical applications.
5. Justify significance of IOT in research and development.
6. Plan IOT with future trends in biotechnology.

Module 1: Historical background of IoT[4 Hours]

The concept, The idea of connected device - “embedded internet” or “pervasive computing”. Pioneering work done by Kevin Ashton at Procter & Gamble in 1999 in the field of supply chain management by RFID technology. Gap until 2010. Emergence from 2011 as a technology, Concept - “The Internet of Things”.

Module 2: Components of IoT[5 Hours]

Sensors & Actuators, Transceivers, Communication platforms - Ethernet, cellular, and Wi-Fi. Processors & Boards, Power Supplies - Conventional thin film batteries; photovoltaic panels and energy harvesting modules, Gateways & Routers, Devices & Equipment Products used by end users - enabled equipment, wearables, hand-held scanners, and tracking devices.

Module 3: IoT in Biotechnology [6 Hours]

IoT in Agricultural Biotechnology - the demand of more food with other challenges including extreme climatic and weather conditions, reducing ground water supply and associated environmental impact, development of smart sensors, automated hardware's and vehicles, robotics control systems, Agricultural farming - variable rate irrigation optimizer (VRI), soil moisture probes, virtual optimizer PRO and other IoT based systems. Soil fertility. Smart green houses, Drones for aerial monitoring of land. Cloud computing in agriculture.

Module 4: IoT in Pharmaceutical Biotechnology [5 Hours]

Discovery of novel drugs and biologics, Challenges - product instability and subsequent recalls, GMP and GDP regulations, supply chain management. Concept of "Organ in a Chip", Smart warehouses, 2D bar-coding, RFID tags, Automatic Information Data Collection (AIDC) in packaging, Complete digital foot print - cold chains for the temperature-sensitive drugs during the transport.

Module 5: IoT in Research and Development in Biotechnology – Case Studies [5 Hours]

Era of "omics" - high evolutionary pace of novel microbial strains, phages and other biological breakthroughs, acquisition of reproducibility and consistency, Challenge of reproducibility, Case Study - Healthcare leader Bayer, Amgen. Negative Case Study - Amyris (bioreactors). IoT enabled instruments with intelligence, interconnected communication protocols - RF and Bluetooth low energy, high end sophisticated sensors, Cloud servers, Case Study - Laboratory automation - Synbio. (Europe British) enhancing productivity, accuracy and reproducibility, Automated smart labs (USA), Case Study - Ginkgo Bio-works.

Module 6: Current Challenges and Future Prospects [5 Hours]

The emergence of IoT paradigm, Innovation, invention and productivity in biotechnological research for the successful implementation at global scale, Challenges - The complex configurations of IoT devices, Acceptance in biotech industry, End users, Security interfaces, Auditing and logging. Future perspectives - Establishment of network integrity in the R&D laboratory, Networking. Automation in the laboratory.

Total Hours: 30

Text Book:

1. Tripathy B.K., Anuradha J. Internet of Things (IoT), Technologies, Applications, Challenges, and Solutions. CRC Press London. 2018.

Reference Books:

1. Michael Miller. The Internet of Things: How Smart TVs, Smart Cars, Smart Homes, and Smart Cities Are Changing the World. 2015.
2. Dieter Uckelmann, Mark Harrison, Florian Michahelles. Architecting the Internet of Things. 2011.
3. Sean Dodson and Rob van Kranenburg. The Internet of Things. 2008.

20BT2060	DEVELOPMENTAL BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide with fundamentals and concepts of developmental biology.
2. To make students understand about the events involved in the formation of embryo.
3. To impart the knowledge in the environmental assaults in human embryonic development and ethical issues.

Course Outcomes:

The students will be able to

1. Describe the basics of early development of embryos
2. Relate the role of genes and its expression during the process of the development of organs in the embryo and its development
3. Interpret about Cell to communication and the role of hormones for the embryonic development
4. Appraise the knowledge of organs in the embryo
5. Describe the role of gene expression in embryonic development

6. Analyze about the environmental impact on embryo development and ethical issues on the same.

Module 1: Early Drosophila Development (7)

Cleavege, Gastrulation, Origin of anterior-posterior polarity, maternal effector genes, Segmentation genes, gene pattern, body plan.

Module 2: Internal fertilization in mammals (8)

Getting gametes into oviduct: Translocation and capacitation Hyperactivation, thermotaxix and chemotaxis Recognition at Zona pellucida- Gamete Fusion and Prevention of Polyspermy Fusion of genetic material

Module 3: Cell to cell communication in development of embryos (7)

Induction and competence, paracrine factors, Signal transduction pathways, Juxtacrine signaling, crosstalk pathways.

Module 4: Early mammalian development: (9)

The unique mammalian cleavage, compaction escape from zona pelucida, Gastrulation in mammals, modification and development, formation of extra embryonic membrane, organogenesis

Module 5: Gene expression and human disease (9)

In born errors of nuclear RNA Processing, In born errors of translation, Diagnosis infertility, In vitro fertilization procedure, prenatal diagnosis, preimplantation genetics.

Module 6: **Environment assaults on Human development (5)**

Endocrine disruptors and human development, Teratogenic agents, ethical issues in *In vitro* development of embryo.

Total Hrs (45)

Text Books

1. Scott F. Gilbert, "Developmental Biology, 9th edn. Sinauer Associates, Incorporated,USA. 2010.

Reference Books:

1. Willium. J. Larsen, Human Embryology 3rd ed. Churchill Livingstone, 1998
2. Bruce M. Carlson, Human Embryology and Developmental Biology, 5th ed.,Saunders Publication, Elsevier 2013.

20BT2061	BIOLOGY FOR ENGINEERS	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:

The students will be able to

1. Define Life and Life forms.
2. Recognize the importance of Human health, disease and Comorbidities.
3. Analyze biomolecules and enzymes in biological processes.
4. Appraise the Significance of entrepreneurship and industry.
5. Design a sustainable idea that is a trend for drug resistance.
6. Evaluate ethics and honors for research in Biology.

Module 1: Life and Life-Forms

Brief Introduction about the Course. Evolution, Origin of Universe, Origin of Life, Evolution of Life Forms, Evidences of Evolution, Adaptive Radiation, Theories of Evolution, Biological Evolution, Hardy–Weinberg Principle, A Brief Account of Evolution. A History of Biology in 20 Objects Case Study – Neanderthals to Homo-Sapiens. [8 Hours]

Module 2: Health and Well-Being and Stress Management

Eukaryotic Cells, Cell Cycle and Cell Division, M Phase, Meiosis, Cell Differentiation, Nutrition in Humans – Macronutrients and Micronutrients. The Human Body during Health and Disease – Example –

Two Systems – Circulatory and Digestive. 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. **[9 Hours]**

Module 3: Molecules that make us

Biomolecules (Carbohydrates, Proteins, Lipids, and Nucleic Acids) – Types and Properties. Enzymes, Classification and Nomenclature of Enzymes, Co-Factors, Importance of Enzymes. Case Study - Crime Scene Investigation. **[7 Hours]**

Module 4: Biotechnology at Home and in Industry

Microorganisms, Growth Kinetics, Culture Media, Sterilization, Microscopy, Applications of Microbiology, Immunology and Immunity, Cancer Biology, Stem Cell. Bread, Beer and Batter. The Fermentation Industry – Principles, Processes and Products. Case Study – Kraft Beer Industry. **[7]**

Module 5: Trends in Genetics and Drug Resistance

Genetics - Mendelian Law, Mendel's Laws of Inheritance, Gene Interaction, Multiple Alleles, Chromosomal Theory of Inheritance, Linkage, Recombination (Crossing Over), Chromosome, Mapping, Genetic Disorders, Biofuels. Human Cloning. Drug Resistance. **[8 Hours]**

Module 6: Ethics and Genetic Code (5)

Biosafety and Ethics. Central Dogma of Molecular Biology, Transcription, Genetic code, Translation, Regulation of Gene Expression. **[8 Hours]**

Total Hours: 45

Text Books:

1. G. K. Suraish Kumar, Biology for Engineers, Oxford University Press, 2019.
2. Rajiv Singal, Gaurav Agarwal, Ritu Bir, Biology for Engineers, CBS Publishers and Distributers Pvt. Ltd.

References Books:

1. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, "Principles of Fermentation Technology", Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2nd edition, 2005.
2. Arthur C Guyton, "A Textbook of Human Physiology", Elsevier Saunders, International Edition, 11th Edition, 2006.
3. Peter Raven et al "Biology", McGraw-Hill Education; 10th Edition, 2013.

20BT2062	ROLE OF BIOTECHNOLOGY IN ENVIRONMENT	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

The students will be able to

1. Acquire knowledge on the scope of biotechnology
2. Classify the health hazards of various pollutants
3. Explain 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. Bio accumulation – Bio magnification. Biological control. Principles of environment Impact. Assessment and environmental monitoring.

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; A general account on multilateral treaties- the role of CBD, IUCN, GEF, IBPGR, NBPGR, WWF, FAO, UNESCO and CITES-Bioresources

Module 5: **Bioremediation and Biodegradation (9 hrs)**

Types- Ex situ and In situ , Bioremediation genetically Engineered Microbes for Bioremediation. Applications of genetic engineering- Transgenic animals-cow, sheep and rabbit

Module 6: IPR and Biosafety (4)

IPR, patenting, biosafety - levels of biosafety, guidelines for biosafety and principles of biosafety

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.

20BT2063	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 function of various biomolecules.
2. To introduce them to the basic nature and properties of nucleic acids
3. To understand the significance of these biomolecules

Course Outcomes:

The students will be able to

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

Module 1:Carbohydrates (9)

Definition, Nomenclature, Classifications and Structures of sugars. Structural features of polysaccharides. Glycolysis, glycogen breakdown and synthesis, Gluconeogenesis,

Module 2:Fatty Acids (9)

Fatty acids- basic structure, types, isomers, properties, functions and essential fatty acids; Classes, structure, properties and functions of lipids: Simple lipid- examples, Compound lipid- examples, ether lipid, Derived lipid –Metabolism of lipids: Fatty acid biosynthesis and oxidations.

Module 3:Amino Acids (9)

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

Module 4:Enzymes (9)

Enzymes and co-enzymes, IUB classification and nomenclature of enzymes, regulation of enzyme activity, active sites, activators and inhibitors; Isoenzymes, allosteric enzymes.

Module 5:Nucleotides (5)

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 6: Vitamins (4)

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

Total Hours: 45

Text Book:

1. Lehninger, A.L, Nelson D.L and Cox, M.M, "Principles of Biochemistry", Freeman Publishers, New York, 7th edition, 2017.

Reference Books:

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

20BT2064	PATHOLOGY AND MICROBIOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. To learn the medical aspects of bacteriology, virology, mycology and parasitology along with concepts of symptoms, pathogenesis, transmission, prophylaxis and control
2. To understand how disease processes affect physiological function of the host
3. To analyze how disease processes can result in specific clinical signs and symptoms

Course Outcomes:

The students will be able to

1. Recognize the basic elements concerning cell injury and death, tumors and the mechanisms of response to tissue injury
2. Compare different clinical manifestations of different types of pathogens
3. Compare and contrast experimental approaches with their advantages/disadvantages of each approach for specific pathogens.
4. Adapt the physical and chemical methods to control the growth of microbes
5. Evaluate immunopathology, oncology, general and organ-specific pathophysiology
6. Critically analyse the standards of practice of medical laboratory science in clinical/research microbiology laboratories including laboratory safety standards

Module 1: General Pathology (9 Hours)

Cellular adaptation- atrophy, hypertrophy; Cell Injury- necrosis and apoptosis; Inflammation and repair (Healing); Thrombosis and embolism, Oedema, Haemorrhage, Shock, Infarction, Amyloidosis, Hyperlipidaemia and lipidosis, Neoplasia: Benign and Malignant; Carcinoma and Sarcoma. Tumor

immunology. Laboratory diagnosis: Cytology, Biopsy, Tumor markers, Immunity: innate and specific immunity

Module 2: Systemic Pathology (5 Hours)

General overview of the diseases: Cardiovascular system, Kidney and lower urinary tract, Male reproductive system and prostate, Female genitalia and breast, Eye, ENT and neck, Respiratory system, Gastro Intestinal System, Skin and soft tissue

Module 3: Basics of Microbiology (8 Hours)

Organization and function of prokaryotic and eukaryotic cells; Structure and function of cell organelles-surface structure, special organelles, cellular reserve materials; Microscopy- Bright field, Scanning Electron Microscopy – Bacterial Staining: Gram; Cultivation- Media for growth; pure culture concept and cultural characteristics; Control of microorganisms by physical and chemical agents

Module 4: Bacterial diseases (8 Hours)

Normal microflora (microbiome) of human body and its role – Skin, mouth and respiratory tract, intestinal tract, urogenital tract; Pathogenesis and virulence factors - Koch's postulates, Adherence and invasion, Toxins, Enzymes- Clostridium spp., Staphylococcal infections, E. coli, Helicobacter pylori, Mycobacterium spp. Antibacterial chemotherapy (with few examples of antibiotics) - antimicrobial activity *in vitro*

Module 5: Viral, Fungal and protozoan infections (8 Hours)

Viral Pathogenesis - Routes of entry, Viral spread (local and systemic infection); Dengue, Influenza virus-Swine flu, HIV/AIDS; Emerging viral diseases – Ebola, Chikungunya; Fungal infections: Types of Mycoses (with specific example of causative fungi) – Superficial, Cutaneous, Sub-cutaneous; Endemic and Opportunistic; Mycotoxins- Aflatoxins; Protozoan diseases - Amoebiasis, Infection by Helminths – Nematodes

Module 6: Collection and Transportation of Specimen (7 Hours)

General Principles, Containers, Rejection, Samples- Urine, Faeces, Sputum, Pus, Swab; Care and Handling of Laboratory Animals- Fluid, Diet, Cleanliness, Cages, ventilation, Temperature, Humidity; Disposal of Laboratory/Hospital Waste- Non-infectious waste, Infected sharp waste disposal, infected non-sharp waste disposal.

Textbooks:

1. KC Carroll, SA Morse, T Mietzner, S Miller. (2016), Jawetz, Melnick and Adelbergs's Medical Microbiology, 27th edition, McGraw Hill.
2. V Kumar, AK. Abbas and JC Aster, (2015), Robbins & Cotran Pathologic Basis of Disease, 9th Edition, Elsevier.
3. Ramzi S Cotran, Vinay Kumar and Stanley L Robbins, "Pathologic Basis of Diseases", 7th edition, WB Saunders Co. 2010.

Reference Books:

1. Dubey RC and Maheswari DK. "A Text Book of Microbiology" Chand & Company Ltd, 2014.
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.

20BT2065	HUMAN ANATOMY AND PHYSIOLOGY	L	T	P	C
		3	0	0	3

Course objectives:

1. Provide the basics on the structure of cell and organelles
2. To ensure the students study the structure of different organ systems
3. Impart knowledge in the human anatomy and physiology

Course Outcomes:

The students will be able to

1. Define the basic concepts of cells, their functions and membrane transportation
2. Discuss the importance in body fluids and its role in homeostasis.
3. Appraise the function and the components of respiratory and cardiovascular systems.
4. Comprehend the role of neurons and its application
5. Illustrate the structure and functions of nervous system and parts of brain of Human system
6. Analyze the physiological conditions of the human body and understand the symptoms pertaining to any disease

Module 1: Cellular and Tissue Organization (7)

Structure and organelles, function of each component. Cell membrane, transport across membrane, cell membrane potential, action potential.

Module 2: Blood Composition (8)

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 (7)

Structure and function of trachea, bronchi, bronchioles and alveoli, lungs- position, associated structure pleura and pleural cavity, cycle of respiration, Lung volume and capacity. -

Module 4. Heart and Its Regulation (8)

Heart- position, structure pericardium, myocardium, endocardium, interior of the heart, flow of blood through the heart, blood supply to heart, Conducting system of the heart, factors affecting heart rate, the Cardiac cycle, cardiac output, blood pressure, control of blood pressure, pulse and factors affecting the pulse rate. Circulation of the blood- pulmonary circulation, systemic circulation aorta

Module 5: Structure of a Neuron (7)

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 and Excretion system(8)

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

Total Hours: 45

Text Books:

1. Guyton and Hall, "Text book of Medical Physiology", 11th edition Saunders, an imprint of Elsevier Inc. Philadelphia. 2011.
2. 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.

20BT2066	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:

The students will be able to

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 immune cells.
5. Comprehend the cellular/molecular pathways in health and disease.
6. Apply the principles of immunology in disease protection and immune disorders.

Module 1: Features of cell (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.

Module 2: Cytoskeleton and Cell Transport (8 hrs)

Microtubules, microfilaments, intermediate filaments and their binding proteins, Cell- cell communications, Passive and active transport, 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)

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

Module 5: Cells of the Immune System, Antigen-Antibody Complex (9 hrs)

Granulocytes & Agranulocytes, Haematopoisis,. Antigens- chemical and molecular nature; Haptens; Adjuvants. Antibody – structure and classes, Antigen-Antibody reactions: Neutralization, Opsonization, Phagocytosis, Complement, Cytokines.

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

Major Histocompatibility Complex; antigen processing and presentation, T-Cell activation and the cellular immune response. Immunity to pathogens; Immune dysfunction, Autoimmunity, hypersensitivity, Immunodeficiency. Immunosupression and Transplantation:

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.

20BT2067	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:

The students will be able to

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. Regulation at transcription and translation in eukaryotics.

Review on loss of regulation and defect in DNA repair system leading to genetic disorders and diseases.

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

20BT2068	PRINCIPLES OF PLANT BIOTECHNOLOGY AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To recall the plant tissue culture techniques and its applications.
2. To examine the plant transformation and breeding techniques
3. To employ the drug production strategies in plant biotechnology

Course Outcomes:

The students will be able to

1. Summarize cell and tissue culture techniques.
2. Illustrate the knowledge on plant genetic engineering tools.
3. Enumerate the different vectors used in plant transformation
4. Employ different methods of in vitro drug production techniques
5. Examine the principles of plant breeding and protection
6. Assess the different bioreactors and its applications in plant biotechnology

Module 1: Plant Tissue Culture (8 hrs)

History-tissue culture lab - establishing aseptic conditions -types of media and their preparation plant hormones -organogenesis–direct and indirect (meristem/shoot apex culture, callus and suspension culture), Significance and application of anther culture, ovule culture, embryo culture-somatic

embryogenesis-protoplast fusion-somaclonal variation-artificial seeds-micropropagation. Hardening and acclimatization of tissue cultured plants

Module 2: Plant Genetic Engineering Tools (8 hrs)

Biology of Agrobacteriumtumefaciens-plant transformation methods-stable and transient-Agrobacterium-mediated,biolistic,PEG/liposome-mediated,electroporation,chloroplast Transformation, protoplast transformation, site directed integration of transgene (zinc finger).

Module 3: Vectors in plant transformation (8 hrs)

Binary and co-integrate vectors-gateway vectors-promoters-selectable and screenable markers-marker free transgenics-significance and applications. Plant as Bioreactors- edible Vaccines; Germplasm conservation; Gene Banks; Crop improvement; legume symbiosis, N_2 Fixation; Regulation of NIF and NOD Genes.

Module 4: Secondary metabolite production in tissue culture: **(6 hrs)**

Callus culture initiation, biotransformation, elicitation, hairy root culture, immobilization, permeabilization.

