Bachelor of Technology (Biotechnology)
Credit-Based
SCHEME OF STUDIES/EXAMINATIONS
Semester – III (w.e.f. the session 2019-20)

S. No.	Course No.	Course Title	Teaching Schedule				Credits	Allotment of Marks				Duration of Exam (Hrs.)
			L	T	P	Hours/Week		Major Test	Minor Test	Practical	Total	
1	BTE-201	Cell Biology & Genetics	3	0	0	3	3.0	75	25	0	100	3
2	BTE-203	Microbiology	3	0	0	3	3.0	75	25	0	100	3
3	BTE-205	Biochemistry	3	0	0	3	3.0	75	25	0	100	3
4	BTE-207	Principles of Biostatistics	3	0	0	3	3.0	75	25	0	100	3
5	HM-901	Organizational Behavior	3	0	0	3	3.0	75	25	0	100	3
6	BTE-209L	Cell Biology & Genetics Lab	0	0	3	3	1.5	0	40	60	100	3
7	BTE-211L	Microbiology Lab	0	0	3	3	1.5	0	40	60	100	3
8	BTE-213L	Biochemistry Lab	0	0	3	3	1.5	0	40	60	100	3
		Total	**15**	**0**	**9**	**24**	**19.5**	**375**	**245**	**180**	**800**	
9	BTE-215	Industrial Training-I	2	0	0	2	-	-	100	-	100	-
10	*MC-902	Constitution of India	3	0	0	3		75	25	0	100	3

Note: BTE-215 is a mandatory credit less course in which the students to be evaluated for the industrial training undergone after 2nd semester and students will be required to get passing marks to qualify.

***MC-902** is a mandatory credit less course in which the student will be required to get passing marks in the major test

Bachelor of Technology (Biotechnology)
Credit-Based
SCHEME OF STUDIES/EXAMINATIONS
Semester – IV (w.e.f. the session 2019-20)

S. No.	Course No.	Course Title	Teaching Schedule				Credits	Allotment of Marks				Duration of Exam (Hrs.)
			L	T	P	Hours /Week		Major Test	Minor Test	Practical	Total	
1	BTE-202	Molecular Biology	3	0	0	3	3.0	75	25	0	100	3
2	BTE-204	Bio-analytical Techniques	3	0	0	3	3.0	75	25	0	100	3
3	BTE-206	Immunology	3	0	0	3	3.0	75	25	0	100	3
4	BTE-208	Industrial Biotechnology	3	0	0	3	3.0	75	25	0	100	3
5	BS-202	Basics of Thermodynamics and Organic Chemistry	3	0	0	3	3.0	75	25	0	100	3
6	BTE-212L	Molecular Biology Lab	0	0	3	3	1.5	0	40	60	100	3
7	BTE-214L	Bio-analytical Techniques Lab	0	0	3	3	1.5	0	40	60	100	3
8	BTE-216L	Industrial Microbiology Lab	0	0	3	3	1.5	0	40	60	100	3
9	BTE-218L	Immunology Lab	0	0	3	3	1.5	0	40	60	100	3
		Total	**15**	**0**	**12**	**27**	**21**	**375**	**285**	**240**	**900**	
10	MC-901*	Environmental Sciences*	3	0	0	3		75	25	0	100	3

***MC-901** is a mandatory credit less course in which the student will be required to get passing marks in the major test.
Note: All the students have to undergo 4-6 weeks industrial training after IV semester and to be evaluated in V semester.

Bachelor of Technology (Biotechnology)
Credit-Based
SCHEME OF STUDIES/EXAMINATIONS
Semester – V

S. No.	Course No.	Course Title	Teaching Schedule				Credits	Allotment of Marks				Duration of Exam(Hrs.)
			L	T	P	Hours /Week		Major Test	Minor Test	Practical	Total	
1	BTE-301	Recombinant DNA Tech	3	0	0	3	3.0	75	25	0	100	3
2	BTE-303	Bioprocess Engineering	3	0	0	3	3.0	75	25	0	100	3
3	BTE-305	Downstream Processing	3	0	0	3	3.0	75	25	0	100	3
4	BTE-307	Healthcare Biotechnology	3	0	0	3	3.0	75	25	0	100	3
5	OEC-I*		3	0	0	3	3.0	75	25	0	100	3
6	BTE-307L	Recombinant DNA Technology Lab	0	0	3	3	1.5	0	40	60	100	3
7	BTE-309L	Fermentation & Downstream Processing Lab	0	0	3	3	1.5	0	40	60	100	3
8	OEC-IL		0	0	2	2	1.0	0	40	60	100	3
		Total	**15**	**0**	**10**	**25**	**19**	**375**	**245**	**180**	**800**	
9	**MC-903	Essence of Indian Traditional Knowledge	3	0	0	3		100		0	100	3
10	*BTE-311	Industrial Training-II	0	0	2	2	0	0	100		100	

****MC-903** is a mandatory credit less course in which the student will be required to get passing marks in the major test.

* BTE-311 is a mandatory credit less course in which the students to be evaluated for the industrial training undergone after 4th semester and students will be required to get passing marks to qualify.

The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.

The students should select one open Elective Courses (OEC) from the following list.

Course No.	OEC-I*
ES-201	Essentials of Information Technology
ES-211L	Information Technology Lab
ES-213	Python
ES-215L	Python Lab
MOOC-1	Any one MOCC course with lab through SWAYAM

Bachelor of Technology (Biotechnology)
Credit-Based
SCHEME OF STUDIES/EXAMINATIONS
Semester – VI

S. No.	Course No.	Course Title	Teaching Schedule				Credits	Allotment of Marks				Duration of Exam (Hrs.)
			L	T	P	Hours/ Week		Major Test	Minor Test	Practical	Total	
1	OEC-II		3	0	0	3	3.0	75	25	0	100	3
2	BTE-304	Plant Biotechnology	3	0	0	3	3.0	75	25	0	100	3
3	BTE-306	Animal Biotechnology	3	0	0	3	3.0	75	25	0	100	3
4	BTE-308	Food Biotechnology	3	0	0	3	3.0	75	25	0	100	3
5	BTE-310	Environmental Biotechnology& Engineering	3	0	0	3	3.0	75	25	0	100	3
6	HM-902	Business Intelligence & Entrepreneurship	3	0	0	3	3.0	75	25	0	100	3
7	BTE-312	Animal Cell Culture Lab	0	0	3	3	1.5	0	40	60	100	3
8	BTE-314	Plant Cell Culture Lab	0	0	3	3	1.5	0	40	60	100	3
9	BTE-316	Food & Environmental Biotechnology Lab	0	0	3	3	1.5	0	40	60	100	3
		Total	**18**	**0**	**9**	**27**	**22.5**	**450**	**270**	**180**	**900**	

Note: All the students have to undergo 4-6 weeks industrial training after VI semester and it will be evaluated in VII semester.
The students should select two open Elective Courses (OEC) from the following list.
The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.

Course No.	OEC-II		Course No.	OEC-II
OEC-BT-302	Nano Biotechnology		OEC-BT-322	Introduction to Arts & Aesthetics
OEC-BT-318	Introduction to MEMS		MOOC-2	Anyone MOOC through SWAYAM
OEC-BT-320	Non Conventional Energy Resources			

Bachelor of Technology (Biotechnology)
Credit-Based
SCHEME OF STUDIES/EXAMINATIONS
Semester – VII

S. No.	Course No.	Course Title	Teaching Schedule				Credits	Allotment of Marks				Duration of Exam (Hrs.)
			L	T	P	Hours/ Week		Major Test	Minor Test	Practical	Total	
1	BTE-401	Bioinformatics	2	1	0	3	3.0	75	25	0	100	3
2	BTE-403	Pharmaceutical Biotechnology	3	0	0	3	3.0	75	25	0	100	3
3	*PE-I	Program Elective-I*	2	1	0	3	3.0	75	25	0	100	3
4	*PE-II	Program Elective-II*	2	1	0	3	3.0	75	25	0	100	3
5	BTE-405	Bioinformatics Lab	0	0	3	3	1.5	0	40	60	100	3
7	BTE-407	Project-I**	0	0	8	8	4.0	0	100	100	200	3
		Total	**9**	**3**	**11**	**23**	**17.5**	**300**	**240**	**160**	**700**	
8	*BTE-409	Industrial Training (Viva-Voce)***	0	0	2	2	-	0	0	100	100	

The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.

Course No.	***PE-I**
BTE-411	Biosensor and Bioinstrumentation
BTE-413	Biochips and Microarray Technology
BTE-415	Enzyme Technology

Course No.	***PE-II**
BTE-417	Advanced Management Information System and Information Technology
BTE-419	Stem Cell Technology
BTE-421	Herbal Drug Technology

**The project should be initiated by the students in the beginning of VII semester and will be evaluated at the end of the semester on the basis of a presentation and report.

*BTE-409 is a mandatory credit less course in which the students to be evaluated for the industrial training undergone after 6th semester and students will be required to get passing marks to qualify.

Bachelor of Technology (Biotechnology)
Credit-Based
SCHEME OF STUDIES/EXAMINATIONS
Semester – VIII

S. No.	Course No.	Course Title	Teaching Schedule				Credits	Allotment of Marks				Duration of Exam (Hrs.)
			L	T	P	Hours/ Week		Major Test	Minor Test	Practical	Total	
1	*PE-III		2	1	0	3	3.0	75	25	0	100	3
2	*PE-IV		2	1	0	3	3.0	75	25	0	100	3
3	BTE-402	Biocatalysis & Biotransformation	3	0	0	3	3.0	75	25	0	100	3
4	**OEC-III		3	0	0	3	3.0	75	25	0	100	3
5	BTE-416	Project-II	0	0	15	15	7.5	0	100	100	200	3
		Total	**10**	**2**	**15**	**27**	**19.5**	**300**	**200**	**100**	**600**	

The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.

*The student should select two Program Elective Courses (PEC) from the following list.

Course No.	PE-III	Course No.	PE-IV
BTE-404	Metagenomics	BTE-410	Developmental Biology
BTE-406	Molecular Modeling and Drug Design	BTE-412	Protein Engineering
BTE-408	Cancer Biology	BTE-414	Bioethics, IPR and Bio-safety

*The student should select one Open Elective Courses (OEC) from the following list.

Course No.	OEC-III
OEC-BT-418	Biomedical Electronics
OEC-BT-420	MATLAB & Simulation
OEC-BT-422	History of Science
OEC-BT-424	Internet of things
MOOC-3	Anyone MOOC through SWAYAM

Additional Courses for B.Tech. (Honours Degree)
Branch/Course: Biotechnology

In order to have an Honours degree, a student may choose 20 credits from the following professional electives courses or MOOC through SWAYAM in addition. In addition to the following list, the student can also opt some more courses offered under MOOCs at Swayam portal from time to time

Bachelor of Technology Biotechnology										
Scheme of Studies/Examination										
Additional Courses for B.Tech. (Honours Degree)										
S. No.	Course Code	Subject	L:T:P	Hours/Week	Credits	Examination Schedule (Marks)				Duration of Exam (Hrs)
						Major Test	Minor Test	Practical	Total	
1	PEC-BT-H 801	Chemical Genetics	3:0:0	3	3	75	25	0	100	3
2	PEC-BT-H 802	Biological Waste Treatment	3:0:0	3	3	75	25	0	100	3
3	PEC-BT-H 803	Industrial Biotechnology	3:0:0	3	3	75	25	0	100	3
4	PEC-BT-H 804	Enzyme Engineering & Technology	3:0:0	3	3	75	25	0	100	3
5	PEC-BT-H 805	Bioprocess Equipment design & Economics	3:0:0	3	3	75	25	0	100	3
6	PEC-BT-H 806	Protein Engineering	3:0:0	3	3	75	25	0	100	3
7	PEC-BT-H 807	Biomaterial Sciences	3:0:0	3	3	75	25	0	100	3
8	PEC-BT-H 808	Biosensors	3:0:0	3	3	75	25	0	100	3
9	PEC-BT-H 809	Biodiversity, Bio-prospecting and Organic farming	3:0:0	3	3	0	40	60	100	3
10	PEC-BT-H 810	Molecular Biophysics	3:0:0	3	3	0	40	60	100	3
11	PEC-BT-H 811	Virology	3:0:0	3	3	0	40	60	100	3
12	PEC-BT-H 812	Vaccine Biotechnology	3:0:0	3	3	0	40	60	100	3

Open Elective Course for B. Tech. Students of other Departments

Course No.	OEC
BTE 401	Bioinformatics
BTE-414	Bioethics, IPR and Biosafety

Bachelor of Technology (Biotechnology)
Credit-Based
SCHEME OF STUDIES/EXAMINATIONS
Semester – IV (w.e.f. the session 2019-20)

S. No.	Course No.	Course Title	Teaching Schedule				Credits	Allotment of Marks				Duration of Exam (Hrs.)
			L	T	P	Hours /Week		Major Test	Minor Test	Practical	Total	
1	BTE-202	Molecular Biology	3	0	0	3	3.0	75	25	0	100	3
2	BTE-204	Bio-analytical Techniques	3	0	0	3	3.0	75	25	0	100	3
3	BTE-206	Immunology	3	0	0	3	3.0	75	25	0	100	3
4	BTE-208	Industrial Biotechnology	3	0	0	3	3.0	75	25	0	100	3
5	BS-202	Basics of Thermodynamics and Organic Chemistry	3	0	0	3	3.0	75	25	0	100	3
6	BTE-212L	Molecular Biology Lab	0	0	3	3	1.5	0	40	60	100	3
7	BTE-214L	Bio-analytical Techniques Lab	0	0	3	3	1.5	0	40	60	100	3
8	BTE-216L	Industrial Microbiology Lab	0	0	3	3	1.5	0	40	60	100	3
9	BTE-218L	Immunology Lab	0	0	3	3	1.5	0	40	60	100	3
		Total	**15**	**0**	**12**	**27**	**21**	**375**	**285**	**240**	**900**	
10	MC-901*	Environmental Sciences*	3	0	0	3		75	25	0	100	3

***MC-901** is a mandatory credit less course in which the student will be required to get passing marks in the major test.
Note: All the students have to undergo 4-6 weeks industrial training after IV semester and to be evaluated in V semester.

BTE-201	Cell Biology and Genetics (B.Tech. Biotechnology) Semester-III						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	0	3	75	25	100	3hrs
Purpose	To familiarize the students with the basic of cell biology and genetics.						
Course outcome							
CO1	Student to learn the fluidity and structural organization of bio membrane and cytoskeleton						
CO2	To learn the fundamentals of inheritance via both qualitative and quantitative patterns.						
CO3	Able to understand the basic concept of evolution and genetic basis of variations.						
CO4	Student will learn about the genome mapping by different techniques ranging from bacteria to human beings.						

UNIT-1

Bio membrane-Physical and chemical properties, Structural organization, Cell signaling (Different Pathways), cell recognition and membrane transport, Membrane receptor for macromolecules and regulation of receptor expression and function. Receptors for neurotransmitters

Structural organization and functions -Microtubule, Microfilament and Inter-mediatery filaments.

UNIT-II

Mendelism – History of Mendel, Monohybrid, Di- hybrid and Tri-hybrid cross, Gene interaction, Concept of dominance - incomplete ,complete and co-dominance(Blood group system in human beings),Multiple alleles(Skin color in rabbit),Concept of lethality and pedigree analysis. Sex linked, sex influenced and sex limited inheritance.

Quantitative inheritance-History, Yule experiment, Nelsson-Ehle experiment, skin color in human beings, Basis of genetic variation. Numerical problems on quantitative inheritance.

UNIT-III

Population Genetics- Concept of Random Mating and controlled mating and Inbreeding. Hardy Weinberg Law-Allele frequency, Genotype frequency, Causes of variations (Mutation, Migration, Random genetic drift, and Natural selection).

Mutation-Classification, application, detection, site directed mutagenesis and DNA repair Mechanism-(Mismatch repair, Photo-reactivation, tolerance, retrieval system.

UNIT-IV

Genome mapping-Difference between cytological, physical and molecular mapping. Recombination, Linkage, Gene mapping based on Two point cross in Neurospora and Three point test cross in wheat. History and development of human genome project.

Muscle contraction-Types of muscles, Structural proteins of muscles , regulation and energetic of muscle contraction.

Nerve Transmission- structure and function of neurons. Action and resting potential, Mechanism of nerve transmission, Neuromuscular junction.

Text /ReferenceBooks

1. Cell Biology: Organelle structure and function, Sadava, D.E.(2004) Panima Pub., New Delhi.
2. Fundamentals of Genetics, Singh, B.D., Kalyani Publishers, New Delhi.
3. Basic Genetics. (2000) Miglani, G.S., Narosa Publishing House, New Delhi.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-203	Microbiology (B.Tech. Biotechnology) Semester- III						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3.0	75	25	100	3hrs
Purpose	To familiarize the students with the basic of Microbiology						
Course outcome							
CO1	To learn the history and classification of microbiology						
CO2	To learn microbial nutrition and various microbiological techniques						
CO3	Able to understand microbial growth and genetics						
CO4	Student will learn about various microbial diseases and drugs						

UNIT - I

1. **History and scope of Microbiology**: Development of Microbiology, various branches of microbiology and applications of microbiology.
2. Classification of Microorganisms: Microbial Taxonomy- criteria used including molecular approaches. Microbial phylogeny and current classification of bacteria.

UNIT - II

3. **Microbial Diversity**: Morphology and cell structure of major groups of microorganisms e.g. bacteria. fungi, algae, protozoa and viruses.
4. **Cultivation and microbial nutrition of Microorganism**: Methods of isolation, purification and preservation. Pure culture technique and sterilization methods. Requirement for C, N, S and growth factors. Nutritional categories of microorganisms.

UNIT - III

5. **Microbial Growth and Metabolism**: Growth curve (normal and biphasic) and generation time. Measurement of growth. Synchronous, batch and continuous cultures. Microbial fermentation and its types.
6. **Microbial Genetics**: Bacterial plasmids. Bacterial recombination: transformation, transduction and conjugation. Formation of endospores and mechanism of sporulation.

UNIT - IV

7. **Environmental Microbiology**: Normal and contaminating microflora of water, soil and air. Methods to study water and air pollution.
8. **Medical Microbiology**: Antibacterial, Antiviral, Antifungal and Antiprotozoan drugs, Major water, air and soil borne microbial diseases.

Text Book:

1. Microbiology 5th Edition. Prescott, L.M.; Harley, J.P. and Klein, D.A.(2003) McGraw Hill, USA.
2. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. and Krieg, N.R. (1993) Tata McGraw Hill, New Delhi.

References Books:

3. Modern Food Microbiology. Jay, J.M. (1996) CBS Publishers and Distributors, New Delhi.
4. Food Microbiology 2nd ed, Adam, M. R. and Moss (2003) Panima Pub, New Delhi.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-205	Biochemistry (B.Tech Biotechnology) Semester-III						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs.
Purpose	To introduce the students with basics of Biochemistry						
Course Outcomes							
CO1	The students will be able to learn the structure and functions of carbohydrates and proteins						
CO2	The students will be able to learn structure and functions of lipid and nucleic acids along with basic concepts of enzymes.						
CO3	The students will be able to write major pathways of carbohydrates and lipid metabolism						
CO4	To make the students learn synthesis and degradation of pyrimidine nucleotides						

UNIT-I

1. **Amino acids & Proteins** –Structure and properties of amino acids. Peptide bonds.

   Proteins classification based on their biological roles. Forces stabilizing protein structure and shape. Different levels of structural organization of proteins. Ramachandran plot, alpha helix, beta plated sheets, domain motif and fold.

2. **Carbohydrates-Structure and functions:** Structures and properties of glucose and fructose, distinguishing features of different disaccharides. Ring structure and mutarotation. Structure and brief introduction of starch, glycogen and cellulose.

UNIT – II

3. **Lipids-Structure and functions:** Classification of lipids based on their biological roles and their general functions. Membrane lipids and brief discussion on fatty acids.
4. **Nucleic Acids-Structure and functions:** Structure and properties of purine and pyrimidine bases.A brief introduction of ATP, GTP, CTP AND UTP.

5. **Enzymes:** Classification of Enzymes according to enzyme commission report. Activation energy and rate of reaction. Rate constant, reaction order. A brief introduction of mechanism of enzyme catalysis. Enzyme inhibition and concept of allostery. Michaelis-Menten equation.