Module 5: **Plant Breeding and Protection (6 hrs)**

Sexual hybridization Mutagenesis – Polyploidy, Genetic resources for breeding, Germplasm conservation, Marker assisted selection, cultivar release and commercial seed production, Biotic stress factors and natural disease resistance pathways, Abiotic stress factors - tolerance mechanisms.

Module 6: **Bioreactors for drug production (9 hrs)**

Bioreactors: In-Process control (IPC), determination of plant cell growth: Illumination, Types of bioreactors for plant cell suspension culture, Re- and multi usable bioreactors for plant cell suspension culture, Single-use and disposable bioreactors for plant cells and tissue cultures, Re- and multi usable bioreactors for root culture, Single use vs re- and multiusable bioreactors. Advantages and disadvantages.

Total Hours: 45

Text Books:

1. Adrian Slater, Nigel W. Scott, Mark R. Fowler,"Plant Biotechnology-TheGenetic Manipulation of Plants"third edition, Oxford University Press, 2008.
2. Mantal S.H., Mathew J.A.,Mickee R.A., Principles of Plant Biotechnology. An Introduction to Genetic Engineering in Plants, Blackwell Scientific Publication, 2006.

Reference Books:

1. Dodds J.H., Plant Genetic Engineering, Cambridge University Press, 2005.
2. C Neil Stewart Jr. "Plant Biotechnology and Genetics "- John Wiley & Sons, Inc., New Jersey 2008

20BT2069	ADVANCES IN ANIMAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart technical knowledge in cell culture techniques and development of skills for *In vitro* culture of cells and its products
2. To conceptualize tissue engineering techniques for organ transplantation
3. To acquaint learners with the development of transgenic animals, and debate on the boon and bane of Genetically Modified Organisms

Course Outcomes:

Students will be able to:

1. Demonstrate the cell culture techniques for maintenance of cell lines
2. Recognize the importance of scaling up of cell culture for development of cell culture products
3. Interpret the applications of tissue engineering and 3D cell culture techniques
4. Relate the need of genetic screening for *In vitro* fertilization
5. Apply the knowledge of livestock improvement using transgenesis
6. Assess the scope, applications and ethical issues in animal biotechnology

Module 1: Cell Culture, Cell Separation and Characterization (12 hrs)

Layout of cell culture laboratory, Introduction to culture techniques, chemically defined media, serum and serum free media. Primary cell culture and types, Establishment of cell lines, maintenance and preservation, Cell separation by density gradient, Fluorescent activated cell sorting, Characterization: Morphology, Chromosome analysis, Isoenzymes, Cell Banks.

Module 2: Scaling up of Cell Cultures and Product Development (6hrs)

Scaling up of adherence and suspension cultures, Continuous flow culture, Cell culture as a source of various products-Vaccines, Enzymes and Hormones.

Module 3: Tissue Engineering :(7hrs)

3D culturing, protocols for 3D culturing of cells, Scaffolds as biomaterials for tissue engineering, Stem cells in tissue engineering, Organs for transplantation protocols (Skin, Bone, Nerve and Cardiovascular Tissue)

Module 4: Nutritional Biotechnology (5hrs)

Bio conservation of lignocellulose (high quality dietary fiber), Genetic manipulation of microbes for improved feed utilization and health, Fermentation process of milk and meat

Module 5: Micromanipulation of Embryos (7hrs)

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 6: Transgenic Animals and Live Stock Improvement (8hrs)

Molecular diagnosis of animal diseases, Concepts of transgenic animal technology: Strategies for the development of transgenic animals and their importance in Biotechnology, Stem cells in the development of transgenic animals, Marker assisted selection, Gene knock out in animals, gene banking, Use of Artificial Intelligence in Animal monitoring, Ethical and Regulatory issues in Animal Biotechnology.

Total Hours: 45

Text Books:

1. Ranga M.M. Animal Biotechnology. 3rd ed., Agrobios. 2007.
2. *R. Ian Freshney. Introduction to Culture of Animal Cells:* A Manual of Basic Technique and Specialized Applications, 6thed.,.*Publisher*, John Wiley & Sons, 2011.
3. Birbal Singh, Gorak Mal, Sanjeev K Goutam. Advances in Animal Biotechnology, 1st ed. Springer, 2019.

Reference Books:

1. Animal Biotechnology 1**. Niemann,** Heiner, **Wrenzycki**, Christine .ed., Springer Publishing. 2018.
2. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. *New Generation Vaccines*. 3rd Ed. Informa Healthcare. 2004.
3. Animal Cell Culture by John R.W. Masters 3rd ed., Oxford University Press, 2009.

20BT3001	ADVANCES IN BIOPOLYMER AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

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

Course Outcomes:

The students will be able to

1. Recall the basic structure, composition and functions of biopolymers.
2. Demonstrate the applications of biopolymers in medical, pharma, food and agro industries
3. Apply technologies such as 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 biopolymers research and their applications

Module 1: Glycans and Glycobiology (10 Hours)

Glycoconjugates – glycoproteins, glycolipids and lipopolysaccharides; Glycans and blood groups, Lectins 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 and Enzyme technology (10 Hours)

Structure- function relationship in fibrous and globular proteins, industrially significant peptides; Protein Engineering Methods - Applications of proteins: Food industry, Environmental, Medical. 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. Enzyme immobilization techniques and its applications.

Module 3: Hormones and Antibodies (6 Hours)

Mechanism of actions of chemically diverse hormones, Hormone therapy, Applications of hormones in anti-ageing medicine. Antibody engineering, Abzymes

Module 4: Lipid Technology and Applications (7 Hours)

Industrial applications of fatty acids and lipids, role of lipids in pharmaceutical industry, Structured Lipids for Food and Nutraceutical Applications

Module 5: Nucleic Acid Biopolymer (6 Hours)

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

Module 6: Recent trends in Biopolymer applications (6 Hours)

Applications of biopolymers in food and packaging industry, Biopolymer scaffolds and tissue engineering, Biopolymers and bioremediation, Liposomes and their novel applications in nanobiotechnology and medicine.

Text book:

1. Lehninger A. L, Nelson D. L. and CoxM. M. “Principles of Biochemistry” Seventh Edition (Freeman Publishers), New York, 2017.

Reference Books:

1. Varki A, Cummings R.D, Esko J.D, Freeze H.H, Stanley P, Bertozzi C.R, Hart G.W,Etzler M.E., “ Essentials of Glycobiology”, Second edition; Published by Cold Spring Harbor Laboratory Press, New York, 2009
2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. “Harper’s Biochemistry”, Prentice Hall International, 2015.
3. Donald Voet and Judith G. Voet . “Biochemistry” – Volume 1, Biomolecules, Mechanisms of Enzyme Action and Metabolism, John.Willey and sons, 2010.
4. BurcuTuranli-Yildiz, CerenAlkim and Z. PetekCakar (2012). Protein Engineering Methods and Applications, ISBN: 978-953-51-0037-9

20BT3002	GENETIC ENGINEERING AND RECOMBINANT PRODUCTS	L	T	P	C
		3	0	0	3

Course Objectives:

To gain knowledge about

1. The history and future of genetic engineering

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

Course Outcomes:

The students will be able to

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 of plants for crop improvement
5. Illustrate the techniques employed in the genetic manipulation of 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 Hours)

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

Module 2: Tools employed in Genetic engineering: Vectors & Enzymes (7 Hours)

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 Hours)

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 Hours)

Construction of Genomic DNA libraries & cDNA libraries, PCR Cloning of DNA for Expression in E.coli, Yeast, Plant & Mammalian cells. Physical, chemical and biological methods of transferring recombinant DNA into target cells. Restriction analysis, Probe preparation and labeling methods, hybridization methods

Module 5: Protein and Nucleic Acid products of rDNA technology (9 Hours)

Production of hormones, enzymes for therapeutics and diagnostics. Recombinant enzymes for industrial applications.DNA oligonucleotides for Antigene applications, Gene editing tools: Meganuclease, CRISPER-CAS. ZFN, TALEN; RNA decoys, siRNA, micro RNA

Module 6: Application of Genetically Modified Organisms (9 Hours)

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.

Text Books:

1. Berhard R. Glick, Chery L. Patten, Molecular Biotechnology: Principles and Applications of Recombinant DNA, 5th edition, 2010
2. James D. Watson, Amy A. Caudy, Richard M. Myers, Jan A. Witkowski, Recombinant DNA: Genes and Genomes, W.H. Freeman, 2007

Reference Books:

1. GodbeyW T, **An Introduction to Biotechnology** ,AP, 2014
2. Kadema Carter, Biomedical Applications of DNA Recombinant Technology, Koros, 2014
3. Lilia Alberghina, **Protein Engineering For Industrial Biotechnology**, Hardwood Academic Press, 2000
4. Nigel W. Scott, Mark R. Fowler, Adrian Slater, **Plant Biotechnology**: **The genetic manipulation of plants**,2nd Edition, 2008
5. Carl A. Pinkert, **Transgenic Animal Technology**: A Laboratory Handbook, 2012.

20BT3003	BIOPROCESS MODELLING & SIMULATION	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

The students will be able to

1. Recognize the different stages and their inter-relationship in bioprocess modelling
2. Relate modelling, simulation and parameter estimation
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 Hours)**

Basic modeling principles – Purpose of modelling transient or steady state behavior – deterministic, stochastic, population based, mechanistic and empirical models. Fundamental laws guiding modelling framework – mass and energy balance, charge balance, equilibrium states and chemical kinetics, continuity equation.

Module 2: Mathematical formalization of Bioprocess **(7 Hours)**

Representation of Bioprocess (with examples) in terms of key mathematical expression, Data availability and designing data collection. Identifying key variables, parameters, number of equations, Kinetic expression, Conversion of algebraic to differential form for mass balance equations. Numerical modelling algorithm – initial value problem.

Module 3: Matlab basics for modelling **(10 Hours)**

Basics of Matlab environments, import from web, xls, txt file, variables, vector-matrices operations, Matlab functions, Numerical integration, Euler and fourth order Runge-Kutta method, Matlab ODE solver, choice of numerical solvers ode45, ode15s, ode23. Curve fitting toolbox for kinetic models simulating a bioprocess with known process parameters

Module 4: Matlab application in bioprocess modelling **(5 Hours)**

Solving problems by numerical integration. Modelling simple microbial growth, substrate consumption and product formation kinetics in batch Process. Incorporating substrate and product inhibition, multi-substrate growth models

Module 5: Parameter Estimation and sensitivity analysis, model fitness **(11 Hours)**

Parameter estimation from experimental and modelled data, least square regression, Use of local and global optimization tool for parameter estimation (Genetic algorithm). Cross-validation test for over-fitting, external validation, parameter Sensitivity and confidence interval estimation using boot-strapping

Module 6: Advanced Bioprocess Modelling examples **(5 Hours)**

Modelling and Simulation of Citric Acid Production from Corn Starch Hydrolysate, Mathematical modelling of ethanol production, Dynamic Modelling of Complex Enzymatic Reactions, Dynamic modeling of nutrient removal

Text Books:

1. Verma, Ashok Kumar, Process Modelling and Simulation in Chemical, Biochemical and Environmental Engineering, CRC Press, (2014).
2. Dunn, Irving J. Biological reaction engineering: dynamic modelling fundamentals with simulation examples, Wiley-VCH, (2003).

Reference Books:

1. Nicoletti, Maria Carmo, Computational Intelligence Techniques for Bioprocess Modelling, Supervision and Control. Springer, (2009)
2. Snape, Jonathan B. Dunn, Irving J., Ingham John, Prenosil Jiri E. ,Dynamics of Environmental Bioprocesses: Modelling and Simulation, John Wiley & Sons, (2008)

20BT3004	BIOCHEMICAL ANALYSIS LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. Clinical role of biochemical metabolites in biological sample.
2. Importance of biochemical metabolites and their assays
3. Advanced biochemical characterizationand structure prediction techniques

Course Outcomes:

The students will be able to

1. Recall the basic concepts and principles of different assays
2. Understand the protocol for 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 advanced 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 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 HP-TLC
11. Determination of molecular mass of phytochemicals by Mass spectrometry
12. Biomolecular structure prediction using X-Ray diffraction

Reference Books:

1. S.Sadasivam and A.Manickam, Biochemical Methods. 2nd edition, New Age International publishers, New Delhi, 2005
2. S.K. Sawhney and Randhir singh, Introductory Practical Biochemistry, Narosa Publishers, 2005

20BT3005	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. Performin 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. Media preparation and Axillary bud breaking method
2. Establishment of banana explant and Multiplication
3. Cell Suspension Culture for secondary metabolite production and growth kinetic studies
4. Establishment of hairy root culture for secondary metabolite production
5. Agrobacterium mediated gene transfer in *in vitro* plantlets
6. Passaging of cell line
7. Cryopreservation
8. Membrane integrity assay- Trypan Blue Staining
9. Metabolic activity assay- LDH assay
10. Functional assay- MTT/XTT
11. DNA assay- COMET
12. Micropropagation of medicinal plant

References:

1. Plant Tissue Culture: Theory and Practice Satish Kumar Sinha Oxford Book Company 2012
2. Bojwani, S.S. "Plant Tissue Culture: Applications and Limitations", Elsevier science publishers, 2001.
3. R. Ian Freshney. Introduction to Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. Publisher, John Wiley & Sons, 2011.

20BT3006	ADVANCED PROCESS EQUIPMENT DESIGN AND DRAWING LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To design safe and dependable processing facilities.
2. To design plant layout and selection using AutoCAD.
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. Engineering Letters, Lines and numbers.
2. Basics of various unit operation symbols
3. Design of Pharmaceutical Industry Plant layout
4. Design of Chemical Industry Plant layout
5. Design of Shell and tube heat exchanger
6. Design of Single effect evaporator
7. Design of Batch reactor
8. Design of Airlift Fermentor
9. Design of Fractional distillation column
10. Design of Rotary drum filter
11. Design of Absorption column
12. Design of Venturi meter

Reference Books:

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

20BT3007	GENETIC ENGINEERING LAB	L	T	P	C
		0	0	4	2

Co-requisite: Lab in Molecular Biology

Course Objectives:

To impart knowledge on

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

Course Outcomes:

After completing the course the students will be able to

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

Reference:

1. Michael R. Green, Joseph Sambrook, Molecular Cloning: A Laboratory Manual (Fourth Edition), 2012

20BT3008	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:

The students will be able to

1. Understand the concept of kinetics of immobilization
2. Understand molecular understanding of enzymes
3. Apply enzymes in sterospecific reactions
4. Evaluate application of enzymes
5. Analyze commercial production of enzyme

6. Create inhibition kinetics of the enzymatic reactions

Module 1: Introduction to enzymes (7 hours)

Brief history of enzyme engineering, 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 hours)

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

Module 3: Immobilized enzymes (7 hours)

Introduction, kinetics of immobilized enzymes, Analysis of film and Pore diffusion, Reactor systems and Engineering considerations

Module 4: Industrial enzymes (9 hours)

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

Module 5: Molecular Understanding of Enzymes (7 hours)

Enzyme catalysis- mechanism of enzyme activity, enzyme dynamics and flexibility; specificity of enzymes- substrate specificity, enantioselectivity of enzymes; thermodynamics and stability

Module 6: Enzyme in Organic Synthesis (8 hours)

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

Text Books:

1. Palmer, T., & Bonner, P. L. *Enzymes: biochemistry, biotechnology, clinical chemistry*. Elsevier, 2007
2. Punekar, N. S. *Enzymes*. Springer, 2018

Reference Books:

1. Guisan, J. M. (Ed.). *Immobilization of enzymes and cells* (Vol. 22). Totowa, NJ: Humana Press, 2006
2. Price and Lewis Stevens. Fundamentals of Enzymology, Oxford, United Kingdom, 2000
3. Yoo, Y. J., Feng, Y., Kim, Y. H., &Yagonia, C. F. J. *Fundamentals of enzyme engineering*. Springer, 2017
4. Liu, S. *Bioprocess engineering: kinetics, sustainability, and reactor design*. Elsevier, 2020

20BT3009	MICROBIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To study the role of microorganisms in medicine, agriculture, and the environment.
2. To impart knowledge concerning genomics and proteomics in biotechnology
3. To develop value added microbial based products for commercialization

Course Outcomes:

The students will be able to

1. Gain knowledge about recent advances in microbial biotechnology
2. Apply the concept of genomics and proteomics in biotechnology with regard to microorganisms
3. Acquire practical exposure to recombinant DNA technology in microbes to enhance animal health and production
4. Demonstrate and evaluate the interactions between microbes, hosts and environment.
5. Give an account of important microbial/enzymatic industrial processes in food and fuel industry.

6. Critically analyze any microbial products from an economics/market point of view

Module 1: Introduction to microbial technology (5 Hours)

Microbial technology in human welfare; Isolation and screening of microbes important for industry – advances in methodology and its application; Strain improvement to increase yield of selected molecules, e.g., antibiotics, enzymes, biofuels

Module 2: Microbial Genomics (9 Hours)

Introduction to Microbial genomes -Genome sequencing of different microbes; Microbial genomics for discovery of novel enzymes, drugs/ antibiotics-Multi Drug Resistance, Metagenomics and metatranscriptomics – their potential, methods to study and applications/use (animal and plant health, environmental clean-up, global nutrient cycles & global sustainability), Phylogenetic relationships between various genera of microbes; Global metagenomics initiative - surveys/projects and outcome

Module 3: Microbial Proteomics (8 Hours)

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

Module 4: Microbial interactions (6 Hours)

Interactions of microorganisms with plants, animals and humans- The gut microbiota; Bacteriophages in control of bacteria, Thermal adaptation of decomposer communities to global warming, Gene manipulation of useful microbes, Microbial communication system- Quorum sensing

Module 5: Microbes in food and agriculture (9 Hours)

Food processing and food preservation- Temperature, Food additives, Irradiation, Food Borne Intoxications- Clostridium botulinum, Staphylococcus aureus, Listeria monocytogenes, Mycotoxins, Production of bacteriocins from lactic acid bacteria and their applications in food industry; Non-recombinant ways of introducing desirable properties in Generally recognized as safe (GRAS) microbes to be used in food (e.g., Yeast); Bioinsecticides, biofertilizers, Mycorrhiza

Module 6: Production of Microbial Metabolites (8 Hours)

Production, recovery, stability and formulation of bacterial and fungal enzymes-penicillin acylase, glucose isomerase and Cell based biotransformations of steroids, antibiotics, alkaloids, enzyme/cell electrodes; Microbial fuel cells; Prebiotics and Probiotics; Microbiologically produced food colours and flavours; Biofuel production from microalgae, Production of recombinant bacterial/ viral vaccines against important animal diseases

Textbooks:

1. Ian Humphery-Smith and Michael Hecker, Microbial Proteomics: Functional Biology of Whole Organisms by Publisher: Wiley-Interscience; 1st edition, 2010.
2. Thomas J. Dougherty and Steven J. Projan, Microbial Genomics and Drug Discovery by Publisher: CRC; 1st ed. 2013.
3. Stanbury, P. F., Whitaker and Hall, A. S. J., Principles of Fermentation Technology. Butterworth-Heinemann, 2009.

References:

1. Shuler, M.L. and Karg, I F., Bioprocess Engineering Basic Concepts, 2010.
2. Crueger W. and Crueger, A., Biotechnology. A Textbook of Industrial Microbiology, Sinauer Associates, 2008.
3. El-Mansi, M., & Bryce, C. F. (2007). Fermentation Microbiology and Biotechnology. Boca Raton: CRC/Taylor & Francis.
4. Glazer AN, Nikaido H. 2007. Microbial Biotechnology: Fundamentals of Applied Microbiology. Cambridge University Press
5. Lin YK, Microbial Biotechnology: Principles and Applications. 3rd Ed. World Scientific

20BT3010	AGRICULTURE AND FOOD BIOTECHNOLOGY	L	T	P	C

		3	**0**	**0**	**3**

Course Objectives:

1. To enhance knowledge on principles of Agriculture and plant breeding
2. To analyze the biotechnology processing of food and packaging
3. To elaborate the understanding of marketing of agricultural produce.

Course Outcomes:

The students will be able to

1. Acquire knowledge on basics of biotechnology in Agriculture
2. Outline the applications of microbes in Agriculture
3. Understand the concept of industrial Biotechnology processes
4. Relate the technological applications in food processing
5. Evaluate the advances in Food processing and Packaging
6. Analyze Marketing and Export of Food Products

Module 1: Agriculture Biotechnology (8 Hours)

Plant derived Biotechnological Products, Plant tissue culture and Genetic engineering, integrated pest and nutrient management, poly house technology, Scenario of Biotech industries & Institutes, Concepts of Biotech Park. Entrepreneurship biotechnology

Module 2: Microbes in Agriculture (7 Hours)

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

Module 3: Industrial Perspectives (7 Hours)

Screening of microorganisms for new products. Fermentation process development. Shake flask, Scale up of process and bioreactors. Genetically engineered microbes (GEMs). Production of secondary metabolites. Process and types of bioreactors. Various methods of fermentation.

Module 4: Technological Applications in Food Processing (8 Hours)

Recent trends in food processing. Techniques and applications of immobilized enzymes in food industry. Single cell proteins for human food consumption. Biotechnology for natural and artificial flavor and fragrance production. Safety issues related processed foods, bio-preservation/ Natural preservation. Aseptic packaging/ vaccum packaging, biodegradable plastics, extrusion cooking.

Module 5: Food processing and Packaging (8 Hours)

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

Module 6: Marketing and Export of Food Products (7 Hours)

Food spoilage causes and prevention, Food borne infections and intoxication, immobilization of microbial and cultured plant cells. External trade in Agricultural products, Present status, policy and prospects under WTO regime. Quality parameters and quarantine procedures of export

Text Books:

1. Chawla H S, Introduction to Plant Biotechnology, 3Ed Oxford & IBH Publishing 2020
2. AkhilMathur, Food processing packaging by Anmol publisher (2012)
3. Acharya S.S., Agricultural marketing in India by Oxford & IBH publishing; 6th revised edition edition (2019)
4. William C. Frazier, Dennis C. Westhoff, N.M. Vanitha, Food Microbiology by. McGraw Hill Education; Fifth edition (2017)

Reference Books:

1. Megh R. Goyal, Hafiz AnsarRasul Suleria, Shanmugam Kirubanandan, Technological Processes for Marine Foods, From Water to Fork: Bioactive Compounds, Industrial Applications, and

Genomics (Innovations in Agricultural & Biological Engineering) by Apple Academic Press; 1 edition (25 June 2019)
2. Byong H. Lee, Fundamentals of Food Biotechnology (2015).
3. Jeyabalan Sangeetha, DevarajanThangadurai, SomboonTanasupawat, PradnyaPralhadKanekar,Biotechnology of Microorganisms: Diversity, Improvement, and Application of Microbes for Food Processing, Healthcare, Environmental Safety, and Agriculture by Apple Academic Press; 1 edition (2019).
4. Philip E. Nelson, Principles of Aseptic Processing and Packaging, Purdue University Press, (2010)

20BT3011	BIG DATA ANALYTICS	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

The students will be able to

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 Hours)

Big data analytics overview, Data life cycle, Traditional Data mining Life cycle, CRISP, Big Data life cycle methodologies

Module 2: Data Exploration and Visualization (7 Hours)

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

Module 3: Big Data Methods (9 Hours)

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

Module 4: Charts & Graphs (6 Hours)

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 Hours)

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 Hours)

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

Text Books:

1. VenkatAnkam, “Big Data analytics”, Packt publishing 2016
2. Parag Kulkarni, Sarang Joshi, “Big Data analytics”, PHI learning 2016
3. Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition, 2014

Reference Books:

1. Mark Gardener. Beginning R: The Statistical Programming Language. John Wiley & Sons, 2012.
2. Avril Coghlan, A Little Book of R For Bioinformatics, Release 0.1, 2017
3. Robert Gentleman, R Programming for Bioinformatics, CRC press, Taylor & Francis,2008

20BT3012	BIOETHICS AND BIOSAFETY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To Understand Biosafety regulations and IPR
2. To discuss environmental containments of GMO and ethics of stem cell research
3. To appraise ethical issue of transgenics in plant, animal and microorganisms

Course Outcomes:

The students will be able to

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 Impacts of Biotechnology - Biosafety Regulations and Bioethics (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. Bioethics: Introduction to ethics and bioethics, framework for ethical decision making. Ethical, legal and socioeconomic aspects of gene therapy.

Module 2: Intellectual Property Rights (9 hrs)

Introduction to IPR, Types of IP - Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge and Geographical Indications, Filing of a patent application; Precautions before patenting-disclosure/non-disclosure; Procedure for filing a PCT application, Patenting and the Procedures Involved in the Application for Grading of a Patent, Steps to a Patent, Examples of Patents in Biotechnology

Module 3: Environmental containments of GMO and Farmers rights (9 hrs)

The GM-food debate and biosafety assessment procedures for biotech foods & related products, including transgenic food crops, case studies of relevance. Key to the environmentally responsible use of biotechnology. Environmental aspects of biotech applications. Use of genetically modified organisms and their release in environment. Discussions on recombinant organisms and transgenic crops, with case studies of relevance. Plant breeder's rights. Legal implications, Biodiversity and farmers rights. Ethical implications of GM crops and GMO's.

Module 4: Stem Cell Research (8hrs)

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 guidelines (5 hrs)

DBT - rDNA guidelines and regulatory affairs for transgenics- plants, animals and microorganisms

Total Hours: 45

Text Book:

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

.**Reference Books:**

1. Jonathan, Y.R., Anthology of Biosafety (Vols. 1-4), American Biological Safety Association (2005).
2. Encyclopedia of Ethical, Legal and Policy issues in Biotechnology, John Wiley & Sons Inc. (2005).

20BT3013	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:

The students will be able to

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 urea

Module 2: Industrial Production (8 hrs)

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

Module 3: Oils and Fats (7 hrs)

Process description and flowsheet of extracting vegetable oils. Hydrogenation of oils, major engineering problems and recent technology.

Module 4: Sugar Derivatives (8 hrs)

Manufacturing process with flow diagram for Sugar and starch industries and their different by-products; Glucose, Pulp and paper Industries

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.

20BT3014	IMMUNOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcomes:

The students will be able to

1. Account for the structure and function of the immune system both at the molecular and cellular level.
2. Account for polyclonal, monoclonal and humanized antibodies and production of these.
3. Describe immunization/vaccination, immunological disease and immunotherapy.
4. Plan, carry out and present achieved results of immunological serum analyses by means of different immunotechniques.
5. Discuss immunological techniques and on the instrumentation involved.
6. Implement various immnotechniques in immunology related applications.

Module 1:Immune System(9)

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

Module 2:Immune Response(9)

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

Module 3:Antigen Antibody Reactions(9)

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

Module 4: Autoimmunity, Hypersensitivity(4)

Tolerance and Autoimmunity, Types and mechanism of autoimmune diseases, Hypersensitive reactions, Primary and secondary immunodeficiency, AIDS

Module 5:New Generation Antibodies (5)

New Generation Antibodies; Multigene organization of immunoglobulin genes, Ab diversity; Chimeric antibodies, Antibody engineering; Phage display libraries; Antibodies as in vitro and in vivo probes. Large scale manufacture of antibodies for immunodiagnostics.

Module 6:Immunotechniques (9)

Diagnostics; immunodiffusion, Haemagglutination, ELISPOT assay, immunofluorescence, Surface plasmon resonance, flow cytometry and immunoelectron microscopy. PCR based technology for Antibody generation, Plamsa based therapy, Monoclonal Antibody production, Vaccine development and case studies on Immuno compromising and treatment.

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

20BT3015	COMPUTATIONAL BIOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the fundamental concepts, tools and resources in Computational Biology.
2. To improve knowledge on machine learning and data mining concepts and techniques relevant to biological data along with practical implementation of machine learning techniques.
3. To facilitate the specialized areas related to Computational Biology which will enable high throughput data processing and analysis.

Course Outcomes:

The students will be able to

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 computational experimental techniques.

Module 1: Biomolecular Computing (10 Hours)

DNA Structure, and Processing , Computational operations and Step involve in DNA computing, Bio-soft Computing Based on DNA Length, Beginnings of Molecular ComputingAdelman Experiment. RNA secondary structure prediction: Base pair maximisation and the Nussinov folding algorithm, Energy minimisation and the Zuker folding algorithm, Design of covariance models, Application of RNA fold.

Module 2: MolecularMechanics:(7 Hours)

Introduction, The Morse Potential, The Harmonic Oscillator Model for Molecules, Comparison of Morse and Harmonic Potential, Two atoms connected by a bond, Poly atomic Molecules, Energy due to Stretch, Bend, Stretch-Bend, Torsional strain, van der Waals and Dipole-Diploe interactions. Types of Potentials: Lennard-Jones, Truncated Lennard-jones. Types of Force Fields: AMBER, CHARMM, Merck Molecular Force Field, Consistent Force Field, MM2, MM3 and MM4 force fields.

Module 3: Molecular Dynamics Simulation (7 Hours)

Introduction, Radial distribution functions, Pair Correlation function, Newtonian dynamics, Integrators-Leapfrog and Verlet algorithm, Potential truncation and shifted-force potentials, Implicit and explicit Solvation models, Periodic boundary conditions, Temperature and pressure control in molecular dynamics simulations.

Module 4: Next generation sequencing (7 Hours)

NGS Platforms: Introduction to NGS, Roche/454 FLX, Illumina/Solexa Genome Analyzer, Applied Biosystems SOLiD system, HelicosHeliscope, Pacific Biosciences/single molecule real time (SMRT) sequencing. Biological applications of NGS: Whole-genome sequencing, Exome sequencing, Transcriptome sequencing, Epigenome sequencing, Interactome sequencing, methylome sequencing.

Module 5: Data Mining and Data warehousing (7 Hours)

Need for data warehouse, definition, goals of data warehouse, Data Mart, Data warehouse architecture, extract and load process, clean and transform data, Designing fact tables, partitioning, Data warehouse and OLAP technology. Importance of Data Mining, Relational Databases, Data Warehouses, Transactional Databases, Advance Database Systems and Applications, Data Mining Functionalities, Classification of Data Mining Systems, Major issues in Data Mining.

Module 6: Systems Biology and protein network analysis (7 Hours)

Systems Biology Networks- basics of computer networks, Biological uses and Integration. Basic properties of Network: Degree, average degree and degree distribution. Adjacency matrix, weighted and unweighted networks, Bipartite network, Paths and distances. Metabolic reconstruction, Application.

Text Books:

1. Neil C. Jones, Pavel Pevzner. An introduction to bioinformatics algorithms MIT Press ,(2011)
2. Alan Hinchliffe, Molecular Modelling for Beginners, (2nd Edition) John Wiley & Sons Ltd. (2008)
3. Stuart M. Brown, Next-generation DNA sequencing Informatics, Cold Spring Harbor Laboratory, (2013).

Reference Books:

1. Andrew R. Leach, Molecular Modeling Principles and Applications, Second Edition, Prentice Hall. (2001)
2. Jonathan Pevsner. Bioinformatics and Functional Genomics, 2nd Edition. John Wiley & Sons Inc (2015)
3. Kriete A. Kriete, R.Eils,, R.Eils, Computational systems biology, Academic Press. (2005)
4. Pengcheng Fu, Systems Biology and Synthetic Biology Sven Panke, Wiley InterScience. (2009)
5. Greg Gibson and Spencer V. Muse. A Primer of Genome Science, Third Edition. Sinauer Associates, Inc; (2009)

20BT3016	METABOLIC REGULATION AND ENGINEERING	L	T	P	C
		3	0	0	3

Course Objectives:

1. Impart skills to amend the existing metabolic pathways through metabolic engineering and synthetic biology
2. Enable the students to use molecular techniques to enhance the yield of industrially important product
3. Understand the quantitative basis of metabolic networks

Course Outcomes:

The students will be able to

1. Identify the appropriate metabolic pathways to produce a desired product
2. Characterize the metabolic pathways and propose relevant metabolic engineering strategies to enhance an economically viable products
3. Construct metabolic flux models using available tools
4. Design 13C-labeling strategies and perform metabolic flux analysis to determine metabolic pathway
5. Construct a mathematical representation of a metabolic network, and calculate the internal fluxes based on external measurements.
6. Adapt suitable synthetic biology tools to build and design new pathways, cells and systems

Module 1: Metabolic Pathways and integrated database (6 Hours)

Metabolic pathways database, KEGG, Roche Biochemical Pathways, Pathway of Cellular respirations, Glycolysis, Krebs Cycle, Fermentative Pathways, Metabolism of Proteins and Lipids, Stoichiometry of cellular reactions, reaction rate and flux, dynamic mass balance

Module 2: Regulation of Metabolic Pathways (5 Hours)

Feedback control systems, alteration of feedback regulation for enhanced production of primary metabolites, Regulation of enzyme concentration-lac operon- Metabolic networks-branch point classification

Module 3: Metabolic Flux and Control Analysis (12 Hours)

Flux Analysis basics, Dynamic steady state, Estimation of intracellular metabolic flux, Determined, over determined and under determined system, use of linear programming; Isotopic substrate composition, 13C MFA experimentation, Detection of 13C labelling patterns, Construction of a metabolic model for

13C flux analysis; Coefficients of control analysis, elasticity coefficient, Flux control coefficients, Summation theorem, FC connectivity theorems

Module 4: Synthesis and Engineering Tools in Synthetic Biology (9 hours)

Introduction to Synthetic Biology- New Tools for Cost-Effective DNA Synthesis- Oligonucleotide Synthesis- microarray oligonucleotide synthesis, Microfluidic and fluidic systems; Quality Control-hybridization selection; 'BioBricks: a standard for physical DNA composition; Protein Engineering Methods- Site directed diversification, Screening and selection, high throughput screening in microtitre plates

Module 5: Pathway Engineering as Enabling Synthetic Biology Tool (7 hours)

Introduction-Design and construction of pathways- Pathway design tools; Pathway optimization-strategies for optimizing a metabolic pathway based on gene expression, strategies for optimizing a metabolic pathway based on protein level Ex E.coli (*Molecular Systems Biology 7; Article number 515; doi:10.1038/msb.2011.46)

Module 6: Applications of Metabolic Engineering and Synthetic Biology (6 Hours)

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; metabolic engineering of microalgae for biofuel production

Textbooks:

1. Christina Smolke*ed.*, The Metabolic Pathway Engineering Handbook: Fundamentals, CRC Press, 2009.
2. 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.

Reference Books:

1. 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.
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
3. Eva-Kathrin Ehmoser-Sinner, Cherng-Wen Darren Tan Lessons on Synthetic Bioarchitectures: Interaction of Living Matter with synthetic structural analogues, Springer International Publishing, 2018

20BT3017	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:

The students will be able to

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 Hours)

Origin and History of Clinical Research, Introduction to Drug Discovery and drug Development, Clinical Trials in India–The National Perspective, Clinical Trial Phase I, Clinical Trial Phase II, Clinical Trial

Phase III, Clinical Trial Phase IV –methods, Principles of sampling -Inclusion and exclusion criteria, Methods of allocation and randomization, Termination of trial.

Module 2: Ethical Regulation (8 Hours)

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

Module 3: Regulation in clinical research (7 Hours)

International Conference on Harmonization (ICH) Brief history of ICH, Structure of ICH, ICH Harmonization Process, Responsibilities of Stakeholders: Sponsors, Investigators, CROs, Monitors, Institutional ethics committee

Module 4: Clinical trial important documentation (7 Hours)

Essential Documents in Clinical Trials: SOP, Clinical Trial Protocol and 95Protocol Amendment(S), Investigator Brochure, Master Files, Informed Consent Forms, Consort statement, Case Record Form

Module 5: Clinical trial data management (8 Hours)

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 Hours)

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

Case study in recent epidemics-clinical trials.

Text Books:

1. Lee, Chi -Jen; etal.,"Clinical Trials or Drugs and Biopharmaceuticals." CRC / Taylor &Francis, (2011)
2. Matoren, Gary M. "The Clinical Research Process in the Pharmaceutical Industry" Marcel Dekker, (2001).
3. Spriet A., Dupin-Spriet T., Simon P. Methodology of Clinical Drug Trials, 2ndEdition. Publisher: Karger. (1997)

Reference Books:

1. Shein-Chung Chow, Jen-Pei Liu.Design and Analysis of Clinical Trials: Concepts and Methodologies, 3rd Edition. Publisher: Wiley. (2014)
2. Lionel D. Edwards, Anthony W. Fox, Peter D. Stonier. Principles and Practice of Pharmaceutical Medicine, 3rdEdition. Publisher: Wiley-Blackwell. (2011)
3. Murray Longmore, Ian Wilkinson, Andrew Baldwin, and Elizabeth Wallin.Oxford Handbook of Clinical Medicine, 9th Edition. Oxford Medical Handbooks.(2014)

20BT3018	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 Outcomes:

The students will be able to

1. Develop growth model based on the microbial characteristics
2. Understand working procedure of bioprocess industries
3. Analyze the diversity and nature of bio-products
4. Evaluate enzyme reaction and its kinetics

5. Understand different configurations of bioreactors
6. Understand the sustainability assessment methods

Module 1: Bioprocess and nature of bio-products (6 Hours)

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

Module 2: Bioreactor Design (8 Hours)

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

Module 3: Modeling and Simulation of Bioprocesses (9 Hours)

Microbial growth model, Problem Structuring, Process Analysis, and Process Scheme, leudeking-piret models, Models with growth inhibitors, oxygen transfer model, volumetric mass transfer coefficient, Uncertainty Analysis- Sensitivity Analysis, error analysis, Application-cellulase based catalysis process

Module 4: Sustainability Assessment (7 Hours)

Sustainability, Economic Assessment- Capital-Cost Estimation, Operating-Cost Estimation, Profitability Assessment, Environmental Assessment, case study

Module 5: Reactor Operation (8 Hours)

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 (5 Hours)

Bioprocess Consideration in plant cell cultures, Bioprocess Consideration in animal cell cultures, Industrial Bioprocess, Advanced Membrane bioreactor to facilitate both upstream and downstream processing simultaneously

Text Book:

1. Heinzle E, Biwer AP and Cooney CL, "Development of Sustainable Bioprocesses Modeling and Assessment" 2006 John Wiley & Sons, Ltd

Reference Books:

1. Shuler, M.L. and Kargi,F. " Bioprocess Engineering - Basic concepts" Prentice Hall of India Pvt. Ltd.,2nd edition, 2015.
2. Peter F. Stanbury, Stephen J. Hall & Whitaker. A, "Principles of Fermentation Technology", Butterworth – Heinemann an Imprint of Elsevier India Pvt.Ltd., 2nd edition, 2005.
3. Pauline M. Doran, Bioprocess Engineering Principles, Elsevier Science & Technology Books, 2nd edition, 1995

20BT3019	ADVANCED ANIMAL BIOTECHNOLOGY AND TISSUE CULTURE	L	T	P	C
		3	0	0	3

Course Objectives:

1. To Provide insights into Animal Biotechnology
2. Impart knowledge in manipulation of embryos and animal breeding
3. To make students understand the significance of trangenesis and its importance in livestock improvement

Course Outcomes:

The students will be able to

1. Define concepts in Animal Biotechnology
2. Describe the importance of Cryopreservation of embryos and embryo sexing in animals
3. Relate and evaluate the genetic defects in animal embryos through molecular diagnosis
4. Experiment the technology used for animal breeding
5. Comprehend the fundamental concepts of mammalian cell and generation of cell line and to demonstrate tissue engineering applications for implantable materials.
6. Design the strategies for livestock improvement through transgenesis with ethical concern.