UNIT-III

6 **Carbohydrate Metabolism:** Glycolysis and TCA cycle. Pentose phosphate pathway and its significance. Gluconeogenesis pathway. Biosynthesis of lactose, sucrose and starch. Glycogenolysis, glycogenesis and control of glycogen metabolism.

7.**Lipid Metabolism:** Beta -oxidation of saturated fatty acids, Degradation of triacylglycerols by lipases. Biosynthesis of saturated fatty acids. Biosynthesis of triacylglycerols, phospholipids.

UNIT -IV

8 **Amino Acid Metabolism:** General reactions of amino acids metabolism- transamination, oxidative andnon-oxidative deamination and decarboxylation. Urea cycle and its regulations.

9. **Nucleic Acid Metabolism:** Catabolism,*de novo*-biosynthesis and salvage pathway.

10. **Mitochondrial oxidative phosphorylation:** Mitochondrial electron transport chain. Hypotheses ofmitochondrial oxidative phosphorylation.

Text

1. Biochemistry, concepts and connections, 1st edition, by Dean R. Appling, Spencer J. Anthony-Cahill and Christopher K. Matthews (2015). Pearson Education, Inc.
2. Biochemistry, 4th edition, by L. Stryer (1995). W.H. Freeman & Co. NY
3. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000) Maxmillan/ Worth publishers

References Books:

1. Biochemistry, 4th edition, by G. Zubay (1998). Wm.C. Brown Publishers.
2. Biochemistry, 2nd edition, by Laurence A. Moran, K.G. Scrimgeour, H. R. Horton, R.S. Ochs and J. David Rawn (1994), Neil Patterson Publishers Prentice Hall.
3. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999) . Saunders college Publishing, NY. Sons, NY.
4. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999) , John Wiley & Sons, NY
5. Harper's Biochemistry, 25th edition, by R.K. Murray, P.A. Hayes, D.K. Granner, P.A. Mayes and V.W. Rodwell (2000). Prentice Hall International.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-207	Principles of Biostatistics (B.Tech Biotechnology) Semester-III						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	0	3	75	25	100	3
Purpose	**To Introduce statistical concept for biological data interpretation**						
Course Outcomes							
CO1	**To develop basic understanding about statistics**						
CO2	**To develop basic knowledge of probability and different tests.**						
CO3	**To derive numerical approach between data correlation and their variations.**						
CO4	**To understand the numbers and errors**						

UNIT-1

Introduction: Basic concept of statistics, Difference between statistics and mathematics, Samples and variables, Frequency distribution curve and basic quantitative method: Mean median, mode, standard deviation and variance.

UNIT-II

Probability distribution: Basic concept of probability, binomial distribution, Poisson distribution and normal distribution.

Hypothesis testing: Students T-test, estimation of null hypothesis, confidence limit of variance and chi-square test.

UNIT-III

Analysis of Variance:F-test, Two way ANOVA and Three way ANOVA

Correlation and Regression: Analysis of correlation and their different types, analysis of covariance and multiple regressions.

UNIT-IV

Approximation and error: Introduction, Accuracy of numbers: approximate number, significant number, rounding off. Different types of error.

Role of computer in solving biostatical problem: Genetic Algorithm, Application of statistical methods in biotechnology.

Text Books:

1. Statistical Methods. S.P.Gupta. Sultan chand and sons, New delhi

Reference Books:

1.Introduction to Biostatistics. Glover T. and Mitchell K. (2002). MacGraw Hill, New York.

2. Fundamentals of Biostatistics. Rosner Bernard. (1999), Duxbury Press.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

HM-901	OrganizationaL Behavior(B.Tech Biotechnology) Semester-III						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3
Purpose	To make the students conversant with the basics concepts of organizational culture and behavior for nurturing their managerial skills						
COURSE OUTCOMES							
CO1	An overview about organizational behavior as a discipline and understanding the concept of individual behavior						
CO2	Understand the concept and importance of personality ,emotions and its importance in decision making and effective leadership						
CO3	Enabling the students to know about the importance of effective motivation and its contribution in group dynamics and resolving conflicts						
CO4	Understand how to overcome organizational stress by maintaining proper organizational culture and effective communication						

UNIT -I

Introduction to Organizational Behavior: Concept and importance of Organizational Behavior, Role of Managers in OB, Foundations or Approaches to Organizational Behavior, Challenges and Opportunities for OB

Foundation of individual behavior: Biographical characteristics, concept of Abilities and Learning , Learning and Learning Cycle, Components of Learning, concept of values and attitude, types of attitude, attitude and workforce diversity

UNIT-II

Introduction to Personality and Emotions: Definition and Meaning of Personality, Determinants of Personality, Personality Traits Influencing OB, Nature and Meaning of Emotions, Emotions dimensions, concept of Emotional intelligence

Perception and individual decision making: Meaning of perception, factors influencing perception, Rational decision making process, concept of bounded rationality. Leadership- Trait approaches, Behavioral approaches, Situational approaches, and emerging approaches to leadership.

UNIT-III

Motivation: concept and theories of Motivation, theories of motivation-Maslow, Two Factor theory, Theory X and Y,ERG Theory, McClelland's Theory of needs, goal setting theory, Application of theories in Organizational Scenario, linkage between MBO and goal setting theory, employee recognition and involvement program

Foundations of Group Behavior and conflict management:Defining and classifying of Groups, stages of group development, Informal and Formal Groups - Group Dynamics, Managing Conflict and Negotiation , a contemporary perspective of intergroup conflict, causes of group conflicts, Managing intergroup conflict through Resolution.

UNIT-IV

Introduction to Organizational Communication: Meaning and Importance of Communication process, importance of Organizational Communication, Effective Communication, Organizational Stress: Definition and Meaning Sources and Types of Stress, Impact of Stress on Organizations, Stress Management Techniques

Introduction to Organization Culture- Meaning and Nature of Organization Culture, Types of Culture, Managing Cultural Diversity, Managing Change and Innovation - Change at work, Resistance to change, A model for managing organizational change.

Text Books

Colquitt, Jason A., Jeffery A. LePine, and Michael Wesson. *Organizational Behavior: Improving Performance and Commitment in the Workplace*. 5th ed. New York: McGraw-Hill Education, 2017.

Hitt, Michael A., C. Chet Miller, and Adrienne Colella. *Organizational Behavior*. 4th ed. Hoboken, NJ: John Wiley, 2015.

Robbins, Stephen P., and Timothy Judge. *Organizational Behavior*. 17th ed. Harlow, UK: Pearson Education, 2017.

Stephen P. Robins, Organisational Behavior, PHI Learning / Pearson Education, 11th edition, 2008.

Reference Books

Schermerhorn, Hunt and Osborn, Organisational behavior, John Wiley.

Udai Pareek, Understanding Organisational Behaviour, Oxford Higher Education.

Mc Shane & Von Glinov, Organisational Behaviour, Tata Mc Graw Hill.

Aswathappa, K., Organisational Behaviour– Text and Problem, Himalaya Publication

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-209L	Cell Bio and Genetics Lab (B.Tech. Biotechnology) Semester –III						
Lecture	Tutorial	Practical	Credit	Minor Test	Practical	Total	Time
-	-	3	1.5	40	60	100	3 Hrs
Purpose	To learn working of instruments and their principles to study basic concepts.						
Course Outcomes							
CO1	Students will be able to learn basic instruments need to study all types of cellular structures.						
CO2	Preparation of permanent slides to study histology of different organ systems..						
CO3	Students will come to know about the procedure of division of cells in both somatic and gametic cells.						
CO4	Students will learn Techniques of DNA extraction and its application in fingerprinting.						

LABORATORY EXPERIMENTS

1. Study of different types of microscopes.
2. Microscopy: Structure of Prokaryotic and eukaryotic cell.
3. Microtomy. Histology of various organ systems (Nervous, digestion, reproductive, respiratory and circulatory system).
4. Cell division in onion root tip.
5. Cell division in insect gonads/flower bud.
6. Isolation of Chloroplasts/ Mitochondria from Plants.
7. Fluorescence labeling of cellular organelles.
8. Isolation of DNA and study of its denaturation spectrophotometrically & viscometrically.

Reference books:

1. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
2. Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House, New Delhi.
3. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw-Hill, Book Company, UK.

BTE-211 L	MICROBIOLOGY LAB (B.Tech. Biotechnology Semester III)						
Lecture	Tutorial	Practical	Credit	Minor Test	Practical	Total	Time
-	-	3	1.5	40	60	100	3 Hrs
Purpose	To learn the practical aspects of Microbiology						
Course Outcomes							
CO1	Students will be able to know about the instruments and their working principles.						
CO2	Learning of Culture Media Preparation for Microbial Growth.						
CO3	Students will learn Pure Culture Techniques for isolation and preservation of microbes.						
CO4	Students will learn about staining methods for identification of microbes and effect of different factors on growth of microbes.						

LABORATORY EXPERIMENTS

1. Rule and Regulations of working in the laboratory.
2. To know about the instruments and equipments used in the laboratory
3. Preparation of culture media for culturing microbes.
5. Collection of samples from different sources and serial dilution method.
6. Culture techniques- Pour plate and spread plate.
7. Isolation of pure colonies by streaking method.
8. Gram Staining method to differentiate between gram positive and gram negative bacteria.
8. To analyze the waste water samples for presence of microbes.
9. Measurements of growth and study of effect of various factors on growth of microorganisms-temperature, pH, salt concentration,
10. Milk Microbiology- Testing the quality of milk.

Text and References Books:

1. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. Aneja, K.R. (2003)New Age International Publishers, New Delhi.
2. Microbiology- a laboratory manual. 4th edition. Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.
3. Environmental Microbiology – A Laboratory Manual Pepper. I.L.; Gerba, C.P. and Brendecke, J.W.(1995) Academic Press, New York.

BTE-213L	BIOCHEMISTRY LAB (B.Tech. Biotechnology) Semester-III						
Lecture	Tutorial	Practical	Credit	Minor Test	Practical	Total	Time
-	-	3	1.5	40	60	100	3 Hrs
Purpose	To learn the practical aspects of Biochemistry						
Course Outcomes							
CO1	Students will be able to learn qualitative and quantitative estimation of biomolecules						
CO2	Students will be able to learn procedure to perform enzyme assay of any common enzyme.						
CO3	Students will learn effect of environmental factors on enzyme activity						
CO4	Students will be able to calculate Km and Vmax of any common enzyme						

LABORATORY EXPERIMENTS

1. Qualitative tests for amino acids, proteins, Lipids and carbohydrates.
2. Quantitative estimation of proteins by Lowry method.
3. Determination of reducing sugar by Nelson-Somogyi's method
4. Assay of any commonly occurring enzyme.
5. Effect of pH, temperature, enzyme concentration and protein denaturation on an enzyme activity.
6. Determination of Km and Vmax of any commonly occurring enzyme.

Text/ Reference Books:

1. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
2. Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House, New Delhi.
3. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw-Hill, Book Company, UK.

MC-902	Constitution of India (B.Tech. Biotechnology) Semester- III					
Lecture	Tutorial	Practical	Major Test	Minor Test	Total	Time
3	-	-	75	25	100	3 Hrs.
Purpose	To know the basic features of Constitution of India					
Course Outcomes						
CO1	The students will be able to know about salient features of the Constitution of India.					
CO2	To know about fundamental duties and federal structure of Constitution of India.					
CO3	To know about emergency provisions in Constitution of India.					
CO4	To know about fundamental rights under constitution of India.					

UNIT-I

1. Meaning of the constitution law and constitutionalism, Historical perspective of the Constitution of India. Salient features and characteristics of the Constitution of India.
2. Scheme of the fundamental rights

UNIT - II

3. The scheme of the Fundamental Duties and its legal status. The Directive Principles of State Policy – Its importance and implementation. Federal structure and distribution of legislative and financial powers between the Union and the States.
4. Parliamentary Form of Government in India – The constitution powers and status of the President of India

UNIT - III

5. Amendment of the Constitutional Powers and Procedure. The historical perspectives of the constitutional amendments in India.
6. Emergency Provisions: National Emergency, President Rule, Financial Emergency. Local Self Government – Constitutional Scheme in India.

UNIT-IV

7. Scheme of the Fundamental Right to Equality. Scheme of the Fundamental Right to certain Freedom under Article 19.
8. Scope of the Right to Life and Personal Liberty under Article 21.

Text Books

1. Constitution of India. Prof. Narender Kumar (2008) 8th edition. Allahabad Law Agency.

Reference Books:

1. The constitution of India. P.M. Bakshi (2016) 15th edition. Universal law Publishing.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-202	Molecular Biology (B.Tech. Biotechnology) Semester -IV						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs.
Purpose	To familiarize the students with basic concepts of molecular biology.						
Course Outcomes							
CO1	The students will be able to learn the Basic structure of DNA RNA.						
CO2	To learn the process of DNA replication and regulation.						
CO3	The students will be able to understand the process of Transcription of DNA in Prokaryotes and Eukaryotes.						
CO4	The students will be able to explain the process of Translation.						

UNIT- I

1.Genes : DNA/RNA as the genetic material. Double helical structure of DNA.Types of DNA.Super coiling and periodicity of DNA.Linking number of DNA.Nature of multiple alleles, Cis- acting sites and Trans–acting molecules.Euchromatin and heterochromatin.Nucleosomes.Organelle DNA- Mitochondrial and chloroplast DNA.

2. From Genes to Genomes : exons and introns, repetitive and non –repetitive DNA, C-value paradox.

3. DNA Replication : Origin of DNA replication. Bacterial and eukaryotic replicons.DNA polymerases.Mechanism and regulation of DNA replication in prokaryotes and eukaryotes.

UNIT - II

4. Transcription: Various RNA species and their properties- tRNA as an adapter and turnover of mRNA.

a) **Transcription in Prokaryotes:** RNA polymerases. Mechanism of transcription-initiation, elongation and termination.Role of sigma factor in transcription.

b) **Transcription in Eukaryotes:** RNA Polymerases. Downstream and upstream promoters. Techniques to define promoters- foot printing experiment. Mechanism of transcription.Interaction of upstream factors with basal apparatus.Role of enhancers.Post-transcriptional modifications of various RNA species.Transcription in mitochondria and chloroplast.

c) **The Operon:** Positive and negative control of transcription, repressor-inducer complex, catabolite repression and attenuation.

d) **Regulation of Transcription:** DNA binding domains- zinc finger motif, helix loop helix, leucine zippers and homeodomains. Demethylation and gene regulation.

UNIT -III

5. Genetic Code: Evidence for triplet code. Properties of genetic code, Wobble hypothesis.Mitochondrial genetic code. Suppressor tRNAs.

6. Protein Synthesis :Structure of prokaryotic and eukaryotic ribosomes and their role in protein synthesis. Mechanism of initiation, elongation and termination of protein synthesis.Regulation of translation in prokaryotes and eukaryotes. Post translational modifications of proteins.

7. Protein folding :Role of molecular chaperones.

UNIT -IV

8. Nuclear Splicing :Lariat formation, Sn RNAs, cis-splicing and trans-splicing reactions. Catalytic RNA- Ribozymes- Ribonuclease P, small RNAs, group I &II introns.

Text/Reference Books :

1. Genes XI Lewin, Benjamin(2013)OUP, Oxford.
2. Genomes,2nded, Brown, T. A.(2002) John Wiley and sons ,Oxford
3. Molecular biology of cell 4thed Alberts, Bruce; Watson,J D(2002) Garland Science Publishing, New York.
4. Molecular cell biology 4thedLodish, Harvey and. Baltimore,D(2000) W.H. Freeman and Co., New York
5. Cell and Molecular Biology 8thed, Robertis, EDP De &Robertis, EMF De(2002) lippincott Williams & Wilkins international student edition, Philadelphia.
6. Essentials of Molecular Biology 4thed, Malacinski, G. M. (2003) Jones &Bartlet Publishers, Boston
7. Cell and Molecular Biology: concepts and experiments 3rded Karp, Gerald(2002) John Wiley and sons, New York.
8. The Cell-a molecular approach, 3rded Cooper, G M&Hausman, R E(2004) ASM Press, Washington D C

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-204	Bioanalytical Techniques (B.Tech. Biotechnology) Semester- IV

Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs.

Purpose	To acclimatize students about different bioanalytical techniques.
Course Outcomes	
CO1	The students will be able to understand the principle of microscopy.
CO2	The students will be able to understand the principle and applications chromatography techniques.
CO3	The students will be able to learn underlying principle and applications of spectroscopy.
CO4	The students will be able to learn process of detection and measurement of radioactivity.

UNIT- I

1. **Principles of Microscopy:** Light, electron (scanning and transmission), fluorescence microscopy, marker enzymes.
2. **Centrifugation: Basic concepts and** applications, differential centrifugation, high speed and ultracentrifugation techniques.

UNIT- II

3. **Electrophoresis**: basic principle and applications of Paper and gel electrophoresis, isoelectric focussing, two-dimensional electrophoresis.

4 **Principles of Chromatography**: Ion-exchange, gel filtration, affinity, gas chromatography, High Pressure Liquid Chromatography (HPLC), FPLC and Hydrophobic Interaction Chromatography.

UNIT- III

5. **Principle and applications of Spectroscopy:** UV/visible, IR, NMR, ESR, fluorescence, Raman.
6. **Mass spectroscopy**: LC-MS, X-ray diffraction (molecular crystals), CD.

UNIT- IV

7. **Radioisotope Techniques**: Nature of radioactivity, properties of α, β and γ-rays, detection and measurement of radioactivity, use of radioisotopes in research, autoradiography, radio-immunoassay.

Text/ References Books:

1. Physical Biochemistry, 2nd edition, by D Friefelder (1983). W.H. Freeman & Co., U.S.A.
2. 4. Analytical Chemistry for technicians: John Kenkel (1994), Lewis Publishers. Boca Raton.
3. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.
4. Biophysical Chemistry: Principles and Techniques, 2nd edition by A. Upadhyay, K. Upadhyay and N. Nath. (1998). Himalaya Publishing House, Delhi.
5. Physical Biochemistry, 2nd edition, by K. E. VanHolde (1985), Prentice Hall Inc, New Jersey.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-206 IMMUNOLOGY (B.Tech Biotechnology) semester-IV							
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	**-**	**-**	**3**	**75**	**25**	**100**	**3 Hrs.**
Purpose	**To learn the role of various components of immune system and their response against various diseases**						
Course Outcomes							
CO1	**The students will be able to learn the basic concepts of cells and organs related to immune system.**						
CO2	**Able to learn the formation, maturation and functions of B cells and T cells.**						
CO3	**To learn the concepts of various Immunological techniques and understanding various effector responses of body against an infection.**						
CO4	**To learn the immunological reasons behind various diseases.**						

UNIT – I

1. **Introduction to immune system**: Innate and acquired immunity, cells and organs of immune System- B-Lymphocytes and T-Lymphocytes, primary and secondary lymphoid organs, humoral and cell mediated immune response.

2. Immune System: Antigens. Immunoglobulins- structure and function, antigenic Determinants (isotype, allotype, idiotype).

UNIT –II

3. Generation of B-Cell and T-Cell Responses: Major histocompatibility complex. Antigen Processing and presentation.

4. Cell mediated immunity: T-cell receptor, T-cell maturation, activation and differentiation.

UNIT –III

5 Immunological techniques: Immunoprecipitin reactions, agglutination reactions, ELISA, RIA, Immunofluorescence.

6. Immune effector responses: Cytokines. Complement system.

UNIT – IV

7. Immune System in Health and Disease: Hypersensitive reactions. Auto immunity and immune response to infectious diseases. Immune response to transplants. Vaccines.

Text Book:

1. Kuby's Immunology, 5th ed. Goldsby, R A. Kindt, T.J, Osborne, B.A.(2003) W. H. Freeman and company, New York

Reference Books

1. Essential Immunology, 10th ed Roitt, Ivon; Delves, Peter (2001) Blackwell Scientific Publications Oxford.
2. Fundamentals of Immunology: Paul W.E. (Eds.) Raven Press, New York.
3. Immunology by Presscot.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-208	INDUSTRIAL BIOTECHNOLOGY (B.Tech. Biotechnology) Semester -IV						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs.
Purpose	To learn the various aspects of Industrial Biotechnology						
Course Outcomes							
CO1	To learn basic concepts of Fermentation Bioechnology						
CO2	To learn the theoretical aspects of Process Technology for the production of various products						
CO3	To learn the concepts of biopesticides, biofuels and biofertilizers.						
CO4	To understand the concept of integrated strain improvement program.						