Module 1: CryopreservationOf Embryos and Artificial Insemination (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: Germplasm Preservation and Genetic Diagnosis (7 Hrs)

In situ and ex situ preservation of germplasm, In utero testing of foetus for genetic defects, Pregnancy diagnostic kits, Gene knock out technology and animal models for human genetic disorders, Mouse model for COVID 19.

Module 3: 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 of endangered species, anti-fertility animal vaccines, Ethical, social and moral issues related to cloning

Module 4: Live Stock Improvement (8 Hrs)

Genetic characterization of livestock breeds, Marker assisted breeding of livestock, Transgenic animals and application in expression of therapeutic proteins, Detection of meat adulteration using DNA based methods.

Module 5: Cell Culture (8 Hrs)

Application of animal cell culture for *In vitro* testing of drugs, Cytotoxicity and viability assays, Characterization, Cell line preservation and authentication. Scaling up of cell culture - Adherence and suspension type, Cell culture products.

Module 6: Tissue Engineering (7 Hrs)

Tissue Engineering: Biomaterials in tissue engineering and scaffold fabrication, Artificial blood vessel, Artificial pancreas and liver tissue engineering, 3D Culture with different type of cells with examples and protocols. Spheroid culture.

Total Hours: 45

Text Books:

1. R. Ian Freshney. Introduction to Culture *of* Animal Cells: A Manual of Basic Technique and Specialized Applications, Sixth Edition. *Publisher*, John Wiley & Sons, 2011.
2. John R.W. Masters, Animal cell culture 3rd ed., A Practical Approach Oxford University press New York 2009
3. Birbal Singh, Gorak Mal, Sanjeev K Goutam. Advances in Animal Biotechnology Springer; 1st ed. 2019 edition.

Reference Books:

1. Niemann, Heiner, Wrenzycki, Christine, Animal Biotechnology, Springer Publishing. 2018.
2. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF. 2004. New Generation Vaccines. 3rd Ed. Informa Healthcare
3. John R.W. Masters, Animal Cell Culture 3rd ed., Oxford University Press, 2009.

20BT3020	MOLECULAR DIAGNOSTICS	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. History and Traditional diagnostics in genetic disease.
2. Principles and performance of DNA and RNA isolation, amplification, hybridization, and analysis.
3. Applications in microbiology, diagnosis, cancer, transplantation, and forensic medicine.

Course Outcomes:

The students will be able to

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 kit for the emerging diseases
6. Adapt ethical guidelines for molecular test results

Module 1: Introduction to Diagnostics (7 Hours)

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

Module 2: Traditional Diagnostic Methods (8 Hours)

Diagnosis of infections: Bacteria: *Staphylococcus, Streptococcus, Mycobacterium E.coli, Salmonella, Shigella, and Vibrio,* Fungal diseases: Dermetophytoses, Candidiosis and Aspergillosis. DNA and RNA viruses- Pox viruses, Rhabdo Viruses, Corona Viruses, and Retroviruses. Protozoan diseases: Amoebiasis, Malaria, Leishmaniasis. Helminthic diseases- Ascarislumbricoides, Filariasis- Wuchereriabancrofti.

Module 3: Major Metabolic and genetic disorders (7 Hours)

Traditional methods for the diagnosis, Inborn metabolic errors – Glucose, Lipid, Amino Acid, Protein. Genetics of cancer - chronic myeloid leukemia, colon, breast, and lung cancer. Genetic disorders- Sickle cell anemia, Duchenne muscular Dystrophy, and Cystic Fibrosis**.**

Module 4: Molecular Diagnosis (8 Hours)

Duchenne muscular Dystrophy (Creatine phosphokinase-CPK), PKU (phenylketoneurea) – Amino acid deficiency - Inborn error, G6PD deficiency syndrome (G6PD), PCR diagnosis of Sickle cell anemia, Tuberculosis and COVID-19, Prenatal screening of Cystic Fibrosis. RT-PCR based diagnosis of Cancer, Tumor Metabolome. Biomarkers – PSA and KRAS (Oncogene markers).

Module 5: Hybridization and Sequencing (8 Hours)

Southern, Northern, in-situ- FISH, Western Blot. Principles, Methods and Instrumentation- Advances in DNA sequencing- New Generation sequencing Methods, Pyrosequencing, Personalized Medicine- Pharmacogenomics (ADMET).

Module 6: New Trends in Diagnostics (7 Hours)

Lab on a Chip - DNA chips, Diagnosis of neonatal genetic disorders, human genome project, ethical implications. Different Levels of Biosafety and Containment. Molecular Forensics – DNA profiling RFLP, VNTR, STR and PCR. DNA fingerprinting - The CODIS concept, Ethical and legal issues in genetic counselling.

Text Book:

1. Betty A. Forbes , Daniel F. Sahm, Alice S. Weissfeld, Bailey & Scott's Diagnostic Microbiology (2012), Ernest A. Trevino, Published by C.V. Mosby

Reference Books:

1. David E. Bruns, Edward R. Ashwood, Carl A. Burtis. Fundamentals of Molecular Diagnostics (2010). Saunders Group.
2. Lele Buckingham and Maribeth L. Flaws, Molecular Diagnostics: Fundamentals, Methods & Clinical applications (2007).
3. W.B. Coleman. Molecular Diagnostics for the Clinical Laboratorian 2Ed. 2006, Humana Press.

20BT3021	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:

The students will be able to

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. Oorganize 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 Hours)

Introduction to Drugs: Drug nomenclature, Routes of drug administration and dosage forms, Principles of Pharmacokinetics and Pharmacodynamics: ADME, Bioavailability of drugs -Lipinski's rule; how drugs work -Drug targets, drug-target interaction and dose-response
Relationships.

Module 2: Drug design pipeline (8 Hours)

New Drug Discovery & Development: Overview of new drug discovery, development, cost and time lines. Target Identification & Validation. Lead Discovery: Rational and irrational approaches -Drug repurposing, Natural products, High-throughput screening (HTS), Combinatorial chemistry and computer aided drug design (CADD).

Module 3: Fundamental of Drug Actions: (8 Hours)

Inter and intramolecular interactions: Weak interactions in drug molecules; Chirality and drug action; Covalent, ion, ion-dipole, hydrogen bonding, C-H hydrogen bonding, dihydrogen bonding, van der waals interactions and the associated energies. Cation-and-OH interactions. Receptorology: Drug-receptor interactions, receptor theories and drug action; Occupancy theory, rate theory, induced fit theory, macromolecular perturbation theory, activation-aggregation theory. Topological and stereo chemical consideration.

Module 4: Drug toxicity, Assays and testing (7 Hours)

Preclinical Testing of New Drugs: Pharmacology -In vitro/in vivo Pharmacokinetics and Pharmacodynamics testing; Toxicology-Acute, chronic, carcinogenicity and reproductive toxicity testing; Drug formulation testing. Clinical Trial Testing of New Drugs. 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 Hours)

US Food & Drug Administration (US FDA) and Central Drugs Standard Control Organization (CDSCO), India. Regulatory Applications & New Drug Approval: Investigational new drug (IND) application & New drug application (NDA); Regulatory review and approval process. Regulatory Requirements for Drug Manufacturing: Current Good manufacturing practice (cGMP) and GMP manufacturing facility inspection & approval.

Module 6: Intellectual Property Rights (IPR) (8 Hours)

IPR Definition and implications for discovery & development. Forms of IPR Protection-Copyright, Trademark and Patents. International organization and treaties for IPR protection –World Trade Organization (WTO) & Trade Related Aspects of Intellectual Property Rights (TRIPS) Agreements. Controller General of Patents, Designs & Trade Marks, India (CGPDTM), World Intellectual Property organization (WIPO)-Patent Cooperation Treaty (PCT).

Text Books:

1. Rick NG. Drugs: From discovery to approval 2nd Ed Wiley Blackwell (2009)
2. TripathiKd. Essentials of Medical Pharmacology, 6th Edition, Publisher: Jaypee Brothers (2013)
3. Burger's Medicinal Chemistry and Drug discovery. Volume 2, Wiley-Interscience; Volume 2 edition (2003)

Reference Books:

1. Prankrishna Pal. Intellectual Property Rights In India: General Issues And Implications Publisher: Deep & Deep Publications Pvt.Ltd (2008)
2. Stromgaard, Kristian, PovlKrogsgaard-Larsen, and Ulf Madsen. *Textbook of drug design and discovery*. CRC Press, (2009).
3. Katzung, Bertram G., Susan B. Masters, and Anthony J. Trevor. *Basic and Clinical Pharmacology (LANGE Basic Science)*. McGraw-Hill Education,(2012).
4. Spriet, Alain, et al. *Methodology of clinical drug trials*. Basel: Karger, (2004).

20BT3022	INTRODUCTORY ARTIFICIAL INTELLIGENCE IN BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To Study the concepts of Artificial Intelligence.
1. To learn the methods of solving problems using Artificial Intelligence.
2. To introduce the concepts of Expert Systems and machine learning on various applications.

Course Outcome:

The students will be able to

1. Infer problems that are amenable to solution by AI methods.
2. Demonstrate appropriate AI methods to solve a given problem.
3. Formalise a given problem in the language/framework of different AI method
4. Develop an understanding of Machine learning integration in knowledge inference
5. Acquire knowledge on advanced intelligence computing techniques.
6. Formulate AI based solutions for industrial and healthcare applications.

Module 1: Introduction to al and production systems [9 hours]

Introduction to AI-Problem formulation, Problem Definition -Production systems, Control strategies, Search strategies. Problem characteristics, Production system characteristics -Specialized production system- Problem solving methods – Problem graphs, Matching, Indexing and Heuristic functions -Hill Climbing-Depth first and Breath first, Constraints satisfaction – Related algorithms, Measure of performance and analysis of search algorithms.

Module 2 : Representation of knowledge [9 hours]

Game playing – Knowledge representation, Knowledge representation using Predicate logic, Introduction to predicate calculus, Resolution, Use of predicate calculus, Knowledge representation using other logic-Structured representation of knowledge.

Module 3: Knowledge inference [9 hours]

Knowledge representation -Production based system, Frame based system. Inference – Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning – Certainty factors, Bayesian Theory-Bayesian Network-Dempster – Shafer theory.

Module 4: Planning and machine learning [8 hours]

Basic plan generation systems – Strips -Advanced plan generation systems – K strips -Strategic explanations -Why, Why not and how explanations. Learning- Machine learning, adaptive Learning.

Module 5: Expert systems [5 hours]

Expert systems – Architecture of expert systems, Roles of expert systems – Knowledge Acquisition – Meta knowledge, Heuristics. Typical expert systems – MYCIN, DART, XOON, Expert systems shells.

Module 6: AI for Health care and Industrial Applications [5 Hours]

Maintaining medical records and other data,doing repetitive jobs,Treatment design,Digital Consultation,Virtual Nurses,Medication Management,Drug Creation,Precision Medicine,Health Monitoring,and Health Care System Analysis. Application of AI in Pharmaceutical industry- Biofuel industry- Food industry- Water technology-Bio fertilizers- Bio control. **Total Hours: 45**

Text books:

1. Kevin Night and Elaine Rich, Nair B., "Artificial Intelligence (SIE)", McGraw Hill- 2008.
2. Dan W. Patterson, "Introduction to AI and ES", Pearson Education, 2007.

References:

1. Peter Jackson, "Introduction to Expert Systems", 3rd Edition, Pearson Education, 2007.
2. Stuart Russel and Peter Norvig "AI – A Modern Approach", 2nd Edition, Pearson Education 2007.
3. Deepak Khemani "Artificial Intelligence", Tata Mc Graw Hill Education 2013.

20BT3023	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. The study also focuses on how operations related with fluids and how temperature plays a pivotal role in a drug or a chemical plant.

Course Outcome:

The students will be able to

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: Introduction to Transport Processes (9 Hours)

Basic Mass, Momentum and Energy transport processes; micro and macroscopic views; phenomenological laws; driving forces; transport coefficients. Definition of fluxes; conservation principles; differential elementary volumes and coordinate systems; boundary conditions; dimensionless numbers. Molecular mass transport – Fick's law of binary diffusion; binary gaseous diffusion coefficient – kinetic theory; diffusion in liquids and solids. Effective transport properties (diffusion in suspensions and through a pack of spheres). Steady and transient diffusion processes– examples and application to transport problems.

Module 2: Momentum Transport and Viscous Flows (7 Hours)

Newton's law of viscosity; molecular theory of viscosity of dilute gases and liquids; Couette and falling film flow; Momentum as a flux and as a force – viscous stress tensor; Shell momentum balance and laminar flows – principles; Poiseuille flow; flow in an annulus; creeping flow around a sphere.

Module 3: Macroscopic balances for momentum transport (7 Hours)

Turbulent flows, Reynolds experiment, drag forces; turbulence and eddy flow (similarities with molecular transport) and atmospheric fluxes (eddy covariance method).

Module 4: Energy Transport Heat, Radiation and Phase Change (7 Hours)

Fourier's law of heat conduction; thermal conductivity - molecular and effective; heat flow in one and multi-dimensional geometries; steady-state and transient analytical solutions to Heat conduction; heat flow and convection; nonlinear cooling, macroscopic energy balance. Radiative energy transport– Stefan-Boltzmann law; black body exchange, principles and examples ; radiation through the atmosphere and greenhouse effect.

Phase change and coupled heat and mass transport (falling film, evaporating water drop)

Module 5: Mass Transport in Solid and Laminar I (Film) (6 Hours)

Flow Shell mass balances: boundary conditions, diffusion through a stagnant gas film, diffusion with heterogeneous chemical reaction, diffusion with homogeneous chemical reaction, diffusion into a falling liquid film forced.

Module 6: Mass Transport in Solid and in Laminar-II (Porous Support) (6)

convection mass transfer, diffusion, and chemical reaction inside a porous catalyst: the "effectiveness factor". Analogies between Heat, mass and Momentum and transfer

Text Book

1. Christie John Geankoplis, "Transport Processes and Separation Process Principles", 4th Edition, PHI Learning Private Limited., 2013.
2. Bird R.B., Stewart, W. E. and Lightfoot, E. N., "Transport Phenomena", 2nd Edn.John Wiley and Sons, 2002.
3. Welty, J.R., Wicks, C. E. and Wilson, R. E., "Fundamentals of Momentum, Heat Mass Transfer", 5th Edn., John Wiley and Sons, 2007.

Reference Books

1. Brodkey, R. S. and Hershey, H. C., "Transport Phenomena – A Unified Approach", Brodkey Publishing, 2003.
2. John C Slattery, "Momentum, Energy and Mass transfer in continua", McGraw Hill, Co. (1972).
3. Robert S Brodkey and Harry C Hersing, " Transport Phenomena a Unified approach" McGraw Hill Book Co. (1988).

20BT3024	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 enabling the student to gain in-depth knowledge in fundamental and applied aspects of Microbiology and Immunology.

Course Outcome:

The students will be able to

1. 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 Hours)

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 Hours)

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 Hours)

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 Hours)

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 Hours)

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 Hours)

Rational for formulation of biotherapeutics, 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

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. Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, 2ndEdition, John Wiley & Sons, Inc. (2008)

Reference Books

1. Gary Walsh Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, Inc., (2007).
2. Oliver Kayser, HeribertWarzecha Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, 2nd Edition. John Wiley & Sons, Inc.(2012)

20BT3025	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:

The students will be able to

1. Develop knowledge on various bioreactors.
2. Classify modern biotechnological process in host vector systems.
3. Understand 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, other scale up criteria

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: Mixing Effectiveness (8 hrs)

Mixing equipment, Types of Impeller based on solution viscosity, Mechanism of Mixing, Assessing Mixing Effectiveness, Power requirement in mixing, Improving mixing efficiency, Sparging, Stirring and Bubble, Parameters to be monitored and controlled during fermentation process.

Total Hours: 45

Text Book:

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

Reference Books:

1. P.Stanbury, A.Whitaker,SJ Hall “Principles of fermentation technology”, Second edition, ElsvierPergamon Press,2010.
2. Pauline Doran,”Bioprocess Engineering Principles”, Academic Press, 2010.
3. ElmarHeinzle, 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.

20BT3026	STEM CELL THERAPEUTICS	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcome:

The students will be able to

1. Understand the basic concepts in culturing animal and mammalian cells
2. Understand the aspects of cellular ageing
3. Understand the types of Stem cells, their development and function.
4. Learn the various methods to isolate and culture Stem cells
5. Learn the various therapeutic applications of stem cells
6. Appreciate the bigger picture of Stem Cell Technology and their impact of society and civilization.

Module 1: Culturing Cells in the laboratory (5 Hours)

Overview of Stem Cells. Introduction to Cell Culture, Pros & Cons of Cell culture, Primary and Secondary cultures, Aseptic Technique and Cell culture Lab equipments& etiquette

Module 2: Stem cell-Types (5 Hours)

Types of Stems Cells, Embryonic stem cells, Pleuripotent Stem Cells, Adult Stem cells, Induced Pleuripotent Stem Cells, Transit amplifying cells, Symmetry during cell division in Stem cells.

Module 3: Location, Nature & culturing of stem cells (10 Hours)

Stem Cell Niche, Isolation of Stem Cells, & Growth factors, chord cells, Derivation & differentiation of ES Cells, Derivation & differentiation of Pleuripotent Cells

Induced Pluripotent cell-Methods & Genetic & epigenetic reprogramming. Transdifferentiating, FACS

Module 4: Applications of Stem cell Technology (8 Hours)

Application of stem cells in disorders of nervous system, Stem cells of the skin- Wound healing & cosmetics, Application of Stem cells in Cancer, Application of stem cells in autoimmune disorders.

Module 5: Stem cell in tissue engineering & Regenerative medicine (7 Hours)

Scaffolds, types & topology and effect on tissues, Tissue regeneration and angiogenesis Organoids and organ generation, Organ on Chip, Body on Chip

Module 6: Ethical Implications of Stem cell therapeutics. (10 Hours)

Benefits, Problems and perspectives of stem cell therapy. Beginning of human life, legal, scientific, ethical, Religio-spiritual explanations. Treating infertility, multiple parents, Somatic Cell Nuclear Transfer & Human cloning, Extinction prevention, Stem cells and meat production, Alternatives to stem cells. Deeper concerns in stem cell technology- Ageing longevity, Immortality.

Text Book:

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

Reference Books:

1. Paul Knoepfler, Stem Cells - An Insider's Guide, 30 July 2013.
2. Robert Lanza and Anthony Atala, Essentials of Stem Cell Biology, Second Edition, Academic Press, 2013.
3. Satish Totey and Kaushik D. Deb, Stem Cell Technologies: Basics and Applications, 16 March 2010.
4. Warburton David, Stem Cells, Tissue Engineering an Regenerative Medicine, 1st Edition, 15 December 2014.