UNIT-I

1. Industrial Biotechnologyy: Introduction, objectives and scope.

2. Fermentation Technology:. Biochemistry of fermentation. Ttaditional and modern biotechnology-A brief survey of organisms, processes and products. Basic concepts of upstream and downstream processing in fermentation technology

UNIT - II

3. Production of Primary metabolites and alcoholic beverages Organic acids, dextran, amino acids (Glutamic acid, L-Lysine) and alcohols and alcoholic beverages (wine and beer.

4. Production of Industrial Enzymes- Amylase, protease, lipase, xylanase, lignocellulase. production of acrylamide, adipic acid and 1,2-Propanediol.

UNIT-III

5. Production of Biopesticides and Biofertilizers: Characteristics of biopesticides. Important biopesticides- Bt-toxin, Kasugamycin, Beauverin, Devine and Collego. Beneficial Soil Microorganisms. Biofertilizers.

6. Production of Biofuels: Basic concepts and important types of biofuels. Fuel from biomass, production and economics of biofuels, biogas, biorefineries, Microbial Enhanced Oil Recovery (MEOR).

7. Production of other industrial bioproducts- Single Cell Protein & Mushroom Culture, Biopreservatives Nisin), Cheese, Biopolymers (Xanthan gum, PHB). Biosynthetic Technology. Bioflavours and biopigments: microbial production of flavours and fragrances. Microbial pigments in textile and food industries.

UNIT-IV

8. Strain Improvement Strategies- Improvement of industrially important microorganisms, selection of mutants, use of rDNA technology. Integrated Strain Improvement Program (Precision Engineering Technology)

9. **Microbial Production of Pharmaceuticals**. Antibiotics (penicillin, streptomycin and tetracycline), Enzyme Inhibitors. Production of Vitamin E, K, B_2 and B_{12}, Genetic engineering of microorganisms for production of non-ribosomoal peptides (NRPS) and polyketides (PKS), antiacancer drugs.

Text

1. A Textbook of Basic and Applied Microbiology. Aneja, K. R., Jain, P. and Aneja, R. (2008). New Age International Publishers, New Delhi

Reference Books:

1. Industrial Microbiology.Casida Jr., L.E. (1968) New Age International (P)Ltd. New Delhi.

2. Prescott & Dunn's Industrial Microbiology. Ed. E.G. Reed (1987).CBS Publishers, New Delhi.

3. Biotechnology: A Textbook of Industrial Microbiology 2nd Edition. Crueger, W. and Crueger, A. (2000) Panima Publishing Corporation, New Delhi.

4. Enzymes: Biochemistry, Biotechnology, Clinical chemistry. Palmer, T. (2000) Horwood publishing Colphon.

5. Process engineering in biotechnology. Jackson, A.T. (1991) Prentice Hall.

6. Manual of Industrial Microbiology and Biotechnology 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BS-202	Basics of Thermodynamic and Organic Chemistry (B.Tech. Biotechnology Semester IV)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs
Purpose	To familiarize the students with basic concepts of thermodynamic and organic chemistry.						
Course Outcomes							
CO1	The students will be able to know the basic concepts of naming of organic compounds and general organic reactions.						
CO2	Able to know about spatial arrangement of molecules and their bonding.						
CO3	Able to know about basic concepts of thermodynamics.						
CO4	Able to know about concept of free energy in biomolecules and binding used in biochemical reactions.						

UNIT-I

IUPAC Nomenclature: Systematic IUPAC nomenclature of alkenes, alkynes, cycloalkanes, aromatics, bicyclic and polyfunctional organic compounds. Bond line notation.Types of Organic Reactions: Substitution, Addition, Elimination reactions. Wanger-Meerwin rearrangement reaction. Hyperconjugation : concept and consequences, mole concepts.

UNIT-II

Bonding: Hydrogen bonding- Nature, type, stability and its importance in organic compounds. Tautomerism-Concept, Ring-chain tautomerism, Ring-chain isomerism, properties and reactions of keto-enol tautomers.

Stereo Chemistry: Classification of stereomers, diastereomers, separation of enantiomers, absolute configuration (R & S), projection formulae, stereochemistry of compounds containing two asymmetric C- atoms, stereochemistry of biphenyls. Geometrical isomerism-concept, E & Z nomenclature and aldol condensation

UNIT –III

Thermodynamic parameters –internal energy, enthalpy; their relationship and their significance. First law of thermodynamics. Kirchoff's Equation. Heat capacity at constant pressure and volume and their relationship.

Concepts of Entropy, Second law of thermodynamics. Entropy changes for reversible and irreversible processes. Entropy of mixing.

Third Law of Thermodynamics. Numerical problems on Laws of Thermodynamics.

UNIT-IV

Basic concept of Equilibrium and steady state conditions, Free energy and its relation with equilibrium constant, Chemical potential, Gibbs-Duhem equation and their application, Standard biochemical state and standard free energy changes. Thermodynamic basis of Biochemical reactions, solvent extraction for purification of compounds. Binding – Non-cooperative binding, Co-operative binding and its biological significance

Text/Reference Books:

1. Organic Chemistry V1:6th ed. Finar,I L(2003) Pearson Education, Delhi

2. Organic Chemistry V2:5th ed. Finar,I L(2003) Pearson Education, Delhi.

3. Organic Chemistry 6th ed. Morrison,R & Boyd,T.(2003) Pearson Education, Delhi.

4. Organic Chemistry. Paula Yurkanis Bruice; Pearson Education, Delhi.

5. Principle of Organic Synthesis. Richard Norman and James M Coxon.

6. Organic Chemistry:Reactions & Reagents,37th ed. Aggarwal (2003) Goel Publishing House,Meerut.

7. Organic Analytical Chemistry. Jagmohan (2003) Narosa pub. New Delhi.

Kinetics and Thermodynamics in Biochemistry : Bray & White.

8. Biophysical chemistry Vol. I : Edsall and Wyman

9. Non Equilibrium Thermodynamics in Biophysics : Katchalasky and Curran; Harvard University Press.

10. Principles of Physical Biochemistry : Kensel. E.Van Holde, W. Curtis Johnson, P. Shing Ho (2005) 2 nd edition, Prentice Hall

11. Physical basis of biochemistry: Foundations of molecular biophysics, Bergethan, P.R.(2000) Springer.

BTE-212L		Molecular Biology Lab (B.Tech. Biotechnology Semester IV)					
Lecture	Tutorial	Practical	Credit	Practical	Minor Test	Total	Time
-	-	3	1.5	60	40	100	3 Hrs.
Purpose		To familiarize the students with basic concepts of molecu.					
	Course Outcomes						
CO1		Students will be able to learn Isolation of DNA from Prokaryotic and Eukaryotic Cells					
CO2		Learning of Gel Electrophoresis for separation of DNA, RNA and Proteins					
CO3		Students will learn the technique of PCR Amplification of Nucleic Acids					
CO4		Students will learn Restriction Mapping of Plasmid DNA					

LABORATORY EXPERIMENTS

1. Isolation of genomic DNA from eukaryotic cells.

2. Isolation of RNA from eukaryotic cells.

3. Isolation of proteins from eukaryotic cells.

4. Isolation of genomic DNA from prokaryotic cells.

5. Isolation of plasmid DNA from Prokaryotic cells.

6. Restriction mapping of plasmid DNA:This experiment involves single and double digestion of the plasmid with restriction enzymes.

7. Gel electrophoretic separation of DNA and molecular wt. determination.

8. Gel electrophoretic separation of RNA.

9. Gel electrophoretic separation of proteins.

10. Transblot analysis of DNA.

11. Gel Extraction of DNA.

12. PCR amplification of DNA: Visualization by gel electrophoresis.

Reference Book:

Molecular Cloning – A laboratory manual: 3rd Edition Vol. 1-3. Sambrook J and Russell D.W. (2001). Cold Spring Harbor laboratory Press, New York.

BTE-214L	Bioanalytical Techniques Lab (B.Tech. Biotechnology) Semester- IV						
Lecture	Tutorial	Practical	Credit	Practical	Minor Test	Total	Time
-	-	3	1.5	60	40	100	3 Hrs
Purpose	To learn the Bioanalytical Techniques used in the field of Biotechnology						
Course Outcomes							
CO1	Students will learn about working of spectrophotometer.						
CO2	Students will be able to learn about technique of paper chromatography.						
CO3	Students will be able to learn about technique of electrophoresis.						
CO4	Students will be able to estimate DNA and RNA in any sample.						

LABORATORY EXPERIMENTS

1. To verify the validity of Beer-Lambert's law and determine the molar extinction coefficient of NADH/NAD
2. Separation of amino acids/ sugars by paper chromatography.
3. Extraction and estimation of total lipid content in a given sample of oil seed.
4. Partial purification of an enzyme by ammonium sulphate fractionation,
5. Native gel electrophoresis of proteins.
6. To demonstrate the working of HPLC.
7. Quantitative determination of DNA and RNA by spectrophotometric method.

Reference Books:

1. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), Cambridge University Press, Cambridge.

2. Introductory practical Biochemistry by S.K. Sawhney and Randhir Singh (2000), Narosa Publishing House, New Delhi.

3. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw-Hill, Book Company, UK.

BTE-216L	Industrial Microbiology Lab (B.Tech. Biotechnology) Semester -IV						
Lecture	Tutorial	Practical	Credit	Minor Test	Practical	Total	Time
-	-	3	1.5	40	60	100	3 Hrs
Purpose	To learn the Practical Aspects of Industrial Microbiology						
Course Outcomes							
CO1	Learning of Sterilization Techniques used in Microbiology Lab						
CO2	Learning of Identification of industrially important microorganisms						
CO3	Students will learn production of antibiotics and enzymes from microbes						
CO4	Students will learn determination of microbial cell growth						

LABORATORY EXPERIMENTS

1. Sterilization Techniques (Media, air & water)
2. Construction of various fermenters (bioreactors)
3. Identification of industrially important microorganisms e.g. molds, yeasts and bacteria.
4. Production of various products in the lab. Alcohol, wine, cellulase, protease and bread.
5. Isolation of antibiotic producing microorganisms from the soil.
6. Penicillin production and testing of antimicrobial activity.
7. Isolation of streptomycin-resistant mutants by replica plating method.
8. Isolation of UV induced auxotrophic mutants.
9. Determination of cell growth.
10. Production of organic acids (Citric and lactic) by microorganisms.
11. Production of industrially important enzymes (protease, amylase) by microorganisms.

Reference Books:

1. Experiments in Microbiology, Plant Pathology and Biotechnology. Aneja, K.R.(2003) 4th Edition. New Age International Publishers, New Delhi.
2. Fermentations & Biochemical Hand Book: Principles, Process Design and Equipment. HC Vogel and Noyes(1983).
3. Microbiology Labortary Manual. Cappuccino, J. and Sheeman, N.(2000), 4th Edition, Addison Wesley, California.
4. Manual of Industrial Microbiology and Biotechnology. 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.

BT-218L	Immunology Lab (B.Tech. Biotechnology) Semester -IV						
Lecture	Tutorial	Practical	Credit	Minor Test	Practical	Total	Time
-	-	3	1.5	40	60	100	3 Hrs
Purpose	To learn the practical aspects of Immunology						
Course Outcomes							
CO1	Students will be able to learn basic techniques in handling laboratory animals.						
CO2	Learning of techniques for purification of immunoglobulins.						
CO3	Students will learn the technique of Immunoprecipitation and Agglutination.						
CO4	Students will learn the principles of ELISA.						

LABORATORY EXPERIMENTS

1. Routine techniques in handling laboratory animals: feeding, cleaning and bleeding procedure for mice and rabbit.
2. ABO blood group typing
3. Estimation of heamoglobin in blood sample
4. Detection of antigen/antibody from test sample
5. Purification of immunoglobulins.
6. Immunoprecipitation techniques
7. Agglutination techniques
8. ELISA

Reference Books:

1. Using Antibodies: A Laboratory Manual. Harlow & Lane(1998) Cold Spring Harbor Lab Press.
2. Immunological Techniques Made Easy. Cochet, et al.(1998)Wiley Publishers,Canada.

MC-901	ENVIRONMENTAL SCIENCES (B.Tech. Biotech IV th Sem)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	-	-	-	75	25	100	3 Hrs.
Purpose	**To learn the multidisciplinary nature, scope and importance of Environmental sciences.**						
Course Outcomes							
CO1	**The students will be able to learn the importance of natural resources.**						
CO2	**To learn the theoretical and practical aspects of eco system.**						
CO3	**Will be able to learn the basic concepts of conservation of biodiversity.**						
CO4	**The students will be able to understand the basic concept of sustainable development.**						

UNIT I

The multidisciplinary nature of environmental studies.Definition, Scope and Importance. Need for public awareness. Natural Resources: Renewable and Non-Renewable Resources: Natural resources and associated problems.

(a) Forest Resources: Use and over-exploitation, deforestation, case studies. Timber eztraction, mining, dams and their effects on forests and tribal people.
(b) Water Resources- Use and over-utilization of surface and ground water, floods, drought, conflicts over water, dams-benefits and problems.
(c) Mineral Resources- Use and exploitation, environmental effects of extracting and using mineral resources, case studies.
(d) Food Resources- World Food Problems, changes caused by agriculture and overgazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies.
(e) Energy Resources- Growing energy needs, renewable and non-renewable energy sources, use of alternate energy sources. Case studies.
(f) Land Resources- Land as a resource, land, degradation, man induced landslides, soil erosion and desertification.

Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyle.

UNIT II

Ecosystem-Concept of an ecosystem. Sturcture and function of an ecosystem.Producers, consumers and decomposers.Energy flow in the ecosystem.Ecological Succession.Food Chains, food webs and ecological pyramids. Introduction, types,characteristic features, structure and function of the following ecosystem-

a. Forest Ecosystem
b. Grassland Ecosystem
c. Desert Ecosystem
d. Aquatic Ecosystems(ponds, streams, lakes, rivers, oceans, estuaries

Field Work. Visit to a local area to document Environment assets-river/forest/grassland/hill/mountain.Visit to a local polluted site- Urban /Rural Industrial/Agricultural. Study of common plants, insects and birds. Study of simple ecosystems-pond, river, hill, slopes etc. (Field work equal to 5 lecture hours).

UNIT III

Biodiversity and its conservation. Introduction, Definition: genetic, species and ecosystem diversity. Biogeographical classification of India. Value of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values. Biodiversityof global, National and local levels. India as a mega-diversity nation Hot spots of Biodiversity. Threats to biodiversity: Habitat loss, poaching of wild life, man-wildlife conflicts. Endangered and endemic species of India.Conservation of Biodiversity- In situ and Ex-Situ conservation of biodiversity.

Environmental Pollution Definition. Cause, effects and control measures of- (a) Air Pollution (b) Water Pollution (c) Soil Pollution (d) Marine Pollution (e) Noise Pollution (f) Thermal Pollution (g) Nuclear Hazards
Solid waste management- cause, effects and control measures of urban and industrial wastes. Role of an individual in prevention of pollution.Pollution case studies. Disaster management: floods, earthquake, cyclone and landslides

UNIT IV

Social Issues and the Environment.From unsustainable to sustainable development. Urban problems related to energy. Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people: Its problems and concerns. Case Studies.

Environmental ethics-issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Case studies.Wasteland Reclamation.Consumerism and waste products.

Environment Protection Act.Air (Prevention and Control of Pollution) Act.Water (Prevention and Control of Pollution) Act.Wildlife Protection Act.Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public Awareness.

Human population and the Environment.Population growth, variation among nations. Population explosion-Family Welfare Programme. Environment and human health.

Human rights.Value Education.HIV/AIDS, Women and Child Welfare.Role of Information Technology in Environment and Human Health.Case Studies.Drugs and

their effects; Useful and harmful drugs; Use and abuse of drugs; Stimulant and depressan drugs. Concept of drug de-addiction. Legal position on drugs and laws related to drugs.

Text Books

1. Environmental Studies- Deswal and Deswal. Dhanpat Rai & Co.
2. Environmental Science & Engineering Anandan, P. and Kumaravelan, R. 2009. Scitech Publications (India) Pvt. Ltd., India
3. Environmental Studies. Daniels Ranjit R. J. and Krishnaswamy. 2013. Wiley India.
4. Environmental Science- Botkin and Keller. 2012. Wiley , India

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-301	Recombinant DNA Technology (B.Tech. Biotechnology Semester V)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs.
Purpose	To familiarize the students with the concepts and tools of Genetic Engineering						
Course Outcomes							
CO1	Learner will know about different tools used for Genetic Engineering						
CO2	Students will be able to understand the fingerprinting methods						
CO3	This unit will enable the students to understand different types of mutation						
CO4	Students will be able to learn how to produce biomolecules by using RDNA tech						

UNIT I

1. **Tools of Recombinant DNA:** Restriction endonucleases. DNA/ RNA Modifying enzymes: Methylase, Alkaline phosphatase, Terminal deoxy nucleoside acetyl transferase,T4 Polynucleotide kinase. Blunt end ligation,Linkers Adapters,DNA labeling and detection.
2. **Cloning and Expression Vectors:** Plasmid, Cosmids, Bacteriophages, Phagemids as vectors. Binary and shittle vectors. Creating and screening a gene library cDNA library. Genetic transformation of prokaryotes. Basic strategies for cloning. Cloning DNA sequences encoding eukaryotic proteins. Selection of cloned genes.Vectors for cloning large pieces of DNA.

UNIT II

3. **Chemical synthesis, sequencing and amplification of DNA:** Chemical synthesis of DNA. DNA sequencing techniques. PCR. Analysis of eukaryotic DNA by chromosomal walking. Southern and Northern Blotting. Western Blotting. *In situ* hybridization.

4. **Isolation of cloned genes:** Probes to locate clones and related genes. Identification and isolation of tissue specific cDNA. Procedures to analyze proteins encoded by cDNA clones.

UNIT III

5. **DNA markers**: RFLP. RAPD and DNA fingerprinting.

6. **Study of gene functions:** Directed mutagenesis. Identification of mutant clones. Use of PCR to construct genes encoding chimeric proteins.

7. Mutagenesis-gateway to gene function and protein engineering.

UNIT IV

8. **Application of recombinant DNA in biotechnology:** In medicine and Industry: Production of small biomolecules: Production of insulin, human growth hormone and its variants. Hepatitis-B virus vaccine. Tailoring antibodies for specific applications. Biopolymers production. Heterologous Protein Production in Prokaryotes and Eukaryotes
9. Marshalling recombinant DNA to fight AIDS.

Text Books:

1. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, New York.
2. Molecular Biotechnology: *Principles Application of Recombinant DNA* 2nd Edition. Glick, B. R. and Pasternak, J. J. (1998) ASM press Washington DC.
3. Genetic Engineering. Ahluwalia, K. B. (2002) New Age International (P) Ltd.
4. An Introduction to Genetic Engineering 2nd edition Desmond Nicholl S.T. (2002) Cambridge University Press.
5. Genetic Engineering: *An introduction to Gene analysis and exploitation in eukaryotes*. Kingsman and Kingsman (1998) Blackwell Scientific Publication, Oxford.
6. DNA cloning: *A Practical Approach.* Glover and Hames (2001) Oxford University Press.

BTE-303	BIOPROCESS ENGINEERING (B. Tech. Biotechnology Semester V)						
Lecture	Tutorial	Practical	Sessional	Theory	Total	Time	Credit
3	-	-	25	75	100	3 Hrs.	3
Purpose	To introduce the basics of Bioprocess Engineering to the students for applications in Biotechnology						
Course Outcomes							
CO1	Introduce the fundamentals of Bioprocess Engineering.						
CO 2	To make the students aware of the importance of formulation of culture media and sterilization of process fluids						
CO 3	To introduce the concept of configuration and different types of bioreactors						
CO 4	To make aware of the applications of Bioprocess Engineering to non-conventional Biological Systems						

UNIT-I

1. **Introduction to Bioprocess Engineering**. History and Scope of Bioprocess Engineering. Basic concepts and approaches used in Bioprocess Engineering. Microbial growth Kinetics. Bioprocesses: Regulatory Constraints. Steps in Bioprocess development. Major products of biological processing.
2. **Basics of Bioprocess Engineering**. Introduction to Heat Transfer, Mass Transfer and Diffusion Concepts. Material and Energy Balances in a macroscopic view point. Variables, dimensions and units. Dimensionally Homogenous and non-homogenous equations. Standard conditions and ideal gases.

UNIT II

3. **Formulation of Fermentation Media**. Principles of microbial nutrition. Formulation of culture media. Factors influencing the choice of various carbon and nitrogen sources. Growth factors and precursors in fermentation media. Antifoaming and antifoam agents.
4. **Sterilization of Process fluids**. Kinetics of thermal death of cells and spores. Design of batch and thermal sterilization. Sterilization of air and filter design. Radiation and chemical sterilization.

UNIT III

5. **Design of Bioreactors**. Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles, stirrer glands and bearings. Process parameters and measurement techniques: measurement of temperature, pressure and pH, DO, foam etc.; flow rate of liquid and gases; Automation (processes computerization). Validation of Fermentor

6. **Configuration and Types of Reactors**: Ideal and non-ideal reactors. Batch, plug flow reactor (PFR), continuous stirred tank reactor (CSTR), Fluidized bed reactor, air lift fermenter, and mechanical design of bioreactors.
7. **Choosing the Cultivation Method.** Modifying Batch and Continuous Bioreactors. Immobilized cell systems. Solid-state Fermentations and its applications. Rheology of fermentation fluids. Various approaches to scale-up including regime analysis and scale-down.

UNIT IV

8. **Applications of Bioprocess Engineering to non-conventional Biological Systems**. Bioprocess considerations in using animal and plant cell cultures. Use of Genetically Engineered Microorganisms in Bioprocess development.

Text Books-

1. Shuler, M. L. and Kargi, F. 2002. Bioprocess Engineering-Basic Concepts. Prentice Hall India, New Delhi.
2. Doran, P. M. 2013. Bioprocess Engineering Principles. Elsevier.
3. Mukhopadhyay, S. N. 2012. Process Biotechnology-Theory and Practice. The Energy and Resources Institute, New Delhi/

Reference Books-

1. Ward, O.P. 1991. Bioprocessing. New York
2. Nostrand, R. V., Belter, P.A., Cussler, E. L. and Hu, W. S. 1988. Bioseparations-Downstream Processing for Biotechnology.
3. Lydersen, K. B., D'elia, N. A. and Nelson, K. L. 1994. Bioprocess Engineering: Systems, Equipments and Facilities. John Wiley and Sons, New York.

BTE-305	Downstream Processing (B.Tech. Biotechnology Semester V)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs
Purpose	To familiarize the students with the Downstream Processing						
Course Outcomes							
CO1	Students will become familiar to upstream and downstream processing						
CO2	Students known about cell disintegration and primary methods of separation in DSP						
CO3	Students will develop knowledge to Emerging separation techniques						
CO4	Students will develop focus on different examples of DSP						

UNIT –I

1. **Introduction:** History and scope of downstream processing in biotechnology, problems, requirement of purification. Overview of a bioprocess including upstream and downstream processing., physicochemical basis of bioseparation

UNIT – II

2. **Cell disintegration:** Separation of particulate by centrifugation, settling, sedimentation, decanting and micro filtration. Primary isolation methods including solvent extraction and sorption.
3. **Purification methods:** Precipitation, electrophoresis, electro dialysis and various kinds of chromatography.

UNIT – III

4. **Emerging separation techniques:** Immobilization, reverse osmosis, super critical fluid extraction evaporation, super liquid extraction and foam based separation. Separation of intracellular, extracellular, heat and photosensitive materials.

UNIT – IV

5. **Downstream processes and effluent treatment:** Applications of Unit Operations in Downstream with special reference to membrane separations & extractive fermentation, anaerobic and aerobic treatment of effluents. Typical examples effluent disposal in process industries.

Text books

1. Biochemical Engineering fundamentals 2nd ed. Bailey J. E. and Ollis D. F. (1986) MacGraw Hill, New York.

2. Principles of fermentation technology, Stanbury, P. F. and Whitaker, A. (1984), Pergamonpress.

3. Unit Operation of Chemical Engineering 6th ed. McCabe, W. L; Smith J. C and Harriott P. (2000). MacGraw Hill, New York

Reference Books

1. Bioseparation: Downstream Processing for Biotechnology. Belter, P. A.; Cussler E. L. and Hu W. S. (2003) John Wiley & Sons. OXFORD.

2. Bioseparations Science and Engineering, Harrison R.G.; Todd P.; Rudge S.R. and Petrides D.P. (2003). Oxford Press.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-307	Healthcare Biotechnology (B.Tech. Biotechnology Semester V)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time(H)
3	-	-	3.0	75	25	100	3
Purpose	To Learn the use of biotechnology in the area of healthcare and diagnosis						
Course Outcomes							
CO1	To understand the fundamental of diagnostics						
CO2	To understand the use of therapeutics agents in healthcare.						
CO3	To understand the diagnosis in molecular level.						
CO4	To understand advanced techniques in molecular diagnostics.						

Unit I

Introduction to diagnostics in Heathcare Biotechnology: Different methods to daignose bacterial and parasitic infection. Signal amplification system. FACS. Assay development evalution and validation. Reagent formulation and their self life evalution.

Production of antibody in *E.coli.* Regulatory aspect of therapeutic proteins and approaches for producing HIV therapeutics agents.

Unit II

Therapeutics Agents in Pharmaceutical and Enzymes: Human Interferons, Human Growth Hormone, Tumor Necrosis factos, Dnase I, Alginate Lyase, Phenylalanine Ammonia Lyase and alpha-Antitrypsin.

Nucleic Acid as Therapeutic Agents: Antisense RNA, Ribozymes, Interfering RNAs and Antibody Genes.

Unit III

DNA Diagnostics: Radioactive and non radioactive nucleic acid hybridisation. DNA fingerprinting and RAPD as diagnostic tools.

Vaccines: Subunit Vaccines for herpese simplex virus and Foot-and-Mouth Disease. Genetic Immunization by DNA vaccine. Attenuated and vector vaccines.

Unit IV

Molecular Diagnosis of Genetic Disorder: Diagnosis before onset of symptoms and identification of carriers of heredity disorder. Significance in prenatal diagnosis. PCR/OLA Procedures for diagnosis heredity disease caused by mutation without affecting restrictions sites. Genotyping with FISH and related techniques. Detection of mutation.

Text Books:

1. Moloecular Biotechnology: Principles and Applications of Recombinant DNA. 3rd Edition. Glick Bernard R.and Pasternak Jack J. (1998), ASM Press washington DC.

2. Kuby's immunology, 5th Edition. Goldsby, R A., Kindt, T.Jand Osborne B.A.(2003). W. H. Freeman and company, New york.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-307L	Recombinant DNA Technology Lab(B. Tech. Biotechnology Semester V)						
Lecture	Tutorial	Practical	Credit	Minor Test	Practical (Major Test)	Total	Time
-	-	3	1.5	40	60	100	3 Hrs
Purpose	To learn the experiments of Recombinant DNA Technology						
Course Outcomes							
CO1	The students will be able to digest, ligate and amplify the DNA						
CO2	The students will learn how to design primers						
CO3	The students will learn about protein expression						
CO4	Students will learn techniques of DNA extraction and its analysis						

LIST OF EXPERIMENTS

1. Target selection
2. Strategy for cloning
3. Primer design
4. Isolation of genomic DNA
5. Gene amplification by PCR
6. Ligation of desired gene sequence
7. Transformation
8. Verification of cloned DNA
9. Induction of expression
10. Verification of protein expression

References Book:

1.Molecular Cloning – A laboratory manual 3rd Edition Vol. 1-3. Sambrook J. and Russell D.W. (2001) Cold Spring Harbor laboratory Press, New York

2. Molecular Biology-Principles and Practices. Singh, N. and Siwach, P. Luxmi Publications, Delhi

BTE-309L	Fermentation and Downstrean Processing LAB (B.Tech. Biotechnology Semester V)						
Lecture	Tutorial	Practical	Credit	Practical (Major Test)	Minor Test	Total	Time
-	-	3	1.5	60	40	100	3 Hrs.
Purpose	To familiarize the students with different Downstream Processing techniques						
Course Outcomes							
CO1	Students will learn how to optimized the fermentation conditions						
CO2	Students will learn different chromatography used in DSP						
CO3	Students will work on purification of antigen						
CO4	Students will work on cell lysis by different methods						

Note: A college should offer 70% of the below listed experiments. The remaining 30% experiments may be modified by college according to facilities available

LIST OF EXPERIMENTS

1. **Study of factors affecting bioprocesses in submerged fermenters** (pH, O2, Temperature, Foam, Ingredients)

2. Purification of bacterial protein

a) Cell lysis by different methods.

b) Cell debris separation by different methods.

c) Column purification

I. Separation by Molecular weight.

II. Separation by charge.

III. Separation by metal affinity.

IV. Separation by Receptor-Ligand affinity.

d) Dialysis

e) Crystallization

f) Lyophilization

3. Purification of O-PS

a) Cell lysis

b) Harvesting of cells

c) Purification of O-PS antigens

References:

1. Biophysical Chemistry: Principles & techniques 2nd Edition. Upadhyay, A.; Upadhyay, K. and Nath, N. (2002) Himalaya Publication House, New Delhi.

2. Bioprocess Engineering: Systems, Equipment & facilities. Eds. Lydersen K.B.; D'elia N.A. and Nelson K.L. (1994) John Wiley & Sons, New York.
3. Physical Biochemistry 2nd Edition. Friefelder D. (1983) W.H. Freeman & Co., USA.
4. Physical Biochemistry: Principles & applications. Sheehan David (2000) John Wiley & Sons Ltd. New York.
5. Bioseparations- Downstream processing for biotechnology. Belter, P.A.; Cussler, E.L. and Hu, W.S. (1988) John Wiley and Sons, New York.
6. Encyclopedia of Bioprocess Technology: Fermentation, biocatalysis and bioseparation Vol. 1-5. Eds. Flickinger M.C. and Drew S.W. (1999) John Wiley & Sons, New York.

MC-903	Essence of Indian Traditional Knowledge B. Tech. Biotechnology (Semester V)							
Lecture	Tutorial	Practical	Credits	Major Test	Minor Test	Practical	Total	Time (Hrs.)
3	0	0	--	100	--	--	100	3
Purpose	To impart basic principles of thought process, reasoning and inferencing.							
Course Outcomes								
CO 1	The students will be able to understand, connect up and explain basics of Indian traditional knowledge in modern scientific perspective.							

Course Contents

- Basic structure of Indian Knowledge System: अष्टादशविद्या -४वेद,४उपवेद (आयुर्वेद, धनुर्वेद, गन्धर्ववेद, स्थापत्य आदि) ६वेदांग (शिक्षा, कल्प, निरुक्त, व्याकरण, ज्योतिष, छंद) ४ उपाङ्ग (धर्मशास्त्र, मीमांसा, पुराण, तर्कशास्त्र)
- Modern Science and Indian Knowledge System
- Yoga and Holistic Health care
- Case studies

References

- V. Sivaramakrishnan (Ed.), *Cultural Heritage of India-course material*, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014
- Swami Jitatmanand, *Modern Physics and Vedant*, Bharatiya Vidya Bhavan
- Swami Jitatmanand, *Holistic Science and Vedant*, Bharatiya Vidya Bhavan
- Fritzof Capra, *Tao of Physics*
- Fritzof Capra, *The Wave of life*
- VN Jha (Eng. Trans.), *Tarkasangraha of Annam Bhatta*, International Chinmay Foundation, Velliarnad, Arnakulam
- *Yoga Sutra of Patanjali*, Ramakrishna Mission, Kolkata
- GN Jha (Eng. Trans.), Ed. RN Jha, *Yoga-darshanam with Vyasa Bhashya*, Vidyanidhi Prakashan, Delhi 2016
- RN Jha, *Science of Consciousness Psychotherapyand Yoga Practices*, Vidyanidhi Prakashan, Delhi 2016
- P E Sharma (English translation), *Shodashang Hridayam*

Pedagogy: Problem based learning, group discussions, collaborative mini projects.

Swami Jitatmanand, Modern Physics and Vedantharatiya Vidya Bhavan

•Swami Jitatmanand, Holistic Science and Vedantharatiya Vidya Bhavan •Fritzof Capra,

Tao of Physics •Fritzof Capra,

The Wave of life •VN Jha (Eng. Trans.), Tarkasangraha of Annam Bhatta, International Chinmay Foundation, Velliarnad,Arnakulam •

Yoga Sutra of Patanjali, RamakrishnaMission,Kolkata •

BTE-304	Plant Biotechnology (B.Tech. Biotechnology Semester VI)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs.
Purpose	To familiarize the students with the concepts of tissue culture and transgenic plants						
Course Outcomes							
CO1	Students will learn about different types of tissue culture techniques						
CO2	Students will be able to understand about male and female tissues used for culturing						
CO3	Students will learn about different gene transfer methods						
CO4	Learner will be able to understand about transgenic plants and products						

UNIT I

Introduction: Cyto and organogenic differentiation. Types of culture: seed, embryo, callus, organ, cell and protoplast culture. Secondary metabolites; their production and applications.

Micropropagation: Axillary bud proliferation, meristem and shoot tip culture, bud culture, organogenesis, embryogenesis, advantages and disadvantages of micropropagation.

In Vitro haploid production: Androgenic methods: anther culture, microspore culture, factors effecting and organogenesis. Significance and use of haploids, ploidy level and chromosome doubling, diplodization. Gynogenic haploids: factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

UNIT II

Protoplast Isolation and fusion: Methods of protoplast isolation, protoplast development, somatic hybridization, identification and selection of hybrid cells, cybrids, potential of somatic hybridization, limitations.

Somaclonal variation: Nomenclature, methods, causes applications and disadvantages. Gametoclonal variation.

Germplasm storage and Cropreservation: Methods, cryoprotectants, pretreatment, freezing, storage, thawing, slow growth cultures, DNA clones, Advantages and disadvantages

UNIT III

Plant Growth Promoting bacteria: Nitrogen fixation, nitrogenase, hydrogenase, nodulation, Growth promotion by free-living bacteria

Gene transfer in plants: Transient and stable gene expression, marker genes, selectable markers, chimeric gene vectors.

Gene transfer methods: Agrobacterium, viruses and transposable elements. Vectorless or direct DNA transfer: Physical, chemical and imbibation methods of gene transfer.

UNIT IV

Transgenics in crop improvement: Resistance to biotic stresses- insect, virus and disease (fungus and bacterium) resistance, herbicide resistance. Development of stress and senescence-tolerance – Oxidative stress, salt stress and fruit ripening. Transgenics for : improved quality, longer life, flower color and shapes, for male sterility, for terminator seed. Trangenic plants as bioreactors: production of carbohydrates, lipids, vitamins and minerals, biodegradable plastics, peptides, proteins and edible vaccines. Commercial transgenic crops.

Text Books:

1. Introduction to Plant Biotechnology 2nd edition. Chawla, H.S. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi
2. Molecular Biotechnology: Principles and Applications of recombinant DNA. Glick, B. R. and Pasternak J. J. (1998) ASM press, Washington DC.
3. Plant Tissue culture: Theory and Practice. Bhojwani, S.S. and. Razdan M.K (1996) Elsevier Science, Netherlands.

Reference Books:

1 Handbook of Plant Biotechnology, Vol. I and II. By Paul Christou and Harry Clee. John Wiley and Sons, Ltd.
2. Improving Plant draught, salt and freezing tolerance by gene transfer of a single stress-inducible transcription factor. (1999) *Nature Biotechnology 17(3):* 287-291. Kasuga, M., Q. Liu, et al.
3. Heterologous expression of *Arabidopsis* phytochrome B in transgenic potato influences photosynthetic performance and tuber development.(1999) *Physiology***120,** (1):73-81. Thiele, A., Herold M., et al.
4. Exploiting the full potential of disease-resistance genes for agricultural use. Curr Opin Biotechnol. 2000 Apr;11(2):120-5. Review Rommens CM, Kishiore GM
8. Directed molecular evolution in plant improvement. Curr Opin Plant Biol. 2001 Apr;4(2):152- 156. Review. Lassner M, Bedbrook J.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus

BTE- 306	Animal Biotechnology (B.Tech. Biotechnology Semester VI)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3.0	75	25	100	3 Hrs.
Purpose	To introduce the students with basics of Animal Biotechnology.						
Course Outcomes							
CO1	Basic concepts of animal cell culture.						
CO2	To understand the concept of Reproductive Biotechnology.						
CO3	To learn the concepts of Molecular biological techniques for rapid diagnosis of genetic diseases.						
CO4	To learn the theoretical aspects of Transgenic animals Methodology.						

UNIT I

Introduction and Scope of Animal Biotechnology. History and scope of animal cell culture; Cell culture media and reagents, culture of cells, tissues and organs, establishment of cell culture, continuous cell lines, suspension cultures, application of animal cell culture for *in vitro* testing of drugs

UNIT II

Reproductive Biotechnology: Artificial insemination, super ovulation, In *Vitro* fertilization and embryo transfer. Cryopreservation of cell lines and animal germplasm (i.e. semen, ovum and embryos). DNA bar coding.

UNIT III

Molecular biological techniques for rapid diagnosis of genetic diseases and gene therapy. Transfection. Establishment of immortal cell lines, expression of mammalian genes in prokaryotic and eukaryotic systems. Extinction of gene function by antisense RNA and DNA. Brief account of gene silencing.

UNIT IV

Transgenic animals Methodology: Retroviral vector method, DNA microinjection method and engineered embryonic stem cell method. Cloning by nuclear transfer. Yeast artificial chromosome transgenesis.

Text Books:

1. Principles of Gene Manipulations 6th edition. Primrose S.B.; Twyman, R. and Old B. (2002) Blackwell Publishing.
2. Molecular Biotechnology: Principles and Applications of recombinant DNA 2nd Edition. Glick, B. R. and Pasternak J. J. (1998) ASM press, Washington DC.
3. Animal Cell Biotechnology : Spier, R.E. and Griffiths J.B. (1988) Academic press.

References:

1. Living resources for Biotechnology, Animal cells. Doyle, A.; Hay, R. and Kirsop, B.E. (1990) Cambridge University Press, Cambridge.
2. Animal Biotechnology. Murray Moo-Young (1989) Pergamon Press, Oxford.
3. Introduction of Aquaculture Landau Matthew (1991) John Wiley & Sons, New York.
4. Lincoln PJ & Thomson J. 1998. *Forensic DNA Profiling Protocols*. Humana Press.
5. Gordon I. 2005. *Reproductive Techniques in Farm Animals*. CABI.
6. Culture of Animal Cells – a manual of basic techniques 4th Edition. Freshney, R. I. (2000) John Wiley & Sons, New York.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus

BTE-308	Food Biotechnology (B.Tech. Biotechnology Semester VI)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs
Purpose	To familiarize the students with various aspects of Food Biotechnology						
Course Outcomes							
CO 1	Student to learn the method of fermentation and know about fermented foods and fermentation industries.						
CO 2	To learn the development of novel food and food ingredients.						
CO 3	Able to understand various methods of preservation						
CO 4	Student will learn about monitoring of food quality and packaging techniques.						

UNIT I

1. **Introduction to human nutrition**; Nutritive values of foods; Basal metabolic rate

2. **Food Fermentation Technology**: Food as substrate for microorganisms: Classification of foods. Scope and development of fermented products, important fermented foods and beverages, Significance of fermentation. Food Fermentation Industries, Methods of waste disposal from various food industries

UNIT II

3. **Novel Food and Food Ingredients**: Low calorie sweeteners, food supplements, food colorings, probiotics.

4. **Neutraceuticals:** Sources, Types, Significance, role of nutraceuticals in prevention and control of diseases.

UNIT III

5. **Food Spoilage**: Factors affecting spoilage- Intrinsic and extrinsic factors affecting microbial growth in foods: Intrinsic factors (Nutrient contents, pH, moisture contents/water activity, Antimicrobial substances), Extrinsic factors (relative humidity, temperature, gaseous atmosphere).

6. **Methods of food preservation**- Thermal processing, Cold preservation, Chemical preservatives & food dehydration, Use of Radiations for food preservation. Preservation by fermentation: curing and pickling.

UNIT IV

7. **Monitoring of food quality** - HACCP.

8. **Packaging of Food:** Need for packaging, Containers for packaging (glass, metal, plastics and aluminium foil). Types of Packaging- Primary, Secondary and Tertiary; Flexible Packaging, Biodegradable Packaging.