20BT3027	NANOBIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective

1. To introduce the concepts and fundamentals of nanotechnology
2. To understand the synthesis and characterization of nanomaterials and their application in biomedical fields
3. To identify the risk assessments involved nanomaterials in biological application and the impact on environment.

Course Outcome

The students will be able to

1. Understand the basic principles of nanotechnology
2. Understanding the application of various techniques characterization and interpreting the properties of nanomaterials as per required application.
3. Understand and apply the knowledge of nanomaterials and nanobiomaterials to enable health sector advancements.
4. Design devices and systems for various biological applications.
5. Conceptualize the design and development aspects in the domains like NEMS/BIOMEMS

6. Enlighten with comprehensive knowledge of toxicity associated with nanomaterials and Optimize the synthesis for better biocompatibility of Nanomaterials

Module 1 Fundamentals of Nanoscience and Engineering 6 Hrs

History, Types of nanomaterials: Fullerenes, Nanoshells, Quntum dots, Dendrimers, Nanocarriers, Nanofibers, Approaches of Fabrication: TopDown and Bottom-up methods of nanofabrication and Nanosynthesis, Biosynthesis of Nanoparticles, Microbial Nanoparticle production Biomineralization, Magnetosomes. Nanolithography: hard and soft lithography. Characterization of nanomaterials using spectroscopic (UV-Vis, FTIR and Raman) and microscopic methods (SEM, TEM, STM and AFM).

Module 2 Nanobiomaterials 8 Hrs

DNA and Protein based Nano structures. Biomaterial nanocircuitry; Protein based nanocircuitry; Neurons for network formation. DNA nanostructures for mechanics and computing and DNA based computation; DNA based nanomechanical devices. Function and application of DNA based nanostructures. Bionanomaterials in Nature: Lotus leaf as a model self cleansing system. Gecko foot as a case study for biological generation of adhesive forces. Diatoms as an example for silicon biomineralization. Mussel inspired nanofiber for tissue engineering. Biomechanical strength properties of Spider silk

Module3: Micro & Nano Electromechanical systems and Microfluidics 10 Hrs

BioMEMS/BioNEMS: Types of transducers: mechanical, electrical, electronic, magnetic and chemical transducers. Nano sensors: Types: Electronic nose and electronic tongue, magnetic nanosensors. mechanical nanosensors: Cantilever Nanosensors, Microfludics: Laminar flow, Hagen-Peouiselleequation, basic fluid ideas, Special considerations of flow in small channels, micro mixing, microvalves&micropumps, Body on a chip and lab on a chip.

Module 4 :Nanosensors 8 hrs

Nanofabricated devices to separate and interrogate DNA, Interrogation of immune and neuronal cell activities through micro- and nanotechnology based tools and devices. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, NanoBiosensors: NanoBiosensors in modern medicine

Module 5: Medical Nano biotechnology: 9Hrs

Nanomaterials in Diagnostics, therapeutics, drug delivery, Nano Surgery and Tissue Engineering. Drug Delivery Applications, Bioavailability, Sustained and targeted release. Benefits of Nano drug delivery system. Use of Microneedles and nanoparticles for targeted and highly controlled drug delivery. Nano robots in drug delivery and cleaning system. Design of nanoparticles for oral delivery of peptide drugs. Nanotoxicity assessment: In-vitro laboratory tests on the interaction of nanoparticles with cells.

Module 6. Nano Safety Issues 4Hrs

Nanotoxicology: Toxicology health effects caused by Nanoparticles, Ethics, Challenges and Future.

Text Books

1. Vo-Dinh T, editor. Nanotechnology in biology and medicine: methods, devices, and applications. CRC Press; 2017.
2. Binns C. Introduction to nanoscience and nanotechnology. John Wiley & Sons; 2010.
3. Rosenthal SJ, Wright DW, editors. Nanobiotechnology protocols. Totowa: Humana Press; 2005.
4. Wilson M, Kannangara K, Smith G, Simmons M, Raguse B. Nanotechnology: basic science and emerging technologies. CRC press; 2002.

Reference 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.
3. Sandra J Rosethal, David W Wright, Nanobiotechnology Protocols, Series Methods in Molecular Biology, 2005.
4. Christof M. Neimeyer, Chad.A.Mirkin (eds.,) Nanobiotechnology II: More Concepts, and Applications, Wiley VCH Weinheim (2007).

20BT3028	ADVANCED PLANT BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

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

Course Outcome:

The students will be able to

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 (6 hrs)

Genetic material of plant cells, nucleosome structure and its biological significance; transposons, alternative and trans splicing, constitutive and differentially expressed genes in plants

Module 2: Chloroplast and Mitochondria (7 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: DNA delivery methods (7 hrs)

Agrobacterium mediated method - Agrobacterium biology; Ti plasmid-based transformation; super virulence and monocot transformation, binary vector; Floral dip transformation; Direct DNA delivery methods - protoplasts using PEG; electroporation; particle bombardment; Chloroplast transformation and transient expression by viral vectors

Module 5: Design of gene construct and advanced technologies (9 hrs)

Factors influencing transgene expression – designing gene constructs - Promoters and polyA signals; Protein targeting signals; Plant selectable markers; Reporter genes; Positive selection; Selectable marker elimination; Transgene silencing; Strategies to avoid transgene silencing; Analysis of transgenic plants - Advanced technologies – cis genesis and intragenesis; RNAi technology, genome editing technology, CRISPR/Cas etc.

Module 6: Application of transgenic technology (9 hrs)

Applications of transgenic crop technology - Herbicide resistance; Pest resistance, Bt toxin, synthetic Bt toxin; Crop Engineering for disease resistance; genetic improvement of abiotic stress tolerance, Engineering for nutritional quality - Improved seed storage proteins; Improving and altering the composition of starch and plant oils; enhancement of micro-nutrients – beta carotene, vitamin E, iron; Molecular pharming - production of antibodies and pharmaceuticals in plants

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
2. Paul Christou and Harry Klee. Handbook of Plant Biotechnology, 2nd volume set, Wiley publisher, (2004).

Reference Book:

1. Athar Ali, Usha Kiran, Malik ZainulAbdin.PlantBiotechnology: Principles and Applications Springer Publications, 2017

20BT3029	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 develop skills in the cancer management techniques like detection, treatment, prevention and palliative care

Course Outcomes:

The students will be able to

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; Histopathology of cancer, Cancer malignancy – spread, invasion and metastasis; Cancer classes and types; Cancer inflammation, Cancer immunology, Cancer stem cells, 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, Metabolism 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; Genetic markers – DNA, mRNA and Protein expressions.

Module 4: Cancer Detection Methods and Techniques (8 hrs)

Cancer Screening: Clinical Examination; Laboratory Tests for cancer markers;- Immunodetection techniques (Shift before imaging); Imaging Techniques – Ultra sound and Endoscopic Examinations; X-ray; CT, and MRI scans; Nuclear and isotopic techniques - PET scans; Confirming cancer by pathologic report - Biopsy and Smear examinations; Cancer staging and grading; Genetic marker Testing Techniques – PCR, RT-PCR, qPCR, Microchip; Scope for early diagnosis: Early diagnostic methods – Mammography, PAP test

Module 5: Cancer Therapeutics (7 hrs)

Combination Therapy; Adjuvant-Neoadjuvant therapy- Chemotherapy, Radiotherapy; Targeted therapy – Targeted drug delivery, targeted therapy drugs; Molecular therapy, Immunotherapy –Antibody, Interferon, Gene therapy; Hormone therapy; Treatment fatigue; Clinical trials. Review on cancer stem cells.

Module 6: Cancer Prevention and Palliative Care (7 hrs)

Cancer risk factors; Food and lifestyle in cancer prevention; Post treatment recurrence preventive measures; Paliative care; Herbal remedies and plant derived cancer drugs.
Review on recent advancements in cancer management- Role of IoT, Theranostics, Nano-therapy.

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

20BT3030	GENOMICS AND PROTEOMICS	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Genomics and Proteomics including fundamentals, current techniques and applications.
2. To propose appropriate methods for analysis of given sample type with respect to purpose of analysis
3. Recent trends in Genomics and Proteomics research

Course Outcomes:

The students will be able

1. Relate and comprehend the concepts in genome organization, genomics and proteomics.
2. Explain some of the current genomics technologies and illustrate how these can be used to study gene function.
3. Apply interdisciplinary knowledge (e.g. chemistry, biophysics) to solve problems in proteomics and genomics
4. Analyze and infer genomes and proteomes by employing database search, algorithms and tools.
5. Appraise the applications of genomics and proteomics in medicine
6. Compile, discuss and critically review the recent updates / progress in genomics and proteomics research

Module 1: Introduction to Genomics (8 Hours)

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 Hours)

Methodology for DNA sequencing, Contig Assembly, Genetic Mapping- Mendel's Laws of Inheritance, Partial Linkage, DNA Markers and its types, Physical Mapping and its types

Module 3: Functional Genomics and its applications (7 Hours)

Introduction to Functional Genomics, Genome Annotation- traditional routes of gene identification, Detecting Open Reading Frames, Software programs for finding genes, identifying the function of new gene, Gene Ontology. Pharmacogenomics, Comparative genomics

Module 4: Introduction to Proteomics (7 Hours)

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

Module 5: Analytical Proteomics (8 Hours)

2 Dimensional Polyacrylamide Gel Electrophoresis, Mass Spectrometry for Protein and Peptide Analysis (MALDI-TOF and ESI-Tandem MS), Designing Microarray experiments, Types of Microarrays

Module 6: Applications of Proteomics (7 Hours)

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

Text Books:

1. Brown T.A., "Genomes", BIOS Scientific Publishers Ltd, Oxford, 4th Edition, 2018.
2. Daniel C. Liebler, "Introduction to Proteomics: Tools for the New Biology", Humana Press, Totowa, New Jersey, 2002

Reference Books:

1. Sandor Suhai, "Genomics and Proteomics- Functional and computational Aspects", Springer, New York, 2000.
2. Malcolm Campbell A. and Laurie J. Heyer, "Discovering genomics, proteomics and Bioinformatics", Pearson/Benjamin Cummings, New Delhi, 2006.
3. Mount, D. "Bioinformatics; Sequence and Genome Analysis", Cold Spring Harbor Laboratory Press, New York, 2004

20BT3031	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:

The students will be able to

1. Create an awareness of professional responsibility towards protecting the environment.
2. Learn environmental issues involved engineering and resources projects
3. Study the natural and engineered bio-treatment methods to remediate the pollutants
4. Develop treatment methods and create awareness about opportunities in environmental management
5. Future challenges for bioremediation and biodegradation process
6. Investigate the opportunities for incorporating environmental quality into products, processes and projects

Module 1: Environment and Ecosystem (8 hrs)

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

Environment pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, microbial ecology.

Module 2: Environmental Pollution (7 hrs)

Current research on environment of Soil pollution, Water pollution, Air pollution**,** Oil pollution, Heavy metal pollution – case studies and technology development aspects

Module 2: 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 3: 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 4: 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

Methods and strategies of application (biostimulation, bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides (U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects of bioremediation (in situ, ex situ) Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria; Phytoremediation

Module 5: Biomass and Biofuels (7 hrs):

Production of Biofuels: Biogas; bioethanol; biodiesel; biohydrogen; Industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery (MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifiers; Paper production: use of xylanases and white rot fungi.

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

Application of nanobiotechnology in environment, Vermitechnology, Genomic tools in bioremediation, Aerobiotechnology, Development of biodegradable and ecofriendly products, Biosensor, Quorum sensing, 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. InduShekhar Thakur, "Environment Biotechnology basic concepts and applications", IK International, 5th edition, 2016

20BT3032	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:

The students will be able to

1. Understand the principles of product design, basic management techniques, entrepreneurial skills and funding agencies.
2. Apply knowledge to the fundamentals of business plan, practical management concepts like leadership and motivation.
3. Induce entrepreneurial intent as well as innovation, scalability and marketing of the product.

4. Demonstrate the ability to provide a self-analysis in the context of an entrepreneurial career.
5. Assess the commercial viability of a new technology based idea to prototype.
6. Transfer technology and process of the product for commercialization

Module 1: Introduction and Product Design (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 entrepreneurship. Product design and development Process, sources of ideas for designing new products, stages in product design. Guidelines of DBT for formulating project and financing.

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 2: 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 3: 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.

Module 4: Innovation and entrepreneurship in Bio-business (8 hrs)

Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector (e.g. pharmaceuticals vs. Industrial biotech), Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, strategic dimensions of patenting & commercialization strategies.

Module 5: Bio markets - business strategy and marketing (7 hrs)

Negotiating the road from lab to the market, Pricing strategy, Challenges in marketing in bio business (market conditions and segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills. Angel investors and venture capitalist.

Module 6: Technology management (8 hrs)

Technology – assessment, development and upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).

Total Hours: 45

Text Books:

1. Kankanala C., Genetic Patent Law & Strategy, 1st Edition, Manupatra, Information Solution Pvt. Ltd., 2007.
2. Donald F. Kuratko, "Entrepreneurship: Theory", Process and Practice, 9th Edition, Cengage Learning, 2011.
3. Kanka S.S, 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. Jayshree Suresh, "Entrepreneurial Development", 5th Edition, Margham Publications, 2008.
4. Robert D. Hisrich, "Entrepreneurship", 6th Edition, Tata McGraw Hill Publications.2009.

20BT3033	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:

The students will be able to

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;

Module 2: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 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; Oxidation –Ozonation. Photo catalysis, Wet Air Oxidation-Evaporation Ion Exchange-Membrane Technologies – Nutrient removal.

Module 4:Case Studies with Different Industrial Scenarios (7 hrs)

Tanneries-pulp and paper-metal finishing; Petroleum Refining-Pharmaceuticals-Sugar and Distilleries; Food Processing-Thermal Power Plants.

Module 5: Environmental aAudits and Clean up Technology (5 hrs)

Environmental audits, waste audit, life cycle assessment, industrial symbiosis, clean technology and Clean up technology, materials reuse, waste reduction.

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

Waste management Approach – Volume and strength reduction – Material and process modifications – Recycle, reuse and byproduct 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, Industrial Waste Treatment: Contemporary Practice and Vision for the Future, Elsevier, (2010).
2. Wang Lawrence K., Hung Yung-Tse, Lo Howard H., Constantine Yapijakis, Hazardous Industrial Waste Treatment, CRC Press, (2006)
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. Handbook of Advanced Industrial and Hazardous Wastes Treatment, CRC Press, (2009).

20BT3034	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:

The students will be able to

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)

High pressure-high temperature operation- dangerous and toxic chemicals, highly radioactive materials safe handling and operation of materials and machineries. Work environment-noise-effect of noise-unit of sound-noise levels in industries-control of noise

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. Major industrial accidents in India and in other countries,

Module 3: Accident Prevention and Risk Analysis (8 hrs)

Identification and analysis of causes of injury to men and machineries-accident prevention-accident proneness-vocational guidance, fire prevention and fire protection-personal protective equipments. Occupational, industrial health hazards –health standards and rules-safe working environments.

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) , 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, Role of Government, safety organization, management and trade unions in promoting industrial safety- on site and off site safety provisions.

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.

20BT3051	BIOCHEMISTRY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To ensure students will have strong foundation in structure, properties and function of various biomolecules.
2. To provide knowledge regarding the basic structure of biomolecules which are involved in metabolic pathways
3. To articulate the significance of biomolecules

Course Outcome:

The students will be able to

1. Acquire knowledge on structure, properties and biological functions of carbohydrates, lipids and proteins
2. Assess the significance of nucleic acid structure, properties and functions
3. To impart knowledge on the significance of Vitamins and mineral functions
4. Integrate the metabolic pathways of synthesis and degradation of biomolecules
5. Justify the clinical and biological significance of biomolecules
6. Classify the biomolecules and understand their specific roles in biological system.

Module 1: Carbohydrates (9 Hours)

Classification, structure, properties and functions of carbohydrates: Monosaccharides, Disaccharides, Oligosaccharides-examples; Polysaccharide – classes- homo and hetero polysaccharides, glycolysis,TCA cycle, Pentose Phosphate Pathway, bioenergetics and oxidative phosphorylation

Module 2: Fatty Acids and Lipids (9 Hours)

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 –, fatty acid biosynthesis and degradation, biosynthesis of triacylglycerol, Inborn errors of lipid metabolism.

Module 3: Amino Acids, Peptides and Proteins (9 Hours)

Amino acids- classification, properties; Essential amino acids; Peptide bond, significant natural and artificial peptides –examples; Proteins- structure / conformation levels-primary, secondary, tertiary and quaternary, Biosynthesis of aromatic amino acids-tyr,trp,phe, biodegradation of leucine, isoleucine and threonine, urea cycle,.

Module 4: Nucleotides and Nucleic Acids (9 Hours)

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

Module 5: Vitamins (4 Hours)

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

Module 6: Minerals – Functions and Disorders (5 Hours)

Minerals: classification- macro elements and microelements, sources, biochemical functions, dietary requirements and deficiency disorders, review on vitamins and mineral supplementations.

Total Hours: 45

Text books

1. Lubert Stryer Jeremy M. Berg , John L. Tymoczko , Gregory J. Gatto Jr., Biochemistry, 9th Edition, Kindle Edition,2019.
2. Voet and Voet, "Biochemistry", John Wiley & Sons Inc., 2nd Edition, 2013.

References

1. Lehninger, A. L, Nelson D. L and Cox, M. M, "Principles of Biochemistry", Freeman Publishers, New York, seventh edition, 2017
2. Murray R.K, Granner B.K, Mayes P.A, Rodwell V.W. "Harper's Biochemistry", Prentice Hall International, 31st Edition,2018.
3. Jain and Jain "Biochemistry", Chand publication, 2016.Revised Edition

20BT3052	PLANT SECONDARY METABOLITES AND PHARMACEUTICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To recall the myriad of different secondary metabolites produced by plant
2. To analyze the biosynthesis and metabolic engineering of plant secondary metabolites
3. To formulate various products and their dosage forms

Course Outcome:

The students will be able to

1. Enumerate major plant secondary metabolites and its uses.
2. Illustrate the biosynthesis and regulation of plant secondary metabolites
3. Infer the different methods of production of secondary metabolites.
4. Interpret the biochemical pathways for improved secondary metabolite production.
5. Enumerate the pharmaceutical procedures for preformulation studies
6. Examine the development of formulation and dosage forms

Module 1: Plant Secondary Metabolites (6 Hours)

Definition and systematic of secondary metabolites. Structures, functions and commercial significance of secondary metabolites: alkaloids, terpenoids/isoprenoids, flavonoids and phenolics. Secondary metabolites in chemical defense of plants, ecological functions, and biological activities

Module 2: Biosynthesis and Regulation of Secondary Metabolite (8 Hours)

Integration of primary and secondary metabolism. Shikimate and PHA pathways of alkaloid biosynthesis. MEP pathway of terpenoid biosynthesis. Biosynthesis of flavonoids and polyphenol (lignin). Regulation: metabolic channeling, compartmentalization, cross-talk/exchange of intermediates between biochemical pathways. Application of specific enzyme inhibitors. Precursor feeding, genetic regulation of key enzymes, developmental, seasonal and environmental factors

Module 3: Production Technologies (9 Hours)

Production of secondary plant metabolites from higher plants: Tissue cultures, organ cultures, hairy root cultures. Roles of Endophytes in production of secondary metabolites; Bioreactors: scaling up of

production of secondary metabolites. Effects of precursors and elicitors. Production of pharmaceutically important secondary metabolites such as Taxol, Camptothecin, Berberine and rubber

Module 4: Metabolic Engineering of secondary metabolic pathways (8 Hours)

Cloning and characterization of enzymes of the Shikimate and MEP pathway; functional genomics approaches for improvement of secondary metabolite production. Metabolic engineering of yeast for the production of plant secondary metabolites, such as flavonoids, terpenoids and plant-origin alkaloids in yeasts.