Text Books:

1. Microbiology 5th Edition. Prescott, L.M.; Harley, J.P. and Klein, D.A.(2003) McGraw Hill, USA

2. Food Microbiology: Fundamentals and Frontier 2nd Eds. Ed. Beuchat, Doyle & Montville. (2001). Blackwell Synergy.

3. Food Microbiology. Frazier, W.C. and Westhoff, D.C. (2010) Tata Mc-Graw Hill, New Delhi.

4. Modern Food Microbiology. Jay, J.M. (1996) CBS Publishers and Distributors, New Delh

5. Foods: Facts and Principles. (2012) N. Shakuntala Manay and M. Shadakshara Swami. New Age International (P) Ltd, Publishers

Reference Books:

1 Biotechnology: Food Fermentation Vol. I & II. Eds. Joshi, V.K. & Pandey, A. (1999) Educational Publishers and Distributers, Kerala.

2 Biotechnological Strategies in Agroprocessing. Eds. Marwaha S.S & Arora, J.K. (2003)

3. Ray, Bibek.(1996). Fundamental Food Microbiology .CRC Press.

Food Microbiology 2nd ed, Adam, M. R. and Moss (2003) Panima Pub, New Delhi.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-310	Environmental Biotechnology& Engineering (B.Tech. Biotechnology Semester VI)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs
Purpose	To introduce the students with role of environmental biotechnology in pollution control						
Course Outcomes							
COI	The students will be able to understand the microbiology and biochemistry of waste water treatment						
COII	The students will learn different methods for waste water treatment using bioreactors						
COIII	The students will understand the concept of bioremediation and its applications						
CO IV	Students will know novel and biotechnological methods for waste treatment and pollution control						

UNIT – I

1. **Role of Biotechnology in Environment Protection:** Introduction and current status of biotechnology in environment protection, pollution control and waste treatment.
2. **Classification and Characterization of Waste:** Physicochemical characteristics of waste material, Waste Material suitable for biological treatment, Estimation of COD and BOD.

UNIT II

3. **Biological Treatment of Waste:** Impact of pollutants on biotreatment, Recommended Effluent treatment methods. Use of packaged microorganisms and genetically engineered organisms.
4. **Treatment of Industrial Effluent:** Aerobic biological treatment, anaerobic biological treatment. Pulp and paper mill effluent, dye effluent, distillery effluent etc.
5. **Removal of Pollutants using plants and microbes:** Phytoaccumulation, Phytovolatilization, Phytoabsorbtion, Rhizofilteration, role and significance of microbes .

UNIT III

6. **Bioremediation :** Definition, Types of bioremediation. Bioaugmentation, Biostimulation Applications of bioremediation, Biomarkers, Biosensors.

7. **Biotechnology for Hazardous Waste Management :** Xenobiotic compounds, recalcitrant and hazardous waste, Biodegradation of xenobiotics.

UNIT IV

8. **Solid Waste Management :** Incineration, Composting, Biogas Plant.
9. **Restoration of degraded lands :** Development of stress tolerant plants, use of mycorrhizae and microbes for improving soil fertility. Organic farming and Vermitechnology,
10. **Novel Methods for Pollution Control :** Aiming for biodegradable and ecofriendly products.

Text Books

1 1. Environmental Biotechnology. Jogland, S.N. (1995) Himalaya Publishing House, New Delhi.

2 2. Environmental Biotechnology: Bhattacharya and Banerjee (2007) Oxford University Press.

3 2. Comprehensive Biotechnology (Vol. 1-4) Young Murray Moo (Ed.) 1985 Elsevier Sciences.

References Books:

4 1. Waste water Engineering Treatment, Disposal and Reuse. Metcalf & Eddy (1991) McGraw Hill.

5 2. Biochemical Engineering Fundamentals 2nd ed. Bailey, J. E. and Ollis, D. F. (1986) MacGraw Hill. New York

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

HM-902	Business Intelligence & Entrepreneurship (B.Tech. Biotechnology Semester VI)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs
Purpose	To introduce the students with role of environmental biotechnology in pollution control						
Course Outcomes							
COI	Students will be able to understand who the entrepreneurs are and what competences needed to become an Entrepreneur						
COII	Students will be able to understand insights into the management, opportunity search, identification of a Product; market feasibility studies; project finalization etc. required for small business enterprises						
COIII	Students can be able to write a report and do oral presentation on the topics such as product identification, business idea, export marketing etc.						
CO IV	Students be able to know the different financial and other assistance available for the establishing small industrial units						

UNIT -I

Entrepreneurship : Concept and Definitions; Entrepreneurship and Economic Development; Classification and Types of Entrepreneurs; Entrepreneurial Competencies; Factor Affecting Entrepreneurial Growth – Economic, Non-Economic Factors; EDP Programmes; Entrepreneurial Training; Traits/Qualities of an Entrepreneurs; Manager Vs. Entrepreneur, Entrepreneurial challenges.

UNIT -II

Opportunity / Identification and Product Selection: Entrepreneurial Opportunity Search &Identification; Criteria to Select a Product; Conducting Feasibility Studies; Sources of business ideas, Marketing Plan : Conducting of Marketing Research, Industry Analysis, Competitor analysis, market segmentation and positioning, building a marketing plan, marketing mix, launching a new product; export marketing, Methods of Project Appraisal, Project Report Preparation; Specimen of Project Report; Project Planning and Scheduling using Networking Techniques of PERT / CPM.

UNIT -III

Small Enterprises and Enterprise Launching Formalities : Definition of Small Scale; Rationale; Objective; Scope; SSI; Registration; NOC from Pollution Board; Machinery and Equipment Selection , Role of SSI in Economic Development of India; major problem faced by SSI,MSMEs – Definition and Significance in Indian Economy; MSME Schemes, Challenges and Difficulties in availing MSME Schemes.

Unit -IV

Role of Support Institutions and Management of Small Business : DIC; SIDO; SIDBI; Small Industries Development Corporation (SIDC); SISI; NSIC; NISBUD; State Financial Corporation SIC; Venture Capital : Concept, venture capital financing schemes offered by various financial institutions in India.

Special Issues for Entrepreneurs: Legal issues – Forming business entity, requirements for formation of a Private/Public Limited Company, Entrepreneurship and Intellectual Property Rights: IPR and their importance. (Patent, Copy Right, Trademarks) , Case Studies-At least one in whole course.

Note:

• Case studies of Entrepreneurs – successful, failed, turnaround ventures should be discussed in the class.

• Exercises / activities should be conducted on 'generating business ideas' and identifying problems and opportunities.

• Interactive sessions with Entrepreneurs, authorities of financial institutions, Government officials should be organized

Suggested Readings:

1. "Entrepreneurship development small business enterprises", Pearson, Poornima M Charantimath,2013.
2. Roy Rajiv, "Entrepreneurship", Oxford University Press, 2011.
3. "Innovation and Entrepreneurship",Harper business- Drucker.F, Peter, 2006.
4. "Entrepreneurship", Tata Mc-graw Hill Publishing Co.ltd new Delhi- Robert D. Hisrich, Mathew J. Manimala, Michael P Peters and Dean A. Shepherd, 8th Edition, 2012
5. Enterprenеurship Development- S.Chand & Co.,Delhi- S.S.Khanka 1999
6. Small-Scale Industries and Entrepreneurship. Himalaya Publishing House, Delhi –Vasant Desai 2003.
7. Entrepreneurship Management -Cynthia, Kaulgud, Aruna, Vikas Publishing House, Delhi, 2003.
8. Entrepreneurship Ideas in Action- L. Greene, Thomson Asia Pvt. Ltd., Singapore, 2004.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus

BTE-312 L	Animal Cell Culture Lab (B.Tech. Biotechnology Semester VI)						
Lecture	Tutorial	Practical	Credit	Minor Test	Practical (Major Test)	Total	Time
-	-	3	1.5	40	60	100	3 Hrs
Purpose	To learn the Practical Aspects of Animal cell Culture lab						
Course Outcomes							
CO1	Learning of Sterilization Techniques used in Animal cell culture Lab						
CO2	Learning of Preparation of reagents and media for cell culture.						
CO3	Students will learn Quantification of cells						
CO4	Students will learn Cryopreservation of cell primary cultures and cell lines						

LIST OF EXPERIMENTS:

1. Packing and sterilization of glass and plastic wares for cell culture.
2. Preparation of reagents and media for cell culture.
3. Primer culture technique chicken embryo fibroblast.
4. Secondary culture of chicken embryo fibroblast.
5. Quantification of cells by trypan blue exclusion dye.
6. Isolation of lymphocytes and cultivation of lymphocytes
7. Study of effect of toxic chemicals on cultured mammalian cells
8. Study of effect of virus on mammalian cells.
9. Cryopreservation of cell primary cultures and cell lines.

Text Books:

1. Culture of Animal Cells – a manual of basic techniques 4th Edition. Freshney, R. I. (2000) John Wiley & Sons, New York.

References:

1. Animal Cell Biotechnology. Spier, R. E. and Griffiths, J. B. (1988) Academic Press.
2. Living resources for biotechnology: Animal Cells. Doyle, A.; Hay, R. and Kirsop, B. E. (1990) Cambridge University Press.
4. Portner R. 2007. Animal Cell Biotechnology. Humana Press.

BTE-314 L	Plant Cell Culture Lab (B.Tech. Biotechnology Semester VI)						
Lecture	Tutorial	Practical	Credit	Minor Test	Practical (Major Test)	Total	Time
-	-	3	1.5	40	60	100	3 Hrs
Purpose	To learn the Practical Aspects of Plant cell Culture lab						
Course Outcomes							
CO1	Student will learn basic sterilization and nutrient media preparation technique.						
CO2	Student will able to propagate rare and endangered plant species through direct and indirect methods						
CO3	To study somaclonal variations and somatic cell embryogenesis						
CO4	To study fidelity of in vivo and in vitro grown cell culture and applications.						

List of Experiments

1. Laboratory set up for plant cell tissue culture.
2. Preparation of culture media, Nutrients stock solutions and chelating agents.
3. Handling and sterilization of plant material.
4. Establishment of callus culture using different explants.
5. Inoculation and subculture for mass propagation of callus.
6. Callus development stages for somatic embryogenesis.
7. Direct plant regeneration from axillary nodes and nodal tissues.
8. Seed culture on MS media.
9. Isolation of plant genomic DNA using CTAB method.
10. Agrobacterium mediated gene transfer method for gene transfer.
11. Study of fidelity in direct and indirect method of culture (Somaclonal variations).
12. Application of using Plant cell culture in human scenario.

References

1. Plant Tissue Culture- Theory and Practice. Bhojwani ,S.S. and Rajdan ,M.K. (1996).Elsevier, Amsterdam.

BTE-316 L	Food and Environmental Biotechnology Lab (B.Tech. Biotechnology Semester VI)						
Lecture	Tutorial	Practical	Credit	Minor Test	Practical (Major Test)	Total	Time
-	-	3	1.5	40	60	100	3 Hrs
Purpose	To learn the practical aspects of food and environmental biotechnology						
Course Outcomes							
CO1	Students will microbiologically analyze different food samples.						
CO2	Students will learn to test the quality of water, waste water and milk						
CO3	Students will learn the technique of isolation and purification of bacteria from contaminated soil						
CO4	Students will explore the vermicomposting plant and learn the technique of vermicomposting and biogas formation						

List of LABORATORY EXPERIMENTS

(Any 10 experiments will be conducted depending upon the availability of chemicals and instruments)

A. Food Biotechnology:

1. Estimation of proteins in different food samples.
2. Microbiological analysis of food samples.
3. Estimation of viscosity in different liquids .
4 Testing of Milk and Milk Products- Testing the adulterants present in milk.
5. Assay of Vitamin c in juices.
6. Determination of pH and Moisture in food sample
7. Analysis of carbohydrates in various food products

B. Environmental Biotechnology:

8. Qualitative analysis of water/waste water:
9. Bacterial analysis of waste water.
10. Determination of hardness, alkalinity, Electrical conductivity, chlorides and pH.
11. Determination of soluble phosphates.
12. Determination of BOD and DO contents.
13. Decolourization of industrially important dyes by microbes.
14. Isolation of resistant Bacteria from soil containing pollutants .
15. Visit to Vermicomposting Plant .

Text Books:

1. Microbiology- A laboratory manual. 4th edition. Cappuccino J. and Sheeman N. (2000) Addison Wesley, California.
2. Environmental Microbiology – A Laboratory Manual Pepper. I.L.; Gerba, C.P. and Brendecke, J.W.(1995) Academic Press, New York.

Reference Books:

1. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. and Krieg, N.R. (1993) Tata McGraw Hill, New Delhi

2. Experiments in Microbiology, Plant Pathology and Biotechnology. 4th Edition. Aneja, K.R.

(2003) w Age International Publishers, New Delhi.

3. Manual of Industrial Microbiology and Biotechnology. 2nd Edition. Ed. Arnold L. Demain and Julian E. Davies (1999) ASM Press Washington D.C.

OEC-BT-302	Nano Biotechnology (B.Tech. Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	-	-	3.0	75	25	100	3 Hrs.
Purpose	To familiarize the students about different aspects of Nano Biotechnology.						
Course Outcomes							
CO1	Students will learn about Nano biotechnology and different characterization techniques						
CO2	Students will be able to understand about basics of BioMEMS and different advancements in sensors						
CO3	Students will learn about different types of nanomaterials						
CO4	Students will have clear idea about different applications of nanotechnology in life science						

UNIT-I

1. **Introduction to Nanotechnology:** Definition of Nano biotechnology, A brief history of the Super small, Bottom-up versus top-down, discussion on nanofabrication, nanolithography, Nano biotechnology, Structure property relations in materials, materials characterization techniques, microelectronic fabrication, scanning tunneling and atomic force microscopy, Biomolecule-surface interactions, DNA microarrays.

UNIT-II

2. **BioMEMS**: Introduction and overview, biosignal transduction mechanisms. Electromagnetic transducers: basic sensing mechanisms, basic actuating mechanisms. Case studies in biomagnetic sensors. Mechanical transducers: basic sensing mechanisms, basic actuating mechanisms. Case studies in microfluidic devices. Chemical transducers: basic sensing mechanism, basic actuating mechanism, ultimate limits of fabrication and measurement. Recent developments in BioMEMS.

UNIT-III

3. **Nanomaterials:** Buckyballs and buckytubes, fluidics, manufacturing, diagnostics and sensors, nanobiosensors, Fullerenes, Carriers, Dendrimers, nanoparticles, membrane/matrices, nanoshells, quantum dot nanocrystals, nanotubes and hybrid biological/ inorganic devices.

UNIT-IV

4. **Applications of nanotechnology in the life science:** Leading applications of nanobiotechnology: drug delivery. Bioavailability, sustained and targeted release, nanorobots. Benefits of nano drug delivery. Drug delivery using nanocrystals, drug discovery using Resonance Light Scattering (RLS) technology, rapid ex-vivo diagnostics, benefits of nano-imaging agents, nanoscale biosensors, nanosensors, nanosensors as diagnostics, nanotherapeutics

References Books

1. Unbounding the future by K Eric Drexler, C.Pelerson, G.Pergamit Willaim Marrow and Company, 1993

2. Biological molecules in Nanotechnology By Stephen Lee and Lynn M Savage, 2004

3. Nanotechnology By mark Ratner and Dan Ratner, Prentice Hall, 2005.

OEC-BT-318	Introduction to MEMS (B.Tech. Biotechnology Semester VI)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs.
Purpose	To familiarize the students with the Basics of MEMS system.						
Course Outcomes							
CO1	The students will be able to understand the operation of Micro and Nano scale devices						
CO2	Able to learn about applications and technologies used to fabricate MEMS.						
CO3	Able to analyze the simple devices using relevant mechanical/electrical engineering principles.						
CO4	Able to build simple system.						

UNIT -I

Introduction: micro- and nano-scale size domains; scaling of physical laws; MEMS materials and processes; MEMS devices and applications

UNIT -II

Introduction to Submicron Technology: semiconductor materials; photolithography; doping; thin film growth and deposition; CVD and Ion Implantation, metallization; wet and dry etching; silicon micromachining; metal MEMS processes; submicron optical lithography; electron beam lithography; soft lithography and printing.

UNIT-III

MEMS Sensors and Actuators: mechanics including elasticity, beam bending theory, membranes/plates; micro actuators based on various principles, electrostatic, electromagnetic, piezoelectric and SMA; actuator applications e.g. inkjet, electrical and optical switching; physical sensors e.g. acceleration, strain, flow; chemical sensors.

UNIT-IV

Microfluidics: transport in micro-channels; microfluidic components (filters, mixers, valves, and pumps) Bio-Nano (Materials and processes for BioMEMS, Applications: μTAS, Biochips)

Reference Books

Foundations of MEMS, Chang Liu, Prentice Hall (2006)

Fundamentals of Micro fabrication, Marc Madou, CRC (2002)

Introduction to BioMEMS – Albert Folch, CRC (2012)

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus

OEC-BT-320	Non-Conventional Energy Resources (B.Tech. Biotechnology Semester VI)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	-	-	3	75	25	100	3 Hrs
Purpose	To familiarize the students with the Basics of Non –Conventional Energy Resources.						
Course Outcomes							
CO1	The students will be able to explain the classification of NCES						
CO2	Able to learn about different aspects of solar energy						
CO3	Able to understand the different aspects of wind energy.						
CO4	Able to learn about principles of ocean thermal energy conversion						

UNIT – I

Statistics on conventional energy sources and supply in developing countries, Definition Concepts of NCES, Limitations of RES, Criteria for assessing the potential of NCES. Classification of NCES – Solar, Wind, Geothermal, Bio-mass, Ocean Energy Sources, comparison of these energy sources.

UNIT – II

Solar Energy-Energy available form Sun, Solar radiation data, Solar energy conversion into heat, Flat plate and Concentrating collectors, Mathematical analysis of Flat plate collectors and collector efficiency, Principle of Natural and Forced convection, Solar engines-Stirling, Brayton engines, Photovoltaic, p-n junction, solar cells, PV systems, Stand-alone, Grid connected solar power satellite.

UNIT – III

Wind energy conversion, General formula -Lift and Drag- Basis of wind energy conversion: Effect of density, frequency variances, angle of attack, and wind speed. Windmill rotors Horizontal axis and vertical axis rotors. Determination of torque coefficient, Induction type generators- working principle.

UNIT – IV

Introduction, wave motion, wave energy and power, wave patterns, devices, the causes of tides, enhancement of tides flow power, tidal range power, world range power sites, problems.

Principles of Ocean Thermal Energy Conversion (OTEC), heat exchangers, pumping requirements, other practical considerations, introduction to geothermal energy, geophysics, dry rock and hot aquifer analysis, harnessing geothermal resources, problems.

Reference/Text Books:

1. B.H KHAN, "NON-Conventional Energy Resources, McGraw Hill
2. D.Y. Goswami, F. Kreith and J.F. Kreider, "Principle of Solar Engineering", Taylor and Francis, 2000.
3. Sukhatme S.P., "Solar Energy", Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1994.
4. J.F. Kreider, F. Kreith, "Solar Energy Handbook", McGraw Hill, 1981
5. J.A. Duffie and W.A. Beckman, "Solar Engineering of Thermal Processes", John Wiley, 1991.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus

OEC-BT-322	Introduction to Art and Aesthetics (B.Tech. Biotechnology Semester VI)						
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
3	-	-	3	75	25	100	3 Hrs.
Purpose	**To familiarize the students with the Basics of Philosophy of Art and Aesthetics.**						
Course Outcomes							
CO1	**The students will be able to explain importance of art in human life.**						
CO2	**Able to explain the concept of aesthetics and beauty.**						
CO3	**Able to explain the concept of taste and Kant's theory of taste.**						
CO4	**Able to understand the concept of interpretation of literature.**						

UNIT-I

Introduction: Definition of Art? History and nature of the fine arts and the production of art. Different types of arts. Importance of arts in Human life. The modern system of the Art. Expression of art. Languages of Arts. Key issues in philosophy of art.

UNIT –II

Aesthetics: Definition, nature and historical development of Aesthetics experience, what is beauty? Restoration of Beauty. The concept of Sublime and the experience of nature. Origin of idea of beautiful. Importance of environmental aesthetics.

UNIT-III

Taste and aesthetics: Concept of Taste, relationship between taste and aesthetics, Kant's theory of Taste, Hume's standard of Taste, depiction and nature of representation in pictures and photographs, transparent picture.

UNIT-IV

Deception: Philosophical view, concept of music and emotional expression. Production and interpretation of literature, concept of black aesthetics, relationship between politics and black art. An aesthetics adventure.

References Books:

Kristeller, P. O. [1951,78] 'The Modern System of the Arts' selections reprinted in *Aesthetics: A Comprehensive Anthology*. (S. M. Cahn & A. Meskin Eds.). Malden, MA: Blackwell, (2008). pp. 3-15.

Abell, C. (2012) 'Art: What it Is and Why it Matters', *Philosophy and Phenomenological Research*, 85(3), pp. 671–691.

Carrol, N. (2006) 'Aesthetic Experience: A question of Content' in Kieran, M.

Aesthetics and the Philosophy of Art. Malden, MA: Blackwell. pp.

Costelloe, T. M. (2013). *The British Aesthetic Tradition: From Shaftesbury to Wittgenstein*. Cambridge: Cambridge University Press.

Guyer, P. (2005). The Origins of Modern Aesthetics: 1711-1735 *Values of Beauty: Historical Essays in Aesthetics* (pp. 3-36). Cambridge: Cambridge University Press.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus

BS-141 Biology

BT	Biology						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time Hrs.
2	1	-	3	75	25	100	3
Purpose	To familiarize the students with the basics of Biology and Biotechnology						
Course Outcomes							
CO1	Introduction to Living world, Cell & Organisms.						
CO2	Introduction to Biomolecules and Biocatalyst						
CO3	Introduction of basic Concept of Genetics & immune system						
CO4	Introduction of basic Concept of Genetic Engineering, Biochemistry & Role of Biology in Different Fields						

Unit – I

Introduction to living world: Concept and definition of Biology; Importance of biology in major discoveries of life Characteristic features of living organisms; Cell ultra-structure and functions of cell organelles like nucleus and endoplasmic reticulum. Difference between prokaryotic and eukaryotic cell. Difference between animal and plant cell.

Classification of Organisms: Classify the organisms on the basis of Cellularity Unicellular and Multicellular organisms. Energy and Carbon Utilization- Autotrophs, Hetrotrophs and Lithotrops. Nitrogen Excretion:- Ammonotelic, Uricotelic and Ureotelic. Habitat- Acquatic & Terrestrial.

Unit-II

Introduction to Biomolecules: Definition, general classification and important functions of carbohydrates, lipids, proteins, nucleic acids & Enzymes.

Enzymes as Biocatalysts: General characteristics, nomenclature and classification of Enzymes. Effect of temperature, pH, enzyme and substrate concentrations on the activity of enzymes. Elementary concept of and coenzymes. Mechanism of enzyme action.

Unit-III

Genetics:-Mendel's laws of inheritance. Variation and speciation. Concepts of recessiveness and dominance. Genetic Disorders: Single gene &Multiple genes disorders in human.

Human Traits: Genetics of blood groups, Diabetes Type I & II.

Role of immune system in health and disease: Brief introduction to morphology and pathogenicity of bacteria, fungi, virus, protozoa beneficial and har mful for human beings.

Unit-IV

Concepts of Genetic Engineering: Definition; Tools used in recombinant DNA Technology: Enzymes, Vectors & Passenger DNA.

Catabolism: Glycolysis and Krebs cycle, Photosynthesis:- Light and Dark Reaction. Concept of Exothermic and endothermic reactions

Role of Biology: Role of Biology in Agriculture, Medicine, Forensic science, Bioinformatics, Nanotechnology, Bio-MEMS and Biosensors.

Text Book:

1. Introduction to Biotechnology, By Deswal & Deswal, Dhanpat Rai Publications N.A
2.Campbell, J. B. Reece, L. Urry, M. L. Cain and S. A. Wasserman, "Biology: A global approach", Pearson Education Ltd, 2014.
3. E. E. Conn, P. K. Stumpf, G. Bruening and R. H. Doi, "Outlines of Biochemistry", John Wiley and Sons, 2009.
D. L. Nelson and M. M. Cox, "Principles of Biochemistry", W.H. Freeman and Company, 2012.
4.G. S. Stent and R. Calendar, "Molecular Genetics", Freeman and company, 1978.

Note: The paper setter will set the paper as per the question paper templates provided

Suggested Books:

1. Molecular Biology of cell, 4th ed. Alberts, Bruce et al. Garland Science Publishing, New York.
2. Microbiology. Pelczar Jr., M.J.; Chan, E.C.S. and Krieg, N.R. Tata McGraw Hill, New Delhi.
3. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox. Maxmillan/ Worth publishers.
4. Genetics by Snusted& Simmons.
5. Molecular Biotechnology: Principles Application of Recombinant DNA. Glick, B. R. and Pasternak, J. J. ASM press
Washington DC.
6. Kuby's Immunology, Goldsby, R A,.Kindt, T.J, Osborne, B.A.(2003) W. H. Freeman and company, New York.
7. Recombinant DNA 2nd Edition. Watson, James D. and Gilman, M. (2001) W.H Freeman and Company, NewYork

Bachelor of Technology (Biotechnology)
Credit-Based
SCHEME OF STUDIES/EXAMINATIONS
Semester – VI

S. No.	Course No.	Course Title	Teaching Schedule				Credits	Allotment of Marks				Duration of Exam (Hrs.)
			L	T	P	Hours/ Week		Major Test	Minor Test	Practical	Total	
1	OEC-II		3	0	0	3	3.0	75	25	0	100	3
2	BTE-304	Plant Biotechnology	3	0	0	3	3.0	75	25	0	100	3
3	BTE-306	Animal Biotechnology	3	0	0	3	3.0	75	25	0	100	3
4	BTE-308	Food Biotechnology	3	0	0	3	3.0	75	25	0	100	3
5	BTE-310	Environmental Biotechnology& Engineering	3	0	0	3	3.0	75	25	0	100	3
6	HM-902	Business Intelligence & Entrepreneurship	3	0	0	3	3.0	75	25	0	100	3
7	BTE-312	Animal Cell Culture Lab	0	0	3	3	1.5	0	40	60	100	3
8	BTE-314	Plant Cell Culture Lab	0	0	3	3	1.5	0	40	60	100	3
9	BTE-316	Food & Environmental Biotechnology Lab	0	0	3	3	1.5	0	40	60	100	3
		Total	**18**	**0**	**9**	**27**	**22.5**	**450**	**270**	**180**	**900**	

Note: All the students have to undergo 4-6 weeks industrial training after VI semester and it will be evaluated in VII semester.
The students should select two open Elective Courses (OEC) from the following list.
The course of both Program Elective and Open Elective will be offered at 1/3rd strength or 20 students (whichever is smaller) of the section.

Course No.	OEC-II		Course No.	OEC-II
OEC-BT-302	Nano Biotechnology		OEC-BT-322	Introduction to Arts & Aesthetics
OEC-BT-318	Introduction to MEMS		MOOC-2	Anyone MOOC through SWAYAM
OEC-BT-320	Non Conventional Energy Resources			

SEMESTER- II

S. No.	Course Code	Subject	L	T	P	Total	Minor* Test	Major Test	Practical	Cr.	Duration of Exam (Hrs.)
1	MTBT-102	Drug Discovery and Development	3	-	-	3	40	60		3	3
2	MTBT-104	Medical Biotechnology	3	-	-	3	40	60		3	3
3	*	Program Elective-III	3	-	-	3	40	60		3	3
4	**	Program Elective-IV	3	-	-	3	40	60		3	3
5	MTBT-118	Molecular Techniques Lab		-	4	4	40		60	2	3
6	MTBT-120	Advanced Molecular Techniques. Lab	-	-	4	4	40		60	2	3
7	# MTBT-122	Mini Project	-	-	4	2	100	-	-	2	3
8	***	Audit Course-II	2			2	100			0	3
	Total		**14**		**12**	**24**	**340**	**240**	**120**	**18**	**3**
								700			

*Program Elective -III		**Program Elective -IV	
Course No.	**Subject**	**Course No.**	**Subject**
MTBT-106	Metabolic Engineering	MTBT-112	Biomedical Equipments
MTBT-108	Biofuel Technology	MTBT-114	Gene Therapy and Gene Editing
MTBT-110	Advanced Industrial Biotechnology	MTBT-116	Metagenomics

*** Audit Course - II	
MTAD-102	Constitution of India
MTAD-104	Pedagogy Studies
MTAD-106	Stress Management by Yoga
MTAD-108	Personality Development through Life Enlightenment Skills.

#4. **Mini project:** During this course the student will be able to understand the contemporary/emerging technologies for various processes and systems. During the semester, the students are required to search/gather the material/information on a specific topic, comprehend it and present/discuss the same in the class. He/she will be acquainted to share knowledge effectively in oral (seminar) and written form (formulate documents) in the form of report. The student will be evaluated on the basis of viva/ seminar (40 marks) and report (60 marks).

Note: 1.The course of program elective will be offered at 1/3rd or 6 numbers of students (whichever is smaller) strength of the class.

2. *** Along with the credit course, a student may normally be permitted to take audit course, however for auditing a course; prior consent of the course coordinator of the course is required. These courses shall not be mentioned for any award/calculation of SGPA/CGPA in the DMC. A certificate of successful completion of the audit course will be issued by the Director/Head of institution.

3. Students be encouraged to go to Industrial Training/Internship for at least 6-8 weeks during the summer break with a specific objective for Dissertation Part–I (MTBT-203). The industrial Training/Internship would be evaluated as the part of the Dissertation Part–I (with the marks distribution as 40 marks for Industrial Training/Internship and 60 marks for Dissertation work).

BTE-401	Bioinformatics (B.Tech. Biotechnology Semester VII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	-	3	75	25	100	3 Hrs.
Purpose	To familiarize the students with the basics of Bioinformatics						
Course Outcomes							
CO1	Students will learn basic principles of various types of databases						
CO2	Students will come to know about various tools related to sequence alignment and statisticalsignificance of alignment						
CO3	This unit will enable the students to learn various software tools for sequence analysis and primerdesigning						
CO4	Students will be able to learn predictive methods for nucleotides and protein sequence analysis						

UNIT I

1. **Databases**

   a. Sequence Databases: introduction of Databases, primary and secondary databases, nucleotide and protein sequence databases: Genbank, EMBL, DDBJ, Swissprot, pfam, Block,PRI

   b. Structure Databases: Introduction to structures. PDB (Protein Data bank) Molecular Modeling database at NCBI. , visualizing structural information, database structureviewers.

   c. Sequence and Structure File Formats

2. **The Entrez system**: Integrated information axis, Information retrieval from biological database, sequence database beyond NCBI. Medicaldatabases.

UNIT II

3. **Sequence Alignment AND Database Searches**

   Introduction, the evolutionary basis of sequence alignment, Type of Aligmnents, Pair-wise Alignment, Multiple Alignment, The modular nature of proteins, Optimal alignment methods, substitution scores and gap penalties, statistical significance of alignment. FASTA, BLAST, low-complexity regions, repetitive elements, Tool of multiple sequence alignment: CLUSTAL W/X, progressive alignment method.

4. **PhylogeneticAnalysis:**

Elements of phylogenetic models, phylogenetic data analysis: alignment, substitution model building, tree building and tree evaluation, building the data model (alignment), determining the substitution model, tree- building methods, searching for trees, rooting trees, evaluation trees and data, phylogenic software (PHYLIP). Phylogenetic online tool.

UNIT III

Sequence Analysis Using Software Resources:

Introduction. The Wisconsin package, the Seq Lab environment, analyzing sequences with operations and Wisconsin package programmes, viewing output, monitoring programme progress and troubleshooting problems, annotating sequences and graphically displaying annotations in the Seqlab Editor, saving sequences in the Seq Lab Editor, Example of analysis that can be undertaken in Seqlab, extending Seqlab by including programmes that are not part of the Wiscosin package.

Plasmid Mapping and PrimerDesign

Restriction mapping, Mac Vector and OMIGA. Gene construction kit. Vector NTI, primer design for PCR Sequencing, primer design programs andsoftware.

UNIT IV

Predictive Methods using nucleotide sequences: Predictive methods using nucleotide sequences: Introduction, Gene prediction methods, Computational gene prediction in eukaryotes. Gene prediction programs: GRAIL, GeneID, GENSCAN, GENMARK, detecting functional sites in the DNA: Promoters, Intron Splice Sites, and Translation InititionSite.

Predictive methods using protein sequences: protein identity based on composition, physical properties based on sequence, secondary structure and folding classes, specialized structures or features, tertiary structure. Prediction of protein secondary and tertiary structures. Relatedsoftware.

Reference/Text Books-

Bioinformatics by Andreas D.Boxevanis. Wiley Interscience,4th edition 2020.

Bioinformatics: Sequence and genome analysis by David W.Mount, Cold Spring Harbor,2004.

Biocomputing Informatics And The Genome Projects by Smith D.W., Academic Press,2014.

Bioinformatics: A Biologists Guide to Computing and the Internet. by Stuart M. Brown, NKU Medical Center, NY USA,2000.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-403	Pharmaceutical Biotechnology (B.Tech. Biotechnology Semester VII)						
Lecture	Tutorial	Practical	Credit	Minor Test	Major Test	Total	Time
3	0	-	3	25	75	100	3 Hrs
Purpose	To learn various aspects of pharmaceutical biotechnology						
Course Outcomes							
CO1	tudents will learn the procedure for discovery and development of drugs						
CO2	Students will be able to understand the metabolism of drug in the body and effects of drug on the human body						
CO3	Students will learn the basic concepts involved in the preparation of various drugs and their formulations						
CO4	Students will understand the management of different Life Style Diseases and know the procedure of Quality control and assurance.						

UNIT-I

1.Introduction and Different Disciplines of Pharmacy

2. Historical Background and NewDrug Discovery and Development – Preclinical and Clinical trials of drugs. Pharmacogenomics, Types of Drug receptors.

UNIT-II

3.Pharmacokinetics andPharmacodynamics: Drug Bioavailability, Consideration in dosage form design, route of administration (oral, parental, inhalations, topical) Basic Principle of Drug Absorption, Distribution, Metabolism and Excretion.

4. Radiopharmaceuticals and Nanopharmaceuticals- Therapeutic applications of radioisotopes, Applications of Nano technology in Pharmaceuticals.

UNIT-III

5. Basic concepts involved in the preparations of different Drugs and their Dosage forms.Solid Dosage Forms- Tablets , Capsules, Powders , Semisolid Dosage Forms - Creams, Ointments, Pastes, lotions, Liquid Dosage Forms like Mixtures, Solutions, Emulsion, Ophthalmic etc.

6.Additives and Excipients used in drug formulations- Colors , flavours, sweeteners, binders, Disintegrating agents and other additives used in prescriptions.

UNIT- IV

7. **Management of Life style diseases** like obesity, diabetes, B.P., cholesterol heart stroke and cancer, joint problems etc. Neutraceuticals: Sources, Types, Potential Benefits, Role in prevention and control.

8. **Pharmaceutical products and their Types**
Laxatives, Analgesics, Antiseptics, Antacids, Antibiotics.

9. **Quality control and assurance**- GMP, GLP, ISO- 9000, validation and Drug Regulatory affairs

Reference/Text Books:

1. Principles of Medicinal Chemistry Vol. 1 Dr. S.S.Kadam, Dr. K.R. Mahadik, Dr. K.G.Bothara
2. Principles of Medicinal Chemistry Vol. 1 Dr. S.S.Kadam, Dr. K.R. Mahadik, Dr. K.G.Bothara
3. Pharmaceutical Dispensing.(2010) Pratibha Anand and Roop K. Khar. CBS Publishers and Distributors Pvt. Ltd.
4. R. M. Mehta, "*Dispensing Pharmacy*", Vallabh Prakashan, New Delhi.
5. Brahmankar, CBS Publishers.
6. Lipin Cott's Illustrated Reviews Pharmacology. Richard Maria, Pamela, Mary, Sheldon .
7. Cooper and Guunn's, *"Dispensing for Pharmaceutical Students"*, CBS Publishers, Delhi
8. A Owunwonne, *"Hand Book of Radiopharmaceuticals"*, Narosa Publishing House, New Delhi.
9. H C Ansel, *" Introduction to Pharmaceutical Dosage Forms"*, K M Varghese& Co., Mumbai.
10. S.N.Pandeya: A Textbook of Inorganic Medicinal Chemistry, S.G.Publishers, Varanasi.
11. Clarke, E. C. G., "*Isolation and Identification of Drugs*", The Pharmaceutical Press, London

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with thesyllabus.

411							
Lecture	**Tutorial**	**Practical**	**Credit**	**Major Test**	**Minor Test**	**Total**	**Time**
2	1	-	3	75	25	100	3Hrs
Purpose	**To familiarize the students with basic and applied aspects of Biosensors and Bioinstrumentation**						
Course Outcomes							
CO1	**To familiarize with basic concepts of general properties of transducers and other analytical instruments**						
CO2	**Students will come to know about bioassay design and implementation and basic concepts of automation and robotics**						
CO3	**This unit will enable the students to learn about data retrieval, handling and integration of databases and basics of human cardiac and vascular system**						
CO4	**Students will be able to know the basic concepts and applications of various types of biosensors**						

UNIT – I

1. **Introduction:** Electrical quantities and units, functional elements of an instrumentation system, static and dynamic characteristics, principle of analog and digital meters, CRO, energy meters, time and frequency meters, multimeters.
2. **Transducers**: Classification, resistive strain gauges, RTD, LVDT, Piezoelectric transducers, Electromagnetic transducers, Optical transducers, Transducers for biomedical science and their applications.
3. **Analytical Instruments:** pH meters, radiometric devices, fluorescence spectrophotometers, chromatology (chromatographic techniques- GC and HPLC), electrophoresis, lab on a chip – related instrumentation, Validation, commissioning and maintenance of the above equipments.

UNIT-II

4. **Assay Technologies and Detection methods:** Introduction, bioassay design and implementation, radiometric assay, scintillation proximity assay, fluorescence methodology to cover all types of fluorescence measurements and instrumentation, Reporter gene assay applications. Bio-analytical applications.
5. **Automation and Robotics:** Introduction: management and services issues of a centralized robotics HTS (high throughput screening) core, flexible use of people and machines, Bar-code technology and a centralized database, factors for the successful integration of assays, equipment, robotics and software. Perspectives on scheduling.

UNIT-III

6. **Data retrival, handling and integration:** Database systems, systems integration, data management and tracking

7. **Cardiac and Vascular system:** Overview of cardiovascular system, types of blood pressure sensors, Lumped parameters modeling of a catheter- sensor/system, heart sounds, cardiac catheterization, indirect measurement of blood pressure, measuring blood flow rate, measuring blood volume, pacemakers, defibrillators, cardiac-assist devices and heart valves- related instrumentation of equipments and involved sensors.

8. **Respiratory system**: Modeling the respiratory system, measuring gas flow rate and lung volume, tests of respiratory mechanics, measuring gas concentration, tests of gas transport, ventilators, anesthesia machines- related instrumentation of equipments and involved sensors.

UNIT-IV

9. **Biosensors:** Introduction to biosensors: concepts and applications, biosensors for personal diabetes management, micro fabricated sensors and the commercial development of biosensors, electrochemical sensors, chemical fibrosensors, Ion-selective FETs, non-invasive blood-gas monitoring, blood-glucose sensors. Noninvasive biosensors in clinical analysis, Applications of biosensors based instruments to the bioprocess industry. Applications of biosensors to the environmental samples, Introduction to biochips and their application to genomics, BIA core- an optical biosensors

Reference Books

1. M. K.Sezgintürk. Commercial Biosensors and their applications: Clinical, Food and Beyond. Elsevier. 2020.
2. G. Dutta, A. Biswas and A. Chakrabarti. Modern Techniques in Biosensors: Detection Methods and Commercial Aspects. Springer. 2021.
3. Introduction to Bio-analytical Sensors by Alice J Cunningham New York, John Wiley, 1998.
4. Applied Biosensors by DolandL.Wise, 1989
5. Advances in Laboratory Automation – Robotics, Eds. J.R.Strimataitis and J.N. Little, Zymark Corporation, Hopkinton, MA 1991.
6. Instrument methods of analysis by H W Willard, L LMerrit, J A Dean and F ASttle. 6/e, East- West publishers. 1992.
7. Biosensors and their applications by C Yang Victor and TNgo That, Plenum Press NY, 2000

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with thesyllabus.