Module 5: Pharmaceutics – Preformulation Studies (7 Hours)

Goals of preformulation, preformulation parameters, methodology, Solid state properties, Solubility and Partition coefficient, drug excipient compatability. Excipients used in pharmaceutical dosage forms:Properties and selection criteria for various excipients like surfactant, viscosity promoters, diluents, coating materials, plasticizers, preservatives, flavours and colours

Module 6: Powder and Liquid dosage forms (7 Hours)

Formulation development and manufacture of powder dosage forms for internal and external use including inhalations dosage forms, Formulations, production and evaluation of hard and soft gelatin capsules. Recent advances in formulation aspects and manufacturing of monophasic dosage forms. Recent advances in formulation aspects and manufacturing of suspensions and dry syrups

Total: 45 Hours

Text Books:

1. Y. M. Shukla, Plant Secondary Metabolites. New India Publishing Agency, ISBN-10: 8190851225, ISBN-13: 9788190851220, (2009).
2. R. Verpoorte, A. Wilhelm Alfermann, Metabolic Engineering of Plant Secondary Metabolism. Springer Science and Business Media. (2000).

References

1. David S. Seigler, Plant Secondary Metabolism, Springer Science and Business Media, ISBN: 0412019817, 9780412019814, (1998).
2. Liberman, HA &lachman L Pharmaceutical dosage forms: Disperse systems vol I , II & III (1996)
3. Carstensen JT, Theory of Pharmaceutical systems academic press New York and London. (1972)

20BT3053	MOLECULAR BIOLOGY AND CELL SIGNALING	L	T	P	C
		3	0	0	3

Course Objectives:

To improve knowledge on

1. Core principles and applications of molecular biology
2. Gene expression and Cell signaling mechanisms and their regulation
3. Recent trends in biomedical research

Course Outcome:

The students will be able to

1. Exhibit a knowledge base in DNA replication, transcription, translation and Cell signaling
2. Summarize the process of gene expression and its regulation in prokaryotes and eukaryotes
3. Experiment with model organisms in gene expression studies and cancer research
4. Compare and contrast the different molecular processes in gene expression, signalling processes and cancer mechanism
5. Engage in review of scientific literature in the areas of biomedical sciences
6. Critique and professionally present primary literature articles in the general biomedical sciences field

Module 1: DNA replication, repair and recombination (7 Hours)

Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms, homologous and site-specific recombination.

Module 2: Gene expression (10 Hours)

RNA synthesis and processing - transcription factors and machinery, RNA polymerases, formation of initiation complex, capping, elongation, and termination, RNA processing, RNA editing, splicing, and polyadenylation, Protein synthesis and processing - Genetic code, aminoacylation of tRNA, Ribosome, Initiation, elongation and termination, translational inhibitors, Post- translational modification of proteins.

Module 3: Regulation of Gene expression (6 Hours)

Role of Promoters, Enhancers, Silencers in gene regulation. Regulation in Phages - Lytic and Lysogeny. Regulation in Bacteria – operons. Regulation in Eukaryotes - role of chromatin in gene expression and gene silencing (RNA interference). Epigenetic modifications

Module 4: Cell signaling and cellular communication (10 Hours)

Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways. General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix.

Module 5: Molecular basis of Cancer (6 Hours)

Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, apoptosis, therapeutic interventions of uncontrolled cell growth.

Module 6: Review on recent advances in research (6 Hours)

Noble prize research work on Physiology and Medicine – Cells sense and adapt to oxygen availability (2019), Cancer therapy by inhibition of negative immune regulation (2018), Molecular mechanisms controlling the circadian rhythm (2017), Mechanisms for autophagy (2016), Novel therapy against infections caused by roundworm parasites(2015).

Total: 45 Hours

Text book

1. Harvey Lodish, Arnold Berk, Paul Matsudaira, "Molecular cell biology", WH Freeman & Company, New York, 6th edition, 2017.
2. Geoffrey M. Cooper and Robert E. Hausman, The Cell: A Molecular Approach, Fifth Edition, ASM Press and Sinauer Associates, Inc., USA, 2015.

References

1. David R Hyde, "Genetic and Molecular Biology", Tata McGraw Hill Publications, New Delhi, 2010.
2. Bruce Alberts, Alexander Johnson, Julian Lewis and Martin Raff, Molecular Biology of the cell, fifth edition, Taylor and Francis group, 2012.
3. Lehninger, A. L, Nelson D. L and Cox, M. M, “Principles of Biochemistry”, Freeman Publishers, New York, Seventh edition, 2017

20BT3054	MICROBIOLOGY AND MOLECULAR GENETICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To familiarize students with conventional and molecular characterization of microorganisms
2. To illustrate the role of microbes in health care, agriculture and environment
3. To exemplify the importance of genetic composition in microbial inheritance and mutations

Course Outcomes:

The students will be able to:

1. Analyze the classification, diversity, and ubiquity of major categories of microorganisms
2. Demonstrate the structural, physiological differences of microorganisms and their growth control
3. Evaluate the interactions between microbes, hosts and environment.

4. Acquire knowledge on prokaryotic, eukaryotic genome organization and the process of replication
5. Interpret the epigenetic effects on transposons in genes of interest
6. Describe the causes and consequences of mutations on microbial evolution and the generation of diversity

Module I: Microbial diversity and Molecular Taxonomy (9 Hours)

Concepts of species and hierarchical taxa – Bergey‟s system of classification– Classification of Bacteria, Fungi, and Viruses; Modern methods to study microbial diversity: NGS – MiSeq; Molecular Taxonomy- 16S rRNA gene sequencing, Phylogenetic grouping. Fatty Acid Methyl Ester (FAME) analysis, ITS, peptidoglycan, Isoprenoid, quinines; Methods to study microbial community: DGGE, SSCP, T-RFLP.

Module II: Microbial Physiology and Metabolism (8 Hours)

Morphology, structure and functions of prokaryotic and eukaryotic cells, Control of Microbial growth – Physical and Chemical, Metabolic Pathways: Metabolic versatility of microbes, Anaerobic Carbon metabolism: Anaerobic respiration, Sulphate respiration, Methane oxidizing and Methanogenic bacteria, Aerobic Carbon metabolism: TCA cycle alternative metabolic pathways; Quorum sensing: Vibrio fischeri, virulence- Pseudomonas aeruginosa, Staphylococcus aureus, Preservation and maintenance of microbes – Microbial Culture Collection centers – India and International organizations

Module III: Clinical, Agricultural and Environmental Microbiology (9Hours)

Clinical Microbiology- Survey of disease causing microbes; Bacterial Diseases: Mycobacterium tuberculosis, Salmonella, Viral Diseases: HINI, Fungal Diseases: Candida, Protozoan Diseases: Malaria, Antibiotics and their targets, Human Microbiome- gut microbiota, Microbes and Agriculture: Symbiotic Nitrogen fixation Rhizobium, Cyanobacteria (Anabaena, Azolla etc.), Mycorrihizae; Environmental Microbiology: Xenobiotic degrading consortia, Bioremediation; Biofilm and its ecological implication

Module IV: Genetics of bacteriophages and Yeast (6 Hours)

Genetics of bacteria and bacteriophages: Mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers. Yeast genetics: Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch

Module V: Transposons and epigenetics (7 Hours)

DNA-based Transposons in bacteria, Eukaryotic Transposons (DNA-based), Retrotransposons and Retroviruses (eukaryotes); Epigenetics: RNA-based silencing, X-chromosome inactivation, transcriptional memory, silencing of ancient transposons

Module VI: Microbial Mutation (6 Hours)

Molecular basis of mutation, mutagen and origin of spontaneous mutations- Fluctuation test – inference of function of genes based on isolation of mutations – various types of mutations – missense – nonsense – frameshift, Conditional Lethal - mutagens – physical and chemical agents – Mode of action of important mutagens (5BU, 2AP, NTG, Hydroxylamine, Nitrous acid) – use of mutagenic chemicals in isolation of mutants and their advantages – dominant and recessive nature of mutations with examples

Total: 45 Hours

Textbooks

1. Prescott LM, Harley JP, Klein DA, Microbiology, 3rd Edition, Wm. C. Brown Publishers, 2001
2. Brock Biology of Microorganisms by M. Madigan, K. Bender, D. Buckley, W. Sattley, D. Stahl. 15th Edition. Pearson Education. 2018.
3. Modern Microbial Genetics by U.N. Streips and R.E. Yasbin, 2nd edition; Wiley Publishers; 2002

References

1. Lim D, “Microbiology”, Second Edition, WCB-Mc Graw Hill, 2001.
2. Weaver, Robert Franklin, Molecular biology. 5thedition. McGraw Hill, New York. 2012
3. Bergey‟s Manual of Systematic Bacteriology. Volumes 1-5. Williams & Wilkins

4. ErkoStackebrandt. Molecular identification, systematics, and population structure of prokaryotes. Springer-Verlag Berlin Heidelberg. 2006
5. Lewin's GENES X, Volume 10 Benjamin Lewin, Jocelyn Krebs, Stephen T. Kilpatrick, Elliott S. Goldstein Jones & Bartlett Learning, 2011

20BT3055	ANIMAL BIOTECHNOLOGY AND IMMUNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To provide insights into animal biotechnology
2. To impart knowledge in animal breeding
3. To equip students with advancement in immunology and immunotechnology

Course outcomes:

The students will be able to

1. Explain the role of cryopreservation of embryos and embryo sexing
2. Describe the basic concepts in animal biotechnology and its importance in livestock improvement
3. Relate and identify the genetic defects in animal embryos through molecular techniques.
4. Identify the cellular and molecular basis of immune responsiveness through antigen and antibody interactions
5. Describe the roles of the immune system in both maintaining health and contributing to disease,
6. Demonstrate a capacity for problem-solving about immune responsiveness.

Module 1: Embryo Cryopreservation (8 Hours)

Introduction to Animal Biotechnology, Cryopreservation of Sperms, Ova of livestock, Artificial Insemination, Super Ovulation, In Vitro fertilization, Culture of embryos, Cryopreservation of Embryos, Embryo transfer, Embryo splitting, Embryo sexing.

Module 2: Germplasm Preservation and Live stock Improvement (7 Hours)

In situ and ex situ preservation of germplasm, In utero testing of foetus for genetic defects, pregnancy diagnostic kits, anti-fertility animal vaccines, Genetic characterization of livestock breeds, Marker assisted breeding of livestock,

Module 3: Transgenic Animals (7 Hours)

Transgenic animal production and application in expression of therapeutic proteins, Animal model for diseases, Detection of meat adulteration using DNA based methods.

Module 4: Antigen-Antibody Interaction (7 Hours)

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

Module 5: Antibodies (9 Hours)

MAb through hybridoma technology, MAb without hybridoma technology, viral transformation of B cell line, plant as expression systems: plantibodies, applications. Production of abzymes, immunotoxins, chimeric antibodies, bi specific antibodies, diabodies, tetrabodies, intrabodies, plastibodies and their applications

Module 6: Immunity and Infection Mechanism (7 Hours)

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

Total: 45 Hours

Text Books

1. Ian Freshney R. Culture of Animal cells & Manual of basic technique, 6th ed., Wiley – liss publication, 2011.
2. Kuby J, "Immunology", 7th ed., WH Freeman & Co., 2013.

Reference Books

1. Levine MM, Kaper JB, Rappuoli R, Liu MA, Good MF,. *New Generation Vaccines*. 3rd Ed. Informa Healthcare, 2004.
2. Animal Cell Culture by John R.W. Masters 3rd ed., Oxford University Press, 2009.
3. David Male Jonathan BrostoffDavid Roth Ivan Roitt, Immunology. 8th ed., Elsevier, 2012
4. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th ed., Blackwell Publishing, 2002
5. Goldsby , R.A., Kindt, T.J., Osbome, B.A. and Kerby J. Kuby Immunology, 6th ed., W.H. Freeman, 2005

20BT3056	RESEARCH METHODOLOGY AND APPLIED STATISTICS	L	T	P	C
		2	0	0	2

Course Objectives:

1. Empower students to formulate research questions and develop a sufficiently coherent research design
2. Apprehend the need and review the guidelines for good research and publication ethics
3. Enable the students to understandthe need of statistical data analytic techniques in biological research

Course Outcome:

The students will be able to

1. Design their experiment keeping in mind the appropriate statistical test to be adopted in support of research hypothesis
2. Understand key steps to transform a wobbly idea into a convincing research proposal report - connecting the small objectives to big-picture
3. Perform hypothesis testing based on parametric and non-parametric approach in statistical package, office tools
4. Analyze the need of literature, experimental data, and supporting information in realm of research publication
5. Practice good-research and publication ethics
6. Understand the need of statistical analysis pertinent to their experimental data

Module 1: Research Methodologies: strategies, planning (4 Hours)

Resources or search engines available for gathering information and literature in related area,
Critical review of available literature, Problem Identification Formulation (finding research gaps),

Module 2: Research Concepts and Data Collection (5 Hours)

Definition of Research, Qualities of Researcher, Components of Research Problem, Various Steps in Scientific Research, **Types of Research**; Hypotheses Research Purposes - Research Design – Survey Research. **Sources of Data**: Primary Data, Secondary Data; Procedure. Questionnaire - **Sampling** Merits and Demerits - Experiments - Kinds - Procedure; **Control Observation** - Merits - Demerits - Kinds – Procedure. Research conditions: repeatability and reproducibility, bias, measurement and source of error: Type-I Error - Type-II Error, experimental controls, Association versus causality

Module 3: Crafting Scientific publication (6 Hours)

Types of publications - their purpose and readers, Choosing Appropriate Journal/Publisher - available tools, Steps in drafting reports, editing and evaluation of final draft, evaluating the final draft; Good Research Report, observation and research report., *Component of an articles*: Introduction, M&M, Results, Discussion, and Conclusion. Brevity in scientific writing, *Authors guidelines* in scientific publications, Language polishing, Citation style and editor, uniformity.

Module 4: Research, publication, and ethics (3 Hours)

Scientific conduct and misconduct, fabrication, falsification, duplicate-publication, Plagiarism and self-plagiarism, Erratum, Retraction, *Authorship and issues*, statement of authors contribution, Corresponding authors role and responsibility, Need for Acknowledgement, Conflict of interest, Plagiarism, COPE

guidelines, *Publication models* - subscription *vs.* open access, Authors right, Editorial process and publication life-cycle.

Module 5: Advanced and Applied statistics (9 Hours)

Hypothesis Testing: One-Sample Test for the Mean of a Normal Distribution, Hypothesis Testing and Confidence Intervals, Interval Estimation for the Comparison of Means, Two-Sample *t* Test, Paired *t* test, One-way and two-way ANOVA,**Non-parametric** *Wilcoxon Signed-Rank Test*,

Module 6: Correlation and regression analysis (3 Hours)

The Method of Least Squares, Regression coefficient, Correlation Coefficient, Multiple Regression

Total: 30 Hours

Text Book

1. Kothari C.R., 2004. Research Methodology Methods and Techniques, New Age international (P) Limited, New Delhi
2. Rosner, B. (Ed.), Fundamentals of Biostatistics, 8th ed. Cengage Learning, Boston, 2016.

Reference Book

1. Laake, P., Benestad, H.B., Olsen, B.R., 2007. Research methodology in the medical and biological sciences, 1st ed. Academic Press.
2. Blackwell, J, Martin J 2011. A Scientific Approach to Scientific Writing, Springer

20BT3057	BIOPROCESS AND DOWNSTREAM PROCESSING	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the principles of upstream and downstream processing in Bioprocess Technology
2. To illustrate knowledge on the requirement of media formulations, sterilization and inoculum development
3. To acquire knowledge on microbial growth and product formation

Course Outcomes:

The students will be able to;

1. Understand the process of fermentation and its requirements
2. Recall the media formulation, medium optimization and sterilization process
3. Illustrate the importance of microbial screening and preservation in bioprocessing
4. Discuss the cell growth and product formation
5. Apply knowledge on various unit operations in downstream processing
6. Analyze industrial product development in fermentation process

Module 1: Overview of Fermentation Process (6 Hours)

Overview of fermentation industry, general requirements of fermentation processes, basic configuration of fermenter, main parameters to be monitored and controlled in Fermentation processes- Temperature, pH, pressure, flow measurement, rate of stirring, biomass weight, Dissolved Oxygen

Module 2: Medium Formulation, Optimization and sterilization (10 Hours)

Criteria for good medium, medium requirements for fermentation processes, examples of simple and complex media, design of various commercial media for industrial fermentations, medium optimization methods, liquid heat and filter sterlization of media

Module 3: Isolation of Industrially Important Microbes and Inoculum development (6 Hours)

Isolation of industrially important microbes- primary screening, preservation and storage of industrially important microbes, Inoculum development for Industrial fermentation process

Module 4: Cell Growth and Product formation (7 Hours)

Cell number and Cell mass calculations, growth model- Monod model, Effect of Substrate and product inhibition on growth, Product formation model- Leude king piret model, Factors affecting microbial growth

Module 5: Cell separation and Extraction (8 Hours)

Cell disruption for product release, separation of cells from fermented broth- sedimentation, Filtration, Centrifugation , Extraction of product, leaching, adsorption and precipitation of proteins.

Module 6: Purification and Finishing (8 Hours)

Chromatography adsorption, reverse phase, ion exchange, size exclusion, bio affinity and pseudo affinity, crystallization, drying and lyophilization, packaging, case studies of downstream Processing - Baker's yeast, Ethanol, Citric acid, Penicillin.

Total: 45 Hours

Text Books:

1. Shuler M.L. and Kargi F., Bioprocess Engineering: Basic Concepts, Prentice-Hall (2001).
2. Stanbury, P.F., Principles of Fermentation Technology, Book News, Inc. (1992).
3. Vogel H. C.and Haber C. C., Fermentation and Biochemical Engineering Handbook, Noyes Publications (2001).

Reference Books:

1. Bailey, J.E. and Ollis, D.F., Biochemical Engineering Fundamentals, McGraw-Hill (1986).
2. Wang D.C. and Humphrey, L, Fermentation and Enzyme Technology, John Wiley (1989).
3. Doran P M, Bioprocess Engineering Principles, Academic Press (1995).

20BT3058	MOLECULAR MEDICINE AND DIAGNOSTICS	L	T	P	C
		3	0	0	3

Course Objectives:

1. Learn to self-reliantly analyze and understand research results and technologies.
2. Learn techniques for emerging novel molecular diagnostics and therapies.
3. Be able to study applications in healthcare, research and industry.

Course Outcome:

The students will be able to

1. Recognize molecular mechanisms in development of disease
2. Predict the use of molecular genetic methods in the detection, identification and quantification of different microorganisms.
3. Apply the principles of molecular diagnostics and advantages/limitations of its applications
4. Develop technological integration of chemistry, physics and molecular biology for use in bioanalysis relevant for biomedical research and diagnostics.
5. Design advanced study in the theoretical and practical aspects of the genetic basis and diagnosis of disease from both human and pathogen perspectives.
6. Appraise the knowledge of molecular testing to the most commonly performed applications in the clinical laboratory such as: nucleic acid extraction, resolution and detection, analysis and characterization of nucleic acids and proteins, nucleic acid amplification and DNA sequencing.