BTE-413	DEC-I * Biochipsand Microarray Technology (B.Tech. Biotechnology Semester VII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	-	3.0	75	25	100	3 Hrs.
Purpose	The purpose of this course is to familiarize the students with different array techniques						
Course Outcomes							
CO1	To familiarize with basic concepts of biochips and microarray technology						
CO2	Students will be able to understand about RNA and Protein Chips and electrical detection methods for microarrays						
CO3	This unit will enable the students to learn about applications of biochip technology in various fields						
CO4	Students will be able to know the commercial aspects of biochip technology and DNA computing						

UNIT -1

1. **Introduction**: Basics of biochips and microarray technology, historical development of biochip technology .Why are Microarray important.

2. **Biochip and Microarray construction**: DNA microarrays, oligonuleotide, cDNA and genomics microarrays, microchip production technologies, megaclone technology for fluid microarray labels, microarray scanners./headers, microarray robotics. Microfluidics systems, chips and mass spectrometry.

UNIT- II

3. **Biochip and Microarray construction (Continued)**: Biochips, microarrays, Chromosome on a chip, tissue chip, RNA chip, Protein chip technology, glycochips, biochips assays, combination of microarray and biosensor technology, biochip versus gel-based methods, process flow for production and analysis of a chip, standardization of microarray analysis, bioinformatics and microarrays, integrated biochip system, evaluation of conventional microarray technology. Electrical detection methods for microarrays, SERS (Surface-Enhanced Raman spectroscopy)-based microarrays.

UNIT- III

4. **Applications of Biochip Technology:** Molecular diagnostics and pharmacogenomics, Application of microarray technology in drug discovery and development, Gene expression studies, use of DNA chip technology for drug safety, use of microchips for drug delivery, biochips as neural prostheses, use of biochips in health care, use of microarrays in population genetics and epidemiology, use of microarray in forensics. DNA chip technology for water

quality management, Bioagent chip, Application of microarray in the agro-industry, use of microarray in genetic disease monitoring, point of care (POC) applications.

UNIT -IV

5. **Commercial aspects of Biochip technology:** Markets for biochip technologies, commercial support for the development of biochips, government support for biochip development, business strategies and patent issues

6. **DNA Computing:** Introduction, junctions, other shapes, biochips and large-scale structures. Discussion of Robinson and Kallenbach's methods for designing DNA shapes, DNA cube. Computing with DNA, Electrical analogies for biological circuits.Challenges and future trends. Gene ontology and pathway analysis

Reference/Text Books-

1. Arun Jogota, "Microarray Data Analysis and Visualization", The Bay Press, 2001.
2. Ernst Wit and John McClure, "Statistics for Microarrays Design", Analysis and Inference, John Wiley & Sons, 2004.
3. Steen Knudsen, "Guide to analysis of DNA Microarray data", John Wiley & Sons, 2004.
4. Biochips and Microarrays-technology & Commercial Potential, Published by RCK Publishing, 2012.
5 DNA Arrays: Technology and Experimental strategies, Grigorenko(ed), CRC Press, 2002.
6. Microarray Analysis Mark Schena; J. Wiley & Sons (ed., New York), 2002.
7. Microarray Bioinformatics, Dov Stekel, Cambridge University Press, 2003.
8. Microarray Technology and Its Applications, Uwe R. Müller, Dan V. Nicolau, Springer, 2005.
9. DNA Microarrays: Current applications: Emanuele de Rinaldis, Armin Lahm,, Horizon Scientific Press, 2007.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

**** The students should select two Departmental Elective Courses (DEC-I)***

BTE-415	Enzyme Technology (B. Tech Biotechnology semester VII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	-	3.0	75	25	100	3 Hrs
Purpose	To familiarise students about different aspects of enzyme technology						
Course outcome: After completion of this course the students will be able							
CO1	To articulate advantages and disadvantages of enzyme based production processes.						
CO2	To compare different strategies used for protein engineering						
CO3	To explain the principles and parameters used for enzyme immobilization.						
CO4	To differentiate between solid state fermentation and submerged fermentation.						

UNIT I

Introduction to enzyme Technology: What are Biocatalysts? Bio- and Chemo catalysts – Similarities and Differences, Goals and Potential of Biotechnological Production Processes, The Use of Isolated or Intracellular

Enzymes as Biocatalysts, Advantages and Disadvantages of Enzyme-Based Production Processes, Goals and Essential System Properties for New or Improved Enzyme Processes, Essential System Properties for Rational Design of an Enzyme Process , Current Use and Potential of Enzyme Technology

UNIT-II

Enzyme Discovery and Protein Engineering: Enzyme Discovery, Strategies for Protein Engineering, Rational Protein Design, Directed (Molecular) Evolution

Methods to Create Mutant Libraries, Assay Systems, Focused Directed Evolution, Computational Design of Enzymes

UNIT-III

Immobilization of Enzymes: Principles, Parameters of Immobilization, Carriers

Inorganic Carriers, Polysaccharides, Synthetic Polymers, Binding Methods

Adsorption, Covalent Binding, Application of Immobilized Enzymes

Hydrolysis and Biotransformation of Carbohydrates, Amino Acid, Peptide Synthesis, Application of Lipases

UNIT-IV

Enzyme production and Purification: solid state fermentation, submerged fermentation, environmental factors affecting microbial enzyme production in SSF. Strategies to improve production of microbial cellulase.

Reference/Text Books

1. Klaus Buchholz, Volker Kasche, and Uwe T. Bornscheuer "Biocatalysts and Enzyme Technology" 2nd Edition, Wiley-Blackwell, 2012
2. M.Y Khan and Farah Khan " Principles of enzyme technology" PHI, 2015
3. Enzyme Technologies editors: Hsiu-Chiung Yang Wu-Kuang Yeh and James R. McCarthy, Wiley, 2014
4. "Biotechnology of Microbial Enzymes" Editor Goutam Brahmachari, Academic Press, 2017

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with thesyllabus.

BTE-417	Advanced Management Information system and Information Technology (B. Tech Biotechnology semester VIII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	0	3	75	25	100	3 Hour
Purpose	To familiarize the students with Management Information System.						
Course Outcomes After completion of this course the students will be able							
CO1	To Understand and articulate fundamental concepts of information technology management.						
CO2	To Assess and apply IT to solve common business problems.						
CO3	To Suggest and defend effective solutions to business problems, and design a database application to solve a business problem.						
CO4	To Discuss the ethical aspects of information technology use in the organization and its governance issues.						

UNIT I

Introduction: Definition information system, role and impact of MIS, The challenges of Information system, Nature of
MIS, Characteristics of MIS, Myths regarding MIS, Requirements of MIS, Problems & Solutions in implementing MIS, Benefits of MIS, Limitations of MIS, Significance of MIS, Components of MIS. Role of MIS, Major Management challenge to building and using information system in Organization, functions of management.

UNIT II

Information system and Organizations: The relationship between Organization and Information System, Information needs of different organization levels: Information concept as quality product, classification and value of information, methods of data and information collection. Strategic role of information system, Salient features of Organization, Information, management and decision making, How Organization affect Information Systems, How Information system affect Organization, Ethical and Social impact of information system.

UNIT III

Business application of Information System: Foundation Concepts Information systems in Business: Information system and technology, Business Applications, Development and Management. The internetworked E-business Enterprise: Internet, and Extranet in business. Electronic Commerce System: Electronics commerce Fundamentals, Commerce Application and issues. E-business Decision Support: Decision support in E-Business, Artificial Intelligence Technologies in business.

UNIT IV

Strategic and Managerial Implications of Information Systems: Strategic Information System: Introduction, Characteristics of Strategic Information Systems, Strategic Information Systems (SISP), Strategies for developing an SIS, Potential Barriers to developing a Strategic Information System (SIS), Decision Support System (DSS): Decision making concepts, methods, tools and procedures. Managing Information Resources: Introduction, IRM, Principal of Managing Information Resources, IRM functions, Computer Security: Introduction, Computer Security, Types of Computer Security, Disaster Recovery Plan.

Reference/Text Books:

1. W.S . Jawadakar, "Management Information System", McGraw Hill ,
2. J. O. Brien, " Management Information System", TMH, New Delhi
3. Uma G . Gupta, "Management Information System" Fifth Edition TMH.
4. Kenneth C. Laudon, "Management Information System Organisation and Technology" TMH.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with thesyllabus.

BTE-419	Stem Cell Technology(B.Tech. Biotechnology) Semester- VII						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	0	3	75	25	100	3
Purpose	The objective of this course is to enable students to understand the principles of stem cells, their isolation and maintenance and their application in different therapies						
Course Outcomes							
CO1	Students will be able to differentiate among the different types of stem cells						
CO2	Students will be able to explain the concept of stem cell cloning						
CO3	Students will be able to compare the isolation and maintenance methods for different type of stem cells						
CO4	Students will be able to recognize the applications of stem cells in different diseases						

UNIT I

Introduction: Basic concepts and properties of Stem cells, Totipotency and Pluripotency, Types of stem cells: Embryonic stem cells, germinal stem cells, Adult stem cells, Tumor stem cells.

UNIT II

Molecular Cell Biology and Cloning: Molecular mechanisms, Cell cycle regulation in stem cells. Stem cell niches, Stem cell lineage tracing

Therapeutic and reproductive cloning, Nuclear Transfer method, Application of nuclear transfer derived embryonic stem cells.

UNIT III

Stem Cells maintenance and transplant: Sources of stem cells; Cell types for transplantation: Bone marrow, Peripheral stem cells, cord blood stem cells

General methods of Isolation, Identification, Characterization and maintenance of different stem cells: Embryonic stem (ES) cells, Hematopoietic Stem Cells (HSC), Hematopoietic Stem Cells (HSC), Differentiation studies of Mesenchymal stem cells, Neural stem cell and Neural crest stem cell.

UNIT IV

Stem cells and Therapy Cell based therapy, organ factories, drug discovery and development, Medical applications in Leukemia, Immune deficiencies, diabetes, liver diseases, cardiovascular diseases, Neurological disorders

Reference/Text Books

1. Anthony Atala, Robert Lanza. Essentials of Stem Cell Biology. Netherlands: Elsevier/Academic Press, 2014.
2. Atala A & Lanza R, Stem Cells Handbook. Netherlands: Springer New York, 2013.
3. Satish Totey and Kaushik D. Deb. Stem Cell Technologies: Basics and Applications (McGraw-Hill, 2010).
4. Robert A. MeyersStem Cells: From Biology to Therapy (Current Topics from the Encyclopedia of Molecular Cell Biology and Molecular Medicine), 2013

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with thesyllabus.

BTE-421	Herbal Drug Technology (B. Tech. Biotechnology Semester VII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	0	3	75	25	100	3 Hrs.
Purpose	To familiarize the students with basic and applied aspects of Herbal Drug Technology						
Course Outcomes							
CO1	The contents of first unit will enhance the knowledge of students about traditional herbs and herbal medicine.						
CO2	Students will come to know about the basic concepts of various systems of medicine and traditional therapies						
CO3	This unit will learn the skills about technology for production of crude drugs.						
CO4	To familiarize with basic knowledge of use of herbs in the management of health. Students will learn about the economic aspects of herbs and herbal drugs						

UNIT I

Herbs as raw materials: Definition of herb, herbal medicine, herbal medicinal product, Common herbals and herbal medicines of India. Sources of Herbs Selection, Identification and authentication of herbal materials. The need for the study of herbs and herbal medicine.

UNIT II

Systems of Medicine : Evolution of systems of medicine, Traditional Therapies and Types of therapies– Ayurveda , Unani, eight chikitsas , eight chakras, Naturopathy, Homeopathy, Aromotherapy, Faith healing, Religious beliefs and Ethnotherapeutics .Concept of Holistic medicine. Ayurvedic Pharmacopoeia of India.

UNIT III

Technology for production of crude drugs:Herbal drug preparation. Processing of herbal raw material, Principles of extraction and different methods of extraction. Formulation and Standardization of herbal extracts. Stabilization and stability of herbal formulations.

UNIT IV

Health Benefits: Evolution of conscious use of plants in the management of health and disease General aspects, scope and types of products available in the market. Health benefits and role of herbs in ailments like Diabetes, CVS diseases, Cancer, and various Gastro intestinal diseases. Role of herbs in cosmetics.

Economic Aspects of Herbal Drugs:Economic value of herbs and herbal drugs, Databases on herbals and herbal drugs. Rescue and Preservation of traditional medicinal knowledge and herbals. Development of herbal medicine industry- Present Scope and future prospects.

Reference Books-

1. A lexicon of medicinal plants in India. D.N.Guhabakshi, P.Sensarma and D.C.Pal, 1999.Naya prakash - publications.
2. Glossary of Indian medicinal plants. R.N.Chopra, S.L.Nayar and I.C.Chopra,1956. C.S.I.R, New Delhi.
3. Ethnobotany The Renaissance of Traditional Herbal Medicine. Rajiv K. Sinha, 1996.Ina Shree publishers.
4. The indigenous drugs of India. Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
5. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
6. New Natural products and Plant drugs with Pharmacological, Biological (or) Therapeutical activity. H.Wagner and P.Wolff, 1979. Springer, New Delhi.
7. Ayurvedic drugs and their plant source. V.V.Sivarajan and Balachandran Indra, 1994. Oxford IBH publishing Co.
8. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1988. Banarsidass, Delhi.
9. Principles of Ayurveda. Anne Green, 2000. Thorsons, London.
10. Mukherjee, P.W. Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals. Business Horizons Publishers, New Delhi, India, 2002.
11. Pharmacopoeal standards for Ayurvedic Formulation (Council of Research in Indian Medicine & Homeopathy)

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

**** The students should select two Departmental Elective Courses (DEC-I)***

BTE-405	BIOINFORMATICS LAB (B.Tech. Biotechnology Semester VII)						
Lecture	Tutorial	Practical	Credit	Major Test (Practical)	Minor Test	Total	Time
-	-	3	1.5	60	40	100	3 Hrs.
Purpose	To familiarize the students with applied aspects of Bioinformatics						
Course Outcomes							
CO1	To familiarize with computer basics and searching of biological databases						
CO2	Students will come to know about data mining techniques						
CO3	To learn the concepts of phylogenetic analysis using bioinformatics software						
CO4	Students will be able to know the basic concepts of protein structure prediction						

List of Experiments:

1. Computer basics
2. Searching biological database for relevantinformation
3. Data mining techniques inBioinformatics.
4. Searching, retrieval and similarity analysis of biologicaldatabase.
5. Sequence retrieval from nucleic acid and proteindatabase.
6. Restrictionmapping
7. Sequence (FASTA & BLAST)searches.
8. Pair wise comparison ofsequences.
9. Evolutionary studies/ Phylogenicanalysis.
10. Identification of genes ingenomes.
11. Protein databank retrieval andvisualization.
12. Superposition ofstructures.
13. Secondary structure prediction ofproteins.
14. Pattern searching in nucleicacids.
15. Validation of 3Dstructures.

Reference/Text Books-

Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins by Andreas D. Baxevanis and B.F.Francis Ouellette, 4th Edition, A John Wiley and Sons, Inc. Publications,2020.

Bioinformatics: Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor,2004.

Biocomputing Informatics andthe Genome Projects by Smith D.W., Academic Press,2014.

BTE-402	Biocatalysis & Biotransformation (B.Tech. Biotechnology Semester VIII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	-	3.0	75	25	100	3 Hrs
Purpose	To familiarize the students with Concepts of Biocatalysis and Biotransformation						
Course outcome	After completion of this course the students will be able						
CO1	To articulate the concept of Biocatalysis and Biotransformation.						
CO2	To differentiate between different strategies for production of succinic acid.						
CO3	To explain the mechanism of pesticide transformation.						
CO4	To compare computational tools for enzyme function prediction.						

UNIT I

1. **Introduction to biocatalysis**, Current market of biocatalysis, fermentation, concept of biotransformation and advantages and limitations of biotransformation.
2. Development of chemo enzymatic processes: synthetic route design and integration of biocatalysis, chemo-enzymatic process development

UNIT II

4. **Production of Dicarboxylic Acid Using Yeasts**: Current Uses and Production of Dicarboxylic Acids, Selection and Improvement of Yeast Strains, Selection and Improvement of Yeast Strains, Metabolic Engineering Strategies for Biotechnological Production of Succinic Acid
5. **Engineering Proteases for Industrial Applications**: Proteases in Industry, Serine Proteases and Subtilisins, Engineering Subtilisin Protease toward Increased Oxidative Resistance, Increasing Protease Tolerance against Chaotropic Agents.

UNIT III

6. **Transformation of pesticides**: Accumulation of pesticide, Mechanism of pesticide transformation, enzymatic reactions in pesticide metabolism
7. Transaminases: Transaminases as a Biosynthetic Route for Chiral Amines, Kinetic Resolution of Amines Employing ATAs, Recent Advances in Industrially Relevant Asymmetric Reductive Amination Reactions, ATA Screening Kit

UNIT IV

8. **Structural Bioinformatics and Biocatalysis Research**: Computational Tools for Function Prediction and Analysis of Enzymes.
9. **Recent development in biotransformation**: current challenges and future scopes of biotransformation process, practical consideration for enhancing efficiency of biotransformation

Reference/text books

1. Green Biocatalysis edited by Ramesh N. Patel, John Wiley and Sons, 2016.
2. Biotransformation of Agricultural Waste and By-Products edited by Palmiro Poltronieri and Oscar Fernando D'Urso, Elsevier Inc, 2016
3. Applied Biocatalysis edited by Lutz Hilterhaus, Andreas Liese, Ulrich Kettling, and Garabed Antranikian, Wiley-VCH, 2016.
4. Journal of Biocatalysis and Biotransformation.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-404	Metagenomics (B.Tech. Biotechnology Semester- VIII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	-	3.0	75	25	100	3Hr
Purpose	The purpose of this course is to provide focus on next generation DNA sequencing technology and p how the metabolic functions, taxonomic distribution, diversity, evenness and species richness of microbial communities varies across environment						
Course Outcomes							
CO1	Students will become familiar with Metagenomics						
CO2	Students will be able to perform the phylogenetic tree						
CO3	Students will develop the knowledge and able to perform Metagenomic analysis of soil microbial communities						
CO4	Students will develop focus on the application of metagenomics						

UNIT -1

What is metagenomics; Types of metagenomes: Amplicon, Shotgun, Functional; Amplicon metagenomics: History, phylogenetic marker, examples; Shotgun metagenomics: History and examples. Techniques subtractive hybridization (SSH); Differential expression analysis (DEA); Microarrays & Metagenome sequencing

UNIT- II

Direct linking of microbial populations to specific biodegradation and biotransformation processes by stable isotope probing of biomarkers- PhyloChip & GeoChip-Detection of xenobiotic-degrading bacteria by using oligonucleotide microarrays

Phylogenetic analysisand Comparative genomics Software's & Tools and Construction of a metagenomic library; Analysis of Metagenomic Libraries; Sequence-based Metagenomics Analysis; Function-based Metagenomics Analysis

UNIT-III

Metagenomic analysis of soil microbial communities; Metagenomic analysis of marine microbial communities; Metagenome of the Microbial Community in Acid Mine Drainage; Metagenomic Analysis of Bacteriophage; Metagenomics and Its Applications to the Study of the Human Microbiome; Archaeal Metagenomics: Bioprospecting Novel Genes and Exploring New Concepts.

UNIT -V

Application of Metagenomics to Bioremediation; Applications of Metagenomics for Industrial Bioproducts; Escherichia coli host engineering for efficient metagenomic enzyme discovery; Next-generation sequencing approaches to metagenomics; Stable isotope probing: uses in metagenomics; DNA sequencing of uncultured microbes from single cells.

Reference/Text Books

8. Diana Marco Universidad Nacional de Cordoba, Argentina, "*Metagenomics: Theory, Methods and Applications*", Caister Academic Press,2010.
9. Diana Marco Universidad Nacional de Cordoba, Argentina "*Metagenomics: Current Innovations and Future Trends*",Caister Academic Press,2011.
10. Joanna R. Freeland, Heather Kirk, Stephen Petersen, "*Molecular Ecology*", Mc Graw Hill, 2nd Edition "2012.
11. Beebee T.J.C., D G. Rowe," *An Introduction to Molecular Ecology*", Mc Graw Hill, 2004.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-406	Molecular Modelling and Drug Design (B.Tech. Biotechnology Semester VIII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	-	3	75	25	100	3Hrs
Purpose	The course will focus on the Molecular Modelling in context of drug designing						
Course Outcomes							
CO1	To understand the critical relationship among biomolecular structure, function and force field models.						
CO2	To be able to utilize basic modelling techniques to explore biological phenomena at the molecular level.						
CO3	To emphasize Modelling drug/receptor interactions in detail by molecular mechanics, molecular dynamics simulations and homology modelling.						
CO4	An awareness of rational drug design, based on understanding the three-dimensional structures and physicochemical properties of drugs and receptors will be created.						