Module 1: Introduction to Molecular medicine, Nanomedicine (7 Hours)

Extracellular and intracellular signaling systems. Methods of DNA analysis and gene technology. Nanomedicine - Overview. Identification of genes and variants in the genome and gene mapping.

Module 2: Molecular and Medical Microbiology (7 Hours)

Molecular methods for detection and characterization of microorganisms, Primer and probe design. Databases - Molecular genetic assays, genotypic assays for molecular epidemiology.

Module 3: Cell Imaging and Biobanking (8 Hours)

Cell Imaging: Preparation and microscopy of biological specimens, tissue and cell morphology. Biobanks: classifications, common and distinctive features of the different types of biobanks. National regulations, international conventions, use of human biological materials and personal data, Research biobanks, Ethical aspects, role of Research Ethics Committees, consent for biobanking, alternatives to consent, Logistics and quality management, quality assurance and quality control of collection, storage, retrieval and use of samples, Role of biobanks in health surveys like HUNT, Mother-Child etc.,

Module 4: Introduction to Molecular diagnostics (7 Hours)

Introduction and History of diagnostics, Diseases- infectious, physiological and metabolic errors, genetic basis of diseases, inherited diseases. Infection – mode of transmission in infections, factors predisposing to microbial pathogenicity, types of infectious diseases- bacterial, viral, fungal, protozoans and other parasites. · Philosophy and general approach to clinical specimens, Sample collection- method of collection, transport and processing of samples, Interpretation of results, Normal microbial flora of the human body, Host - Parasite relationships.

Module 5: Diagnostic tests and diseases (8 Hours)

Duchenne muscular Dystrophy (Creatine phosphokinase-CPK), Amino acid deficiency - PKU (phenylketonuria) –- Inborn error, G6PD deficiency syndrome (G6PD), Sickle cell anemia, PCR diagnosis of Tuberculosis, Prenatal screening of Cystic Fibrosis. Endocrine disorders related to thyroid and reproduction (TSH, T3, T4, Estradiol, Testosterone, LH, FSH). Pyrosequencing. Lab on a Chip. Personalized Medicine - Pharmacogenomics.

Module 6: Genetic Disorders and Immunodiagnostics (8 Hours)

Major Metabolic disorder, Genetic disorders, Bone and blood disorders. Overview of immune system, Major Histocompatibility Complex (MHC), HLA typing, monoclonal and polyclonal antibodies, Immunoassays – types [Chemiluminescent IA, FIA] and specific applications; Immunohistochemistry – principle and techniques. Good Laboratory Practices. Different Levels of Biosafety, Containment. Future trends.

Total: 45 Hours

Text Books

1. Textbook of Molecular medicine, Jones and Bartlett Publishers, 2008
2. Jawetz, Melnick, &Adelberg's Medical Microbiology (2004), Geo F. Brooks, Stephen A. Morse, Janet S. Butel.

References

1. Principles of Biochemistry (Lehinger) (5th edition), MM Cox and DL Nelson, CBS Publishers, 2013.
2. Molecular Cell Biology: Darnell J, Lodish H and Baltimore D, 5th Edition, 2003.
3. Principles of Immunology and Immunodiagnostics: Ralph Michael Aloisi. Lippincott Williams and Wilkins, 1988.
4. Genomes (3rd edition) TA Brown, Garland Science Publishing, 2006.

20BT3059	MICROBIAL TECHNOLOGY LAB	L	T	P	C
		0	0	4	2

Course Objective:

1. To introduce students to experiments of microbial analysis – Growth curve
2. To deliver hands-on experience on various enzymatic assays
3. Provide idea about quantification of DNA, RNA and protein from microbial samples

Course Outcome:

1. Perform suitable technique to analyse growth curve of bacteria
2. Hands on skills of quantification of DNA, RNA and protein from bacterial cells and its visualization by performing agar electrophoresis.
3. Gain hands-on experience in screening microbial enzymes and assays
4. Apply appropriate technique for the isolation and identification of mutant strains
5. Demonstrate the sensitivity of microbial pathogens to various available drugs.
6. Construct phylogenetic trees using distance-based methods.

Experiments:

1. Establishment of bacterial growth curve
2. Screening of microbes for the production of enzymes - chitinase, protease, lipase, cellulase
3. Antimicrobial Sensitivity Test- Minimum Inhibitory Concentration
4. Quantification of Biofilm using microtitre plate (TCP) method

5. Phylogenetic analysis of microbes using UPGMA method
6. Isolation and quantification of total DNA from bacteria and fungi
7. Isolation and quantification of RNA.
8. Isolation and quantification of microbial protein
9. Replica plating technique- Ames Technique
10. Photoreactivation of UV irradiated E. coli.
11. Development of auxotrophic mutants employing Ethyl Methane Sulfonate
12. Blue and white colony selection employing X-gal-IPTG

Reference Books:

1. James G. Cappuccino Chad T. Welsh, Microbiology: A Laboratory Manual, 11th edition, Pearson, 2017
2. Dubey and Maheshwari, Practical Microbiology, S Chand Publishing, 2010
3. ApurbaSankarSastry, Sandhya Bhat, Essentials of Practical Microbiology**,** 2018

20BT3060	BIOPROCESS AND DOWNSTREAM PROCESSING LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To acquire knowledge about principles of growth of microbes, importance of maintaining the cultures, techniques used for enhancing the yield
2. To design criteria for fermenter and operation of bioreactor, solid state fermentation
3. To produce different metabolites from microbial culture

Course Outcomes:

The student will be able to:

1. Understand the growth kinetics of microorganism.
2. Understand various factors affecting the growth
3. Illustration of fermentation in production of primary and secondary metabolites
4. Application of Immobilization technique in production of metabolites
5. Analyze the various operations in product recovery and isolation
6. Evaluate the purification and polishing of the bioproducts

List of Experiments.

1. Laboratory fermenter, sterilization and operations.
2. Revival of culture from frozen vial to shake flask culture
3. Standardization of conditions for scale up of the culture in fermenter
4. Optimization of growth of bacteria in batch cultivation by statistical method
5. Immobilization of bacteria using alginate and agar
6. Study on growth kinetics and toxic compound inhibition kinetics
7. Solid state fermentation for the production of bioproducts
8. Cell disruption study
9. Isolation of product from the broth by extraction
10. Partial purification of enzymes by ammonium sulphate precipitation
11. Chromatographic techniques (column) for the product purification.
12. Product drying by lyophilization

Text Books

1. Kargi, Michael Shuler L. Fikret, and Matthew DeLisa. Bioprocess engineering: basic concepts. Prentice Hall, 2017.
2. Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall. Principles of fermentation technology. Elsevier, 2013.
3. Doble, Mukesh, and Sathyanarayana N. Gummadi. Biochemical engineering. PHI Learning Pvt. Ltd., 2007

References

1. Todaro, Celeste M., and Henry C. Vogel, eds. Fermentation and biochemical engineering handbook. William Andrew, 2014.
2. Bailey, J.E. and Ollis, D.F., Biochemical Engineering Fundamentals, Tata McGraw-Hill (2010)

20BT3061	IMMUNOLOGICAL TECHNIQUES LAB	L	T	P	C
		0	0	4	2

Course Objectives:

1. To deliver hands-on experience on various immunological techniques
2. To impart technical skills in the preparation of antigen
3. To provide knowledge in the production of antibodies and antibody titre assays

Course Outcomes:

1. Understand the procedure for antigen preparation
2. Categorize the methods of immunization
3. Identify the steps involved for the production of antibodies
4. Perform purification of the antibodies
5. Evaluate the methods involved for antigen and antibody reactions
6. Analyze and interpret the results obtained by the immunological experiments

List of Experiments:

1. Acclimatization of Fish & Chicken
2. Preparation of Antigen
3. Administration of Antigen in Fish & Chicken
4. Isolation of Lymphocytes from lymphoid organs.
5. Drawing Blood and separation of Serum from fish
6. Visualization of immune cells in blood smears.
7. Isolation of IgY antibodies from Chicken egg
8. Molecular weight identification of antibodies using SDS Page analysis
9. Estimation of specific Antibodies using Haemagglutination.
10. Estimation of specific Antibodies using immunodiffusion
11. Graft Rejection
12. Delayed type hypersensitivity in Fish

Reference Books:

1. Frank C Hay, Olwyn M.R. West Wood. Practical Immunology, 4th ed., Wiley- Blackwell,2008
2. David Male, JonathanBrost, David Roth, Ivan Roitt. Immunology. 8th ed., Elsevier, 2012.

20BT3062	INDUSTRIAL BIOTECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To inculcate knowledge on history of biotechnology, origin and analysis of different kinds of microorganisms for industrial biotechnology.
2. To elaborates on the process of industrial biotechnology
3. To facilitate various production strategies of bio products employed for sustainable bioprocess development

Course Outcome:

The students will be able to

1. Acquire knowledge on industrial bioprocess and process flow diagrams.
2. Remember various types of bioproducts and steps in fermentation technology.
3. Understand the problems related to handling microorganisms and selection of microbial culture for specific kind of bioproducts
4. Analyze industrial-market value of the bio products and relate them with the scope of biotechnology

5. Justify the clinical and biological significance of these bio products for sustainable bioprocess engineering,
6. Illustrate the difference in manufacturing commercial bioproducts and the ethical issues related to entrepreneurial aptitude.

Module 1: Introduction to Industrial Bioprocess (10 Hours)

Fermentation- Bacterial, Fungal and Yeast, Biochemistry of fermentation. Traditional and Modern Biotechnology- A brief survey of organisms, processes, products. Basic concepts of Upstream and Downstream processing in Bioprocess, Process flow sheeting – block diagrams, pictorial representation.

Module 2: Production of Primary Metabolites (8 Hours)

Primary Metabolites- Production of commercially important primary metabolites like organic acids, amino acids and alcohols.

Module 3: Production of Secondary Metabolites (8 Hours)

Secondary Metabolites- Production processes for various classes of secondary metabolites: Antibiotics, Vitamins and Steroids.

Module 4: Production of Enzymes and other Bioproducts (11 Hours)

Production of Industrial Enzymes (Amylase, Laccase), Biofertilizers, Biopreservatives, Biopolymers Biodiesel. Cheese, Beer, Mushroom culture, Bioremediation.

Module 5: Production of Modern Biotechnology Products (4 Hours)

Production of recombinant proteins having therapeutic and diagnostic applications, vaccines. Bioprocess strategies in Plant Cell and Animal Cell culture.

Module 6: Production of Target Specific Fine Bioproducts (4 Hours)

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

Total Hours: 45

Text Books

1. Prescott and Dunn, Industrial Microbiology, Fourth Edition, 2004.
2. Stanbury P.F. and Whitaker, Fermentation Technology, Third Edition, 2016.

References Books

1. ElmarHeinzle,Sustainable Bioprocess Development, John Wiley & Sons,2008.
2. Robert H. Perry, Handbook of ChemicalEngineering, McGraw-Hill Education 2019.

20BT3063	PHARMACEUTICAL TECHNOLOGY AND CLINICAL TRIAL	L	T	P	C
		2	0	2	3

Course Objectives:

1. To understand the impact of pharmaceutical technology and manufacturing process of drug formulation.
2. To learn and work on pharmaceutical laboratory process on multidisciplinary tasks.
3. To explore an ability to design an experiment, component or process as per needs and specifications.

Course Outcome:

The students will be able to

1. Distinguish to excel in research and to succeed in Biopharmaceutical technology profession through global, rigorous post graduate education.
2. Contrast students with a solid foundation in pharmacology, scientific and engineering fundamentals required to solve biopharmaceutical related problems.
3. Understand students with good scientific and technical knowledge so as to comprehend novel products and solutions for the health care issues.
4. Articulate in scientific & professional ethics on biological product manufacturing process.
5. Discover scientific methods and SOPs in clinical trials and fundamentals in new drug discovery process.

6. Develop academic environment aware of excellence in new drug discovery and patenting professional career.

Module 1: Introduction of drug action (7 Hours)

History & Definition of Drugs- Sources of Drugs - Plant, Animals, Microbes and Minerals- Different dosage forms- Routes of drug administration- Pharmacodynamics- Physico-Chemical Principles. Mechanism of drug action- drug receptors- and Physiological receptors- structural and functional families -Pharmacokinetics- Drug absorption- factors that affect the absorption of drugs-Distribution of drugs-Biotransformation of drugs- Bioavailability of drugs.

Module 2: Important Unit Processes and their Applications (6 Hours)

Chemical conversion processes – Alkylation – Carboxylation – Condensation and Cyclization – Dehydration, Esterification (Alcoholysis) – Halogenation – Oxidation, Sulfonation – Complex Chemical Conversions – Fermentation

Module 3: Manufacturing Principles (7 Hours)

Compressed tablets – wet granulation – Dry granulation or slugging – Direct compression – Tablet presses formulation – Coating – Pills – Capsules sustained action dosage forms – Parental solutions and injections – Oral liquids –ointments – standard of hygiene and good manufacturing practice.

Module 4: Biopharmaceutical products (7 Hours)

Antibiotics – Biological hormones – Vitamins – preservation- Analytical methods and tests for various drugs and pharmaceuticals- Packing – Packing Techniques – Quality Control - Recent advances in the manufacture of drugs using r-DNA technology.

Module 5: Drug delivery systems (6 Hours)

Biomaterials and their applications-Controlled and sustained delivery of drugs- Biomaterial for the sustained drug delivery- Liposome mediated drug delivery- Drug delivery methods for therapeutic proteins.

Module 6: Drug discovery and Clinical trials (6 Hours)

Glossary of terms in clinical trials, history, requirements, new drug development process, need for new drug, selection of a chemical compound as a potential drug, screening of chemical compounds, translation medicine, assessment of preclinical data. Phases of clinical trials.

Total Hours: 45

Text Books

1. Sathoskar R.S., Bhandrkar S.D., Ainapure S.S., "Pharmacology and pharmacotherapeutics "17th edition, Popular Prakashan pub. (2001)
2. Remington, The Science and Practice of Pharmacy, Lippincot Williams & Wilkins pub.(2014)
3. Leon Lachman, Herbert A. Lieberman and Joseph L. Kanig, Theory & Practice of Industrial Pharmacy, (3rd ed.) Varghese Pub. 2013

References Books

1. Googman and Gilman's The pharmacological Basis of Therapeutics,13th Edition 2017
2. Methodology of Clinical Drug Trials, 2nd Edition. Spriet A., Dupin-Spriet T., Simon P. Publisher: Karger. 2010.

Lab

Course Objective:

1. To prepare students to excel in research and to succeed in Biopharmaceutical technology profession through global, rigorous post graduate education.
2. To train students with good scientific and technical knowledge so as to comprehend, analyze, design, and create novel products and solutions for the health related problems
3. To provide students with a solid foundation in statistical, scientific and engineering fundamentals required to solve biopharmaceutical related problems

Course Outcome:

The students will be able to,

1. Demonstrate to design and conduct experiments, analyze and interpret data.

2. Develop an experiment, component or process as per needs and specifications
3. Construct to visualize and work on laboratory and multidisciplinary tasks.
4. Organize to employ modern technology, software and equipment to analyze problems.
5. Classify to identify, formulate and solve health related issues.
6. Create impact of pharmaceutical technology on the society and also will be aware of contemporary issues

List of experiments:

1. Introduction to CDS (cleaning, decontamination and sanitization) protocols as per GLP norms.
2. Sterility testing of finished biopharmaceutical products (Injectable / freeze dried formulations).
3. Isolation, screening and quantification of bioactive compounds from natural source. Comet assay: single cell gel electrophoresis.
4. Separation and purification of isolated bioactive components.
5. Determination of pharmacokinetic (PK) release profile of biopharmaceuticals.
6. Preparation and evaluation of controlled release formulation.
7. Clinical data integration (eCRF, images, laboratories, and other instrumentation)

Reference:

1. Gary Walsh, Biopharmaceuticals: Biochemistry and Biotechnology, 2nd Edition. John Wiley & Sons, Inc, (2003).
2. Rodney J. Y. Ho, Biotechnology and Biopharmaceuticals: Transforming Proteins and Genes into Drugs, 2nd Edition. John Wiley & Sons, Inc.(2013)
3. Gary Walsh, Pharmaceutical Biotechnology: Concepts and Applications. John Wiley & Sons, Inc.(2007)
4. Oliver Kayser, HeribertWarzecha, Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, 2nd Edition. John Wiley & Sons, InC, (2012).

20BT3064	BIOINFORMATICS AND BASICS OF R PROGRAMMING	L	T	P	C
		2	0	2	3

Course Objectives:

1. To explore various tools and database to understand the Biomolecules at structural and functional level
2. To perform big data analytics for Biological data set.
3. To familiarize with Predictive Analytics and Data Visualization.

Course Outcome:

The students will be able to

1. Familiarized with various biological database and software tools
2. Predict the structure and functions of biomolecules
3. Apprehend the knowledge on ligand and structure based drug design
4. Enable to write, compile, and run R programs.
5. Analyze data from different interfaces
6. Develop R script for various biological problems.

Module 1: Biological Databases (6 Hours)

Nucleotide databanks – Genbank, NCBI, EMBL, DDBJ – protein databanks –sequence databanks – PIR, SWISSPROT, TrEMBL- structural databases – PDB, SCOP, CATH.

Module 2: Sequencing Alignment and Dynamic Programming (6 Hours)

Local, Global alignment, pairwise and multiple sequence alignments. Alignment algorithms. Dynamic programming in sequence alignment: Needleman-Wunsch Algorithm and Smith Waterman Algorithm, Aminoacid Substitution matrices (PAM, BLOSUM).

Module 3: Molecular Modeling and Drug Discovery (3 Hours)

Basic concepts of Molecular modeling, Structure Identifications and Validations, Computer Aided Drug Design, HTVS, QSAR

Module 4: Introduction & R Objects **(6 Hours)**

R console, CRAN, Installation, configuration, R studio environment setup, Basic syntax, Data types, Variables, Operators, Vectors , Lists, Matrices, Arrays, Factors , Data frames

Module 5: R Packages & Data interfaces **(6 Hours)**

Installing a package from CRAN, Manual installation and configuration of a package, loading package to library, Exploring R packages for Bioinformatics applications

Module 6: Big data analytics for Health care **(3 Hours)**

Big data analytics in bioinformatics, Health care, Data mining using sequence data, Chemical mining, Biological sequence motifs and patterns.

Total Hours: 30

Lab

Course Objectives:

1. To explore various tools and databases to understand the Biomolecules at sequential, structural and functional level
2. To performing big data analytics for Biological data set.
3. To familiar with practical knowledge in recent techniques like Predictive Analytics and Data Visualization to plot

Course Outcome:

The students will be able to

1. Analyze Biomolecules using biological databases, software/tools and online
2. Understand and exhibit the knowledge vital role for new drug design by various methodologies to save the human health
3. Recognize the need for independent and lifelong learning experience in bimolecular analysis and application
4. Enable to write, compile, and run R programs.
5. Analyze data from different data interfaces
6. Ability to develop R script for various biological problems.

List of experiments:

1. Biological Databases with Reference to Expasy and NCBI
2. Sequence similarity searching using BLAST
3. Overview of Protein and their interaction with ligand
4. Protein structure modeling, verification and validation.
5. Creation Data frames
6. Creating a pie chart using the R
7. Regression analysis using R
8. Protein data analysis by using R Programming from external sources like Protein Databank (PDB)
9. *ChemmineR*: Cheminformatics Toolkit for R
10. Read and analyse a genome sequence file using seqinr package.

Text Book:

1. A.M. Lesk. Introduction to Bioinformatics. Oxford University Press India, 2017.
2. S.C. Rastogi and N. Mendiratla and P.Rastogi. Bioinformatics methods and applications-Genomics, Proteomics and Drug Discovery. Prentice Hall India, 2013
3. Wang, Baoying, Big Data Analytics in Bioinformatics and Healthcare, IGI global edition

Reference Book:

1. VenkatAnkam, “Big Data analytics”, Packt publishing 2016
2. Parag Kulkarni, Sarang Joshi, “Big Data analytics”, PHI learning 2016
3. D.W. Mount. Bioinformatics: Sequence and Genome Analysis. Cold Spring Harbour Laboratory Press, New York, 2012.

20BT3065	NEXT GENERATION SEQUENCING DATA ANALYSIS	L	T	P	C
		3	0	0	3

Course Objectives:

1. To improve the knowledge of the NGS data analysis
2. To learn NGS data and analyze these in an UNIX/Linux working environment.
3. To solve computational genomics problems using advanced statistical methods.

Course Outcome:

The students will be able to

1. Summarize the applications of the different NGS technologies, including the weakness and strengths of the approaches.
2. Demonstrate the steps involved in a general NGS data analysis.
3. Record key theoretical concepts of alignment and de novo assembly.
4. Synthesize and formulate a project and relevant question within the field.
5. Illustrate the basics of NGS data analysis.
6. Infer analytical and reflective skills in analyzing results from individual steps and the final project.

Module 1: UNIX Operating System (7 Hours)

General purpose utilities; Navigating the File system; Handling ordinary files; The Shell; The Vi Editor; The Environment-Basic File Attributes

Module 2: File Attributes (8 Hours)

System Administration-The Routine Duties; The Regular Expressions and The grep family-The Process; Communication and Electronic mail; Shell Programming

Module 3: NGS Data Analysis (7 Hours)

Next Generation Sequencing: Early Stage NGS data analysis, Computing needs for NGS data management and analysis

Module 4: Application specific NGS data analysis (9 Hours)

Transcriptomics, Genotyping and Genomic Variation discovery by whole genome resequencing

Module 5: Metagenomics (7 Hours)

Metagenome analysis by NGS, changing landscape of NGS, Epigenomics data analysis:*De novo* genome assembly from NGS reads

Module 6: RNA and ChIP Sequencing Analysis (7 Hours)

Mapping Protein-DNA interactions with ChIP-seq, RNA Sequencing Analysis

Total Hours: 45

Textbooks

1. Xinkun Wang, "Next-Generation Sequencing Data Analysis" CRC Press 2016
2. Sumitabha Das, Unix – Concepts and Applications, Tata McGraw Hill, 2ndEdition.

References

1. Next-Generation DNA Sequencing Informatics [Kindle Edition] by Stuart Brown, Cold Spring Harbor Laboratory Press Newyork, 2013.
2. Tag-based Next Generation Sequencing by Matthias Harbers and GuenterKahl (Wiley Blackwell Germany 2012
3. Wong, Lee-Jun C., Next Generation Sequencing- Translation to Clinical Diagnostics, Springer, 2013

20BT3066	ALGAE BIOTECHNOLOGY	L	T	P	C
		2	0	2	3

Course Objective:

1. Impart the knowledge of different techniques employed in alage technology
2. Improve the understanding of applications and products derived from microalgae
3. Illustrate the characterization of algae using biochemical and molecular tools

Course Outcome:

The students will be able to

1. Understand the importance of algae and their culture techniques
2. Summarize the value added products of algae
3. Outline the application of algae in Industry and environment.
4. Elaborate the cell characteristics of microalgae
5. Investigate different products from algal sources through technological interventions
6. Infer algal characterization using molecular tools

Module 1: Algae cells (4 hours)

Algae and its culture - Isolation Techniques (Downstream Techniques) - Growth curve – Microscopy – Streaking - Culture Collection and Maintenance.

Module 2: Culture medium/nutrients and Condition (6 hours)

Culturing Media – Types of Media (BB, CFTRI, Fog's Medium, Shibin, Guillard's F/2 medium, Walne Medium) – Media Modification – Maintaining Conditions (Temperature, pH, Light, Salts etc).

Module 3: Phycoremediation (5 hours)

Adsorbing – Application in Environmental Clean up – Heavy Metal uptake, Wastewater treatment – Dye remediation –Agricultural application

Module 4: Value Added compounds (6 hours)

Oils and fatty acids – PUFA – Single Cell Protein – Biofilms – Secondary metabolites – Pigments – Proteins – Feed and Food - Biofuels

Module 5: Characterization (3 hours)

GC of Fatty acid – MS in Result analysis – FTIR – SEM

Module 6: Genomic studies (6 hours)

Molecular Techniques – DNA isolation – PCR – Molecular Identification – Phylogentic analysis – Pathway Analysis – Biomarkers.

List of Experiments:

1. Isolation of algae cells by serial dilution and microscopic observation
2. Culture Media preparation, sterilization and plating techniques
3. Maintenance of the isolated microalgal cells using synthetic
4. Growth curve measurement of alga cells using spectrophotometer
5. Effect of temperature on biomass generation
6. Dye decolourization studies using microalgae
7. Phycoremediation of waste water using microalgae
8. Solvent extraction of bio-oil from algal biomass
9. Algae bioinformatics – data base search and phylogenetics
10. GC-MS/FID profiling of the Fatty acid obtained from algal biomass

Text Books

1. M. Arumugam, S. Kathiresan., N. Subramani, Applied Algal Technology. Nova Science Publishers, New York, (2020).
2. AVSS Sambamurthy A Textbook of Algae, I.K. International Pvt. Ltd. New Delhi, (2017)
3. C. Vanden Hoek, D.G. Mann and H.M. Jahns . Algae – An introduction to Phycology, Cambridge University Press, (1995).
4. Kristian N. Hagen, Algae - Nutrition, Pollution Control and Energy Sources, Nova Science Publishers, 2009

References:

1. FaizalBux, Yusuf Chisti. Algae Biotechnology: Products and Processes, Springer International Publishing, Switzerland, 2016.
2. Gokare A. Ravishankar, Ambati Ranga Rao. Handbook of Algal Technologies and Phytochemicals, CRC Press, Taylor and Francis Group, 2019.

20BT3067	TISSUE ENGINEERING AND STEM CELL TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objective:

1. To inculcate knowledge in cell culture techniques
2. To develop technical skills in tissue implants and transplants and understand its regulation in tissue engineering
3. To impart the clinical potential, significance and ethics of stem cells

Course Outcome:

The Students will be able to:

1. Explain the concepts in cell culture techniques
2. Understand the importance of 3D cell culture and its applications
3. Analyze tissue engineering process and applications in the field of medicine
4. Categorize different types of stem cells and its functions
5. Examine the methods involved in the isolation of stem cells.
6. Justify the clinical potential, significance and ethics of stem cells

Module 1: Cell Culture (7 Hours)

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 2: 3D Culturing (8 Hours)

3D cell culturing and protocols involved for the 3D cell culture of different types of cells cell transplantation for liver, Multicellular tumor Spheroids, Experimental tissue modeling. Current research in tissue modeling

Module 3: Tissue Engineering (7 Hours)

Tissue Engineering, Design stages for tissue engineering, Cell substrate and support materials, Cell sources, Orientation, Different methods and steps involved in cell seeding of implantable materials

Module 4: Stem cell-Types (7 Hours)

Types of stems cells, Embryonic stem cells, Pleuripotent stem cells, Adult stem cells, Induced pleuripotent stem cells, Transit amplifying cells, Symmetry during cell division in Stem cells.

Module 5: Isolation and culturing of stem cells (8 Hours)

Isolation of Embryonic stem cells, Mesenchymal stem cells, Pleuripotent stem cells, Cord cells, Cord blood banking advantages and dis advantages, Differentiation of stem cells into osteoblast cells with protocols.

Module 6: Applications of Stem cell Technology (8 Hours)

Application of stem cells: Stem cells in Cancer treatment, Stem cells in wound healing, Stem cells in tissue engineering & organ regeneration, Stem cells in autoimmune disorders. Ethical and social concern of stem cell technology.

Total Hours: 45

Text Book Text Book

1. Ian Freshney B. Culture of Animal cells & Manual of basic technique, 6th ed., Wiley – liss publication, 2011.
2. Bernhard Palsson, Jeffery A. Hubbell, Robert Plonsey, Joseph D. Bronzino, Tissue Engineering, 7th ed., CRC Press, 2019**.**

Reference Books

1. Robert Lanza and Anthony Atala, Essentials of Stem Cell Biology, 3rd ed., Elsevier 2014
2. Satish Totey and Kaushik D. Deb, Stem Cell Technologies: Basics and Applications, McGraw-Hill, 2010
3. Warburton David, Stem Cells, Tissue Engineering and Regenerative Medicine, 2015

20BT3068	METABOLIC ENGINEERING FOR INDUSTRIAL PRODUCTION	L	T	P	C
		3	0	0	3

Course Objectives:

1. To understand the basic concepts of metabolism playing role in industrial productions
2. To evaluate the possible mechanisms of metabolic alterations for improved production
3. To analyze the significance and ways of effective bioconversion by metabolic engineering

Course Outcome:

The students will be able to

1 Understand the concepts of metabolism in the industrial productions of bio-products
2 Outline the current status of industrial production and the challenges to improve it
3 Analyze the possible engineering ways of metabolic pathways and their effects in products
4 Evaluate the basic normal and the altered metabolic pathways in industrial bioprocesses
5 Apply the knowledge on the ways of alteration in metabolic pathways in case studies
6 Propose a model of metabolic alteration for improved industrial production process

Module 1: Metabolism overview (6 Hours)

Basic concept of metabolic engineering, Overview of cellular metabolism: Transport of molecules across plasma membrane, Fueling Reactions, Biosynthesis, Polymerization.

Module 2: Regulation of Metabolic Pathways (9 Hours)

Metabolism regulation at enzyme level, Metabolism regulation at whole cell level. Jacob Monod model for gene expression regulation-Lac operon, catabolite regulation/repression- glucose effect- cAMP deficiency. Feed back regulation/repression, regulation in branched pathways- differential regulation by isoenzymes, concerted feed back regulation, cumulative feed back regulation, permeability control: passive diffusion, active transport, group transportation.

Module 3: Metabolic Engineering for Primary Metabolites production (9 Hours)

Role of metabolic engineering in Strain improvement and selection, improving fermentation. Auxotrophic mutants for high yield, Alteration of feedback regulation, limiting accumulation of end products, feedback resistant mutants, alteration of permeability for metabolites. Induction, feed- back repression, mutants resistant to repression for enzyme production.

Module 4: Metabolic Engineering for Secondary Metabolites production (9 Hours)

Producers of secondary metabolites, trophophase - idiophase relationship, Auxotrophic Mutants for high yield, Inducer and enhancer for secondary metabolites- an example, resistant to precursor effects, resistant to toxic compounds and toxic effects of secondary metabolites, Revertant mutant for secondary metabolite production. Metabolic engineering for production of plant secondary metabolites

Module 5: Bioconversions (6 Hours)

Advantages of bioconversions, specificity, yields, factors affecting bioconversion, Xenobiotic degradation, mutation, permeability, co-metabolism, avoidance of product inhibition, mixed or sequential bioconversions, conversion of insoluble substances.

Module 6: Applications and Advancements of Metabolic Engineering (6Hours)

Self - Learning: Applications in different fields, Case studies of metabolic engineering, Review on advancements - designing models.

Total hours : 45 hours

Text Book:

1. Del Carmen Cortassa, S., Aon, MA(2011) *An Introduction to Metabolic and Cellular Engineering* (2nd Edition). World Scientific.
2. Peter F. Stanbury, Stephen J. Hall & A. Whitaker, Principles of Fermentation Technology, Second Edition, Butterworth – Heinemann An Imprint of Elsevier India Pvt. Ltd., 2005

References

1. Nielsen J and Villadsen J, “Bioreaction Engineering Principles”, Springer, 2007.
2. Christiana D Smolke, “The Metabolic Pathway Engineering Handbook Fundamentals”, CRC Press Taylor & Francis Group, 2010.
3. Boris N Kholodenko and Hans V Westerhoff, “Metabolic Engineering in the Post Genomic Era”, Horizon Bioscience, 2004.

4. Stephanopoulos, G.N., Aristidou, A.A., Nielsen, J.(2000). *Metabolic Engineering: Principles and Methodologies*. Academic Press.

20BT3069	HUMAN ANATOMY, PHYSIOLOGY AND HEALTH EDUCATION	L	T	P	C
		3	0	0	3

Course Objectives:

1. To explain the gross morphology, structure and functions of various organs of the human body.
2. To describe the various homeostatic mechanisms and their imbalance
3. To identify the various communicable pandemic disease and healthcare precautions on different systems of human body

Course Outcome:

The students will be able to

1. Recall the anatomical terminology to identify and describe locations of major organs of each system covered.
2. Explain interrelationships among molecular, cellular, tissue and organ functions in each system.
3. Summaries the interdependency and interactions of the systems
4. Enumerate contributions of organs and systems to the maintenance of homeostasis.
5. Describe the physiological role of CVS system on human body.
6. Infer to aware of excellence in health education and first aid and to describe modern technology and tools used to study for excellent education carrier and well beings.

Module 1: Introduction to Human body (7 Hours)

Introduction to human body & organization of human body. b. Functional & structural characteristics of cell. c. Detailed structure of cell membrane & physiology of transport process. Structural & functional characteristics of tissues- epithelial, connective, muscle and nerve.

Module 2: Human Skeletal system (6 Hours)

Divisions of skeletal system, types of bone, salient features and functions of bones of axial and appendicular skeletal system Organization of skeletal muscle, physiology of muscle contraction, neuromuscular junction.

Module 3: Body fluids and blood (7 Hours)

Body fluids, composition and functions of blood, hemopoeisis, formation of hemoglobin, anemia, mechanisms of coagulation, blood grouping, Rh factors, transfusion, its significance and disorders of blood, Reticuloendothelial system.

Module 4: Lymphatic system (8 Hours)

Lymphatic organs and tissues, lymphatic vessels, lymph circulation and functions of lymphatic system Peripheral nervous system: Classification of peripheral nervous system: Structure and functions of sympathetic and parasympathetic nervous system. Origin and functions of spinal and cranial nerves.

Module 5: Cardiovascular system (8 Hours)

Heart – anatomy of heart, blood circulation, blood vessels, structure and functions of artery, vein and capillaries, elements of conduction system of heart and heart beat, its regulation by Autonomic nervous system, cardiac output, cardiac cycle. Regulation of blood pressure, pulse, electrocardiogram and disorders of heart

Module 6: Health education (9 Hours)

Concepts of health and disease. Disease causing agents and prevention of disease.Nutrition: Balanced diet, deficiency disorders of various nutrients, their prevention and treatment. Communicable diseases: The causative agents, modes of transmission and prevention of chicken pox, measles, diphtheria, tuberculosis, malaria, poliomyelitis, filariasis, rabies, tetanus, STD and AIDS. Vaccination schedule. First Aid: Emergency treatment of shock, snakebite, burns, poisoning, fractures and resuscitation methods. Family planning: Different measures of family planning in male and female

Total Hours: 45

Text Books

1. Gray's Anatomy: The Anatomical Basis of Clinical Practice, 41th Ed (2015)
2. Guyton A.C. Hall J.E. Text book of Medical Physiology. (2016)
3. Best and Tailor's "Physiological basis of Medical Practice". (1979)

Reference Books

1. C.C. Chatterjee. Human Physiology (2019)
2. Cyril A. Keek, Eric Neil and Norman Joels, Samson Wright's Applied Physiology. (2008)
3. J.E. Park and K. Park,.Textbook of Preventive and Social Medicine (2015)

20BT3070	VACCINE TECHNOLOGY	L	T	P	C
		3	0	0	3

Course Objectives:

1. To impart knowledge on the role vaccination in improving the immune system.
2. To gain an understanding of recent developments in vaccine technology.
3. To make aware about the commercialization and regulatory guidelines in vaccine production

Course Outcome:

The students will be able to

1. Describe the role of immune cells and their mechanism and concept of vaccination.
2. Categorize the different types of vaccines available for diseases.
3. Understand the modern strategies and routes of immunization.
4. Apply the concept of vaccine technology for development of vaccines.
5. Evaluate various delivery methods suitable for vaccines.
6. Relate the quality control and regulatory guidelines involved in vaccine production.

Module-1 Basics of Immune system (6 Hours)

Overview of the immune system and basic aspects of immune response(s) to vaccines. Active and passive immunity. Humoral and cell mediated immunity. Antibody production mechanism and factors affecting it. Cytokines, Primary and secondary immune response. Monoclonal and polyclonal antibodies. Super-antigens, Induction of cell mediated immunity.

Module-2 Introduction to vaccination (6 Hours)

Vaccination: Introduction, history and principles of vaccine development. Conventional and modern strategies for vaccine improvement. Immunization strategies: Active and Passive. Epidemiology and pathophysiology of vaccine preventable diseases with special emphasis on Diphtheria, Tetanus, Hepatitis, Human papillomavirus.

Module-3 Classification of Vaccines and its production (9 Hours)

Types of vaccines: Live, attenuated, subunit, killed vaccines, Recombinant peptide vaccines, recombinant live vector vaccines, conjugate vaccines, toxoid vaccines, Naked DNA vaccines, cell-based vaccines, edible vaccines. Reverse vaccinology. Adjuvants: history, classification, mechanisms. Factors affecting adjuvants selection and production.

Module-4 Delivery of vaccines (7 Hours)

Controlled delivery system for vaccines: emulsions, microparticles, immune-stimulating complexes (ISCOMs, liposomes), Virosomes. Application of Nanoparticles in vaccine delivery, Induction of immune responses by nanoparticle-based vaccine. Role of polymeric nanoparticles in vaccine delivery. Transdermal vaccine delivery system.

Module-5 Vaccine Design and Development (9 Hours)

Fundamental research to rational vaccine design. Antigen identification and delivery, T-Cell expression cloning for identification of vaccine targets for intracellular pathogens, Fundamentals of Immune recognition, implications for manipulating the T-Cell repertoire, Targeting Dendritic cells; a rational approach for Vaccine development, Cellular basis of T- Cell memory, Rational design of new vectors, CpG adjuvant activity, Transcutaneous immunization.

Module-6 Commercial production and regulatory guidelines (8 Hours)

Quality control and regulations in vaccine research, In-vitro experimental validations for predictions of vaccines by software, Animal testing, Rational design to clinical trials, Large scale production, Commercialization, ethics. Overview of national and international regulatory requirements/ guidance for production of vaccines, quality control and implementation of good clinical practices. Overview of currently approved methods and alternative methods under development. Storage and handling, assessment of vaccine safety. **Total Hours: 45**

Reference books

1. Myrone M. Levine , Myron M. Levine, Gordon Dougan , Michael F. Good , Margaret A. Liu , Gary J. Nabel , James P. Nataro, RinoRappuoli., New Generation Vaccines. Fourth Edition, 2016
2. Stanley Plotkin Walter Orenstein Paul Offit, Vaccines, 6th Edition, 2012

Text books

1. Emily P. Wen Ronald Ellis Narahari S. Pujar, Vaccine Development and Manufacturing. Wiley online, 2014
2. Jose Ronnie Vasconcelos, Vaccines & Vaccine Technologies. OMICS International, 2015
3. Kuby, RA Goldsby, Thomas J. Kindt, Barbara, A. Osborne Immunology, 6th Edition, Freeman, 2002.