UNIT I

1. **Introduction to Molecular Modelling**: Introduction - Useful Concepts in Molecular Modelling: Coordinate Systems. Potential Energy Surfaces. Molecular Graphics. Surfaces. Computer Hardware and Software. The Molecular Modelling Literature.

UNIT II

2. **Force Fields: Fields. Bond Stretching**. Angle Bending. Introduction to Non-bonded Interactions. Electrostatic Interactions. Van der Waals Interactions. Hydrogen Bonding in Molecular Mechanics. Force Field Models for the Simulation of Liquid Water.

UNIT III

3. **Energy Minimisation and Computer Simulation**: Minimisation and Related Methods for Exploring the Energy Surface. Non-Derivative method, 1st and 2nd order minimisation methods. Computer Simulation Methods. Simple Thermodynamic Properties and Phase Space. Boundaries. Analyzing the Results of a Simulation and Estimating Errors. GROMACS and CNS.

UNIT IV

4. **Molecular Dynamics & Monte Carlo Simulation**: Molecular Dynamics Simulation Methods. Molecular Dynamics Using Simple Models. Molecular Dynamics with Continuous Potentials. Molecular Dynamics at Constant Temperature and Pressure. Metropolis Method. Monte Carlo Simulation of Molecules. Models Used in Monte Carlo Simulations of Polymers. Molecular Modeling software: BIOSUITE
5. **Structure Prediction and Drug Design**: Structure Prediction - Introduction to Comparative Modeling. Sequence Alignment. Constructing and Evaluating a Comparative Model. Predicting Protein Structures by 'Threading', Molecular Docking, AUTODOCK and HEX. Structure based De Novo Ligand design, Drug Discovery – Chemoinformatics – QSAR.

Reference/Text Books

1. S. Ramasamy. Molecular Modeling. Lambert Academic Publishing, USA. 2015
2. V. Magnasco. Methods of Molecular Quantum Mechanics- An Introduction to Electronic Molecular Structure. Wiley. 2009
3. A.R.Leach, Molecular Modelling Principles and Application, Longman, 2001.
4. J.M.Haile, Molecular Dynamics Simulation Elementary Methods, John Wiley and Sons, 1997.
5. S. P. Gupta. QSAR and Molecular Modeling, Springer - Anamaya Publishers, 2008.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-408	Cancer Biology(B.Tech. Biotechnology) Semester- VIII						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	0	3	75	25	100	3
Purpose	To give complete overview of cancer as a disease detailed analysis of biological changes of the tumor cells. Analyze the impact of the cell cycle (proliferation), gene mutations and apoptosis in cancer. Discuss the impact of applied/translational research in cancer diagnosis as well as the design of novel targeted therapeutic agents in the treatment of cancer.						
Course Outcomes							
CO1	Students will be able to categorize the different forms of cancer						
CO2	Students will be able to explain the genetic basis of cancer						
CO3	Students will be able to recognize the role of different proteins in cancer and their clinical significance						
CO4	Students will be able to assess/compare different diagnostic and therapy methods						

UNIT I

Fundamentals of Cancer Biology and Principles of Carcinogenesis

Overview of the hallmarks of cancer, Different forms of cancers, Diet and cancer, Natural history of Carcinogenesis, Chemical Carcinogenesis, Metabolism of Carcinogenesis, Principles of Physical Carcinogenesis, X - Ray radiation - mechanism of radiationCarcinogenesis.

UNIT II

Molecular Cell Biology of Cancer: Tumorviruses and Oncogenes, Identification of Oncogenes, Mechanismofoncogene activation, Roleofgrowthfactorsand receptorsincarcinogenesis, RASsignalingincancer

Regulation of Cell cycle, modulation of cell cycle in cancer, Tumor suppressor genes, pRbtumorsuppressor, Apoptosisandp53 tumorsuppressor

UNIT III

Principles of Cancer Metastasis: Three-step theory of Invasion,Proteinases and tumour cell, Basement Membrane disruption, The biology of angiogenesis, Metastatic cascade

UNIT IV

Detection of Cancer and Cancer Therapy: Fundamental principles behind cancer diagnosis, Advances in Cancer detection, Different forms of therapy: Chemotherapy, radiation Therapy, and Immuno therapy,Applications of omics technologies in diagnostics and treatment.

Reference/Text Books

5. Pecorino, Lauren. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. United Kingdom: Oxford University Press, 2016.

6. Weinberg, Robert Allan. The Biology of Cancer. United Kingdom: Garland Science, 2014.

7. Vincent T. DeVita Jr. MD, Theodore S. Lawrence, Steven A. RosenbergCancer: Principles and Practice of Oncology Primer of Molecular Biology in Cancer(3rd edition)

4 Oxford Textbook of Cancer Biology, edited by Pezzella, Francesco, Mahvash Tavassoli, and David J. Kerr. Oxford, UK: Oxford University Press, 2019-05. https://oxfordmedicine.com/view/10.1093/med/9780198779452.001.0001/med-9780198779452.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-410	Developmental Biology (B. Tech. Biotechnology) Semester- VIII						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	-	3.0	75	25	100	3h
Purpose	This course will help the students to understand the basic knowledge of morphogenesis and organogenesis in plants and animals.						
Course Outcomes							
CO1	Students will be able to illustrate the basic concept of development.						
CO2	Students will be able to classify Gametogenesis between plant and animal.						
CO3	Students will be able to develop the knowledge of morphogenesis in animals.						
CO4	Students will be able to develop the knowledge of morphogenesis in plants.						

UNIT -1

Basic concepts of development : Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants; imprinting; mutants and transgenics in analysis of development.

UNIT- II

Gametogenesis, fertilization and early development: Production of gametes, cell surface molecules in sperm-egg recognition in animals; embryo sac development and double fertilization in plants; zygote formation, cleavage, blastula formation, embryonic fields, gastrulation and formation of germ layers in animals; embryogenesis, establishment of symmetry in plants; seed formation and germination.

Unit –III

Morphogenesis and organogenesis in animals : Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in Drosophila, amphibia and chick, organogenesis – vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, metamorphosis; environmental regulation of normal development; sex determination.

UNIT –IV

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem; shoot and root development; leaf development and phyllotaxy; transition to flowering, floral meristems and floral development in Arabidopsis and Antirrhinum. Programmed cell death, aging and senescence.

Reference/Text Books

1. Developmental Biology byGilbert SF and Sunderland MA. 6th Edition, 2000.
2. Abu-Shaar M, Mann R S. Generation of multiple antagonistic domains along the proximodistal axis during *Drosophila* leg development. Development. 1998.
3. The Biology of Agingby Sinauer Associates, Sunderland, MA *2nd Ed 1998.*

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-412	Protein Engineering* (B.Tech. Biotechnology Semester VIII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	-	3.0	75	25	100	3 Hrs.
Purpose	To create awareness with concepts of protein engineering						
Course Outcomes: After completion of this course the students will be able							
CO1	To differentiate between secondary and tertiary structures of protein						
CO2	To demonstrate structure function relationship of membrane proteins						
CO3	To explain the concept of designed protein						
CO4	To identify protein- protein interactions.						

UNIT I

1. **Structure Function Dynamics Correlation**. Basic structural concepts – Primary, secondary, tertiary and quaternary structures. Ramachandran plot, super secondary structures – motif and domain. Protein folding and mechanisms.

UNIT II

2. **Structure Function Engineering**. The correlation of structure and function in – transcription factors, serine proteinases, membrane proteins, signal transduction proteins and recognition in immune system.

UNIT III

3. **Library Construction for Protein Engineering**: Established methods for library construction, critical methods in evaluation of library construction methods. Designed proteins, examples of designed proteins (enzymes) with enhanced stability and efficiency, playing a significant role in industries.

UNIT IV

4. **Engineering of Therapeutic Proteins**: Sources of Protein Therapeutics, Strategies for Designing Effective Protein Therapeutics, Examples of Protein Therapeutics
5. **Proteomics Application**. Mining proteomes, protein expression profiling, identifying protein – protein Interactions and protein complexes, mapping- protein identification, new directions in proteomics.

References/Text Books

1. Amit Kessel and Nir Ben-Tal, "Introduction to Protein" 2nd Edition, Chapman and Hall, 2018
2. Anton Torres Editor "Protein Engineering and Design," Syrawood Publishing House, 2017
3. Daniel C. Liebler, "Introduction to Proteomics – Tools for the New Biology," Humana Press, 2001
4. Protein Engineering and Design edited by Sheldon J. Park Jennifer R. Cochran, CRC Press, 2010

5 M.Romya and P. Ponmurugan, Protein Engineering, Narosa Publications, New Delhi, 2015

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with the syllabus.

BTE-414	Bioethics, IPR and Biosafety(B.Tech. Biotechnology) Semester- VIII						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
2	1	0	3	75	25	100	3hrs
Program Objective (PO)	Students will able to acquire knowledge of regulatory bodies ,acts and organization indulge in creating a balancing force between advent in technology with monitoring their impacts on human and ecology alongwith biosafety measures with ethical conduct to society.						
Course Outcomes							
CO1	Students will be able to describe the basic terms and procedure forIPR, patent filing and implications on society of commercialized products.						
CO2	Students will be able to learn and describe various act, policies, different organizations and guidelines for biosafety.						
CO3	Students will develop knowledge of outbreak and risk assessment and management at laboratory level along with health impacts.						
CO4	Students will develop awareness of ecological impact of release of genetically modified organisms and monitoring methods.						

UNIT -1

Introduction- Intellectual Property Rights, Copyrights, Trademarks, Trade secrets, Geographical indications, Patents, Patent Filing, Indian Patent act and amendments, Implications of intellectual property rights on the commercialization of Biotechnology products, Patented products in Market and Success story.

UNIT- II

Policies, Agreements and Organization -National biosafety policies and law, The Cartagena protocol on biosafety, Convention on biological diversity, Cross border movement of germplasm and agreements, World Trade Organization and agreements, Updated Regulatory frameworks.

UNIT-III

Biological Containment- Risk assessment, Risk management, General principal for biological containment at laboratory level, Health impact of containment issues-Allergenicity, Antibiotic resistance and Toxicology. Case studies.

UNIT –IV

Ecological Impacts-Genetically Modified organism and impact on biodiversity, gene flow, gene escape and creation of superweeds/ superviruses, Monitoring strategies and method of detecting transgenics(Radioactive /Non radioactive methods).Case studies.

Reference/Text Books

1. Padma Nambisan, An introduction to ethical safety and intellectual property rights issues in biotechnology, Academic Press,ISBN-978-0-12-809231-6, 2017.
2. Deepa Goel and Shomini Parashar, IPR, Biosafety and Bioethics, Pearson Education,India,ISBN-978933251429,2013.
3. V. Sree Krishna, Bioethics and Biosafety in Biotechnology, New age international private ltd., 2007.
4. Gerald A. Urban, BioMEMS, Springer, 2010.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with thesyllabus.

OEC-BT-418	Biomedical Electronics (B. Tech Biotechnology semester VIII)							
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Practical	Total	Time
3	-	-	3	75	25	-	100	3
Course Outcomes At the end of this course students will demonstrate the ability to								
CO1	Understand and explain the concept of biomedical signals, electrodes and instrumentation							
CO2	Understand and explain the physiological transducers and recording systems							
CO3	Understand and explain biomedical recorders and patient monitoring systems							
CO4	Understand and explain cardiac pacemakers, defibrillator and patient safety							

UNIT-I

Introduction: Role of technology in medicine, physiological systems of the body, sources of biomedical signals, basic medical instrumentation and their performance requirements, intelligent medical instrumentation systems, consumer and portable medical equipment, implantable medical devices, role of engineers in healthcarefacilities.

Bioelectric Signals and Electrodes: Origin of bioelectric signals, recording electrodes, silver- silver chloride electrodes, electrodes for ECG, electrodes for EMG, electrical conductivity of electrode jellies and creams, microelectrodes.

UNIT-II

Physiological Transducers: Definition, classification and performance characteristics of transducers, displacement, position and motion transducers, pressure transducers, transducers for body temperature measurement, photoelectric transducers, optical fiber sensors, biosensors, smartsensors.

Recording System: Basic recording system, general considerations for signal conditioners, preamplifiers, sources of noise in low level measurements, biomedical signal analysis and processing techniques, the main amplifier and driver stage, writing systems.

UNIT-III

Biomedical Recorders: Electrocardiograph, vectorcardiograph (Vcg), phonocardiograph (Pcg), digital stethoscope, electroencephalograph (Eeg), electromyograph.

Patient Monitoring Systems: System concepts, cardiac monitor, bedside patient monitoring systems, central monitors, measurement of heart rate, measurement of temperature, measurement of respiration rate, catheterization laboratory instrumentation, ambulatory monitoring instruments.

UNIT-IV

Cardiac Pacemakers and Defibrillators: Need for cardiac pacemaker and defibrillator, external pacemakers, implantable pacemakers, pacing system analyzer, DC defibrillator, implantable defibrillators, types of defibrillators, defibrillatoranalyzer.

Patient Safety: Electric shock hazards, leakage currents, safety codes for electromedical equipment, electrical safety analyzer.

Text/Reference Books:

1. R S Khandpur: Handbook of biomedical instrumentation, 3rd ed., McGraw Hill Education.
2. Joseph D. Bronzino: The biomedical engineering handbook, 2nd ed., CRCPress.

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with thesyllabus.

OEC-BT-420	Matlab&Simulation (B.Tech Biotechnology Semester VIII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	-	3	75	25	100	3 Hrs.
Course Outcomes (CO) At the end of the course students will be able to							
CO1	Write basic commands and script files in MATLAB						
CO2	Solve mathematical equations						
CO3	Create 2D and 3D analysis plots						
CO4	Design Simulink models						

UNIT I

Introduction to MATLAB: Introduction to MATLAB software, Key features, MATLAB window, Command window, Workspace, Command history, Setting directory, Working with the MATLAB user interface, Basic commands, Assigning variables, Operations with variables. Working with script tools, Writing Script file, Executing script files, The MATLAB Editor, Saving m files. Introduction to Graphical User Interface (GUI).

UNIT II

Matrix and Data files: Character and string, Arrays and vectors, Column vectors, Row vectors, Basic Mathematics, BODMAS Rules, Arithmetic operations, Operators and special characters, Mathematical and logical operators, Solving arithmetic equations, Operations on matrix, Crating rows and columns Matrix, Matrix operations, Finding transpose, determinant and inverse, Solving matrix, Trigonometric functions, Complex functions. Writing user defined functions.

UNIT III

2D and 3D Plots: Plots: Plotting vector and matrix data, Plot labelling, curve labelling and editing, 2D Plots: Basic Plotting Functions, Creating a Plot, Plotting Multiple Data Sets in One Graph, Specifying Line Styles and Colors, Graphing Imaginary and Complex Data, Figure Windows, Displaying Multiple Plots in One Figure, Controlling the Axes, 3D Plots: Creating Mesh and Surface, About Mesh and Surface Visualizing, Subplots.

UNIT IV

MATLAB Programming and Simulink: Automating commands with scripts, Writing programs with logic and flow control, Writing functions, Control statement Programming, Conditional Statement Programming, Control Flow Conditional Control — if, else, switch, Loop Control — for, while, continue, break, Program Termination — return. Introduction to Simulink, Simulink Environment & Interface, Study of Library, Circuit Oriented Design, Equation Oriented Design, Model, Subsystem Design, Connect Call back to subsystem, Application.

Text and Reference Books/Material:

1. Marvin Marcus, Matrices and MATLAB: A Tutorial, Prentice Hall , 2010
2. MATLAB Primer by MATHWORKS:
   http://www.mathworks.com/help/releases/R2014b/pdf_doc/matlab/getstart.pdf

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with thesyllabus.

OEC-BT-422	History of Science (B.Tech Biotechnology semester VIII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	-	3.0	75	25	100	3 Hr
Purpose	The purpose of this course is to aware the students about development of science in India						
Course outcome : After completion of this course the students will be able							
CO 1	To articulate the scope and importance of science and technology in development of society.						
CO2	To appreciate the development of science and technology in Ancient India.						
CO3	To explain the development of science and technology in Medieval India.						
CO4	To appreciate the Policy development in the field of science and Technology.						

UNIT-I

Concepts and Perspectives: Meaning of History Objectivity, Determinism, Relativism, Causation, Generalization in History; Extent of subjectivity, contrast with physical sciences, interpretation and speculation, concept of historical inevitability, Historical Positivism.

Science and Technology-Meaning, Scope and Importance, Interaction of science, technology & society, Sources of history on science and technology in India.

UNIT-II

Science and Technology in Ancient India: Technology in pre-historic period, beginning of agriculture and its impact on technology, Science and Technology during Vedic and Later Vedic times.

UNIT-III

Science and Technology in medieval India: Legacy of technology in Medieval India, Interactions with Arabs, Astronomy and Mathematics: interaction with Arabic Sciences, Science and Technology on the eve of British conquest

UNIT-IV

Science and Technology in a post-independent India: Science, Technology and Development discourse Shaping of the Science and Technology, Policy Developments in the field of Science and Technology, Social implications of new technologies like the Information Technology and Biotechnology

Reference/Text Books

1. M. Bhardwaj "History of science and Technology in Ancient India" Publisher Bookwin, 2010
2. Bal Ram Singh, Nath Girish and Umesh Kumar Singh " Science and Technology in ancient Indian Text, D.K.Print world, 2012
3. Kamlesh Mohan "Science and Technology in Colonial India, Aakar Publisher, 2014

Note: The Examiner will be given the question paper template and will have to set the question paper according to the template provided along with thesyllabus.

OEC-BT-424	Internet of Things (B.Tech. Biotechnology Semester VIII)						
Lecture	Tutorial	Practical	Credit	Major Test	Minor Test	Total	Time
3	0	-	3.0	75	25	100	3 Hrs
Purpose	To familiarize students about basics of Internet of Things						
Course Outcomes							
CO 1	Understand what IoT technologies are used for today, and what is required in certain scenarios.						
CO2	Understand the types of technologies that are available and in use today and can be utilized to implement IoT solutions.						
CO3	Understand the type of protocols and challenges for designing IoT systems.						
CO4	Apply these technologies to tackle scenarios in teams of using an experimental platform for implementing prototypes and testing them as running applications. Understand operating system requirements of IOT.						

UNIT 1

Introduction to IoT: Defining IoT, Characteristics of IoT, Functional blocks of IoT, Physical and logical design of IoT, Smart cities and IoT revolution, ,Difference between IoT and M2M, M2M and peer networking concepts Ipv4 and IPV6, Software Defined Networks SDN,

UNIT 2

Developing IoTs: IoT design methodology, case study on IoT system for weather monitoring. IoT system Management,
Developing IoT applications through embedded system platform: Introduction to sensors, IoT physical devices and endpoints, Raspberry pi, Raspberry pi interfaces, Arduino, arduino interfaces.

UNIT 3

Protocols for IoT- messaging protocols, transport protocols, Ipv4, Ipv6, URI, Cloud for IoT: IoT with cloud, challenges, introduction to fog computing, cloud computing,
Challenges in IoT: Design challenges, development challenges, security and legal considerations.

UNIT 4

Logic design using Python: Introduction to python, data types, data structures, control flow, functions, modules, file handling and classes., implementing IotT concepts with python, Applications of IoT, Connected cars IoT Transportation, Smart Grid and Healthcare sectors using IoT,

References/Text Books:

1) A Bahaga, V. Madisetti, "Internet of Things- Hands on approach", University press, 2014.
2) S.K.Vasudevan, A.S.Nagarajan, "Internet of Things", Wiley, 2019.
3) CunoPfister, "Getting started with Internet of Things", Maker Media, 1st edition, 2011. Samuel Greenguard, "Internet of things", MIT Press, 2015.

Web resources:

1) http://www.datamation.com/open-source/35-open-source-tools-for-the-internet-of-things-1.html
2) https://developer.mbed.org/handbook/AnalogIn
3) http://www.libelium.com/50_sensor_applications
4) M2MLabs Mainspring http://www.m2mlabs.com/framework Node-RED http://nodered.org